

**COORDINATING TECHNICAL COMMITTEE**  
**ANNUAL REPORT**  
**2009**

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(From June 2009)

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## 1 Executive Summary

### ***CTC Actions in 2009***

#### ***... improved performance of the TCs***

The monthly telephone conferences among CTC members, several EFONGA board meetings and the three traditional CTC business meetings which took place on January 30, 2009 in St. Petersburg, Russia, on June 2, 2009 in Vancouver, Canada and on October 29, 2009 in Venice, Italy, focused on the:

- organization of special events, such as expert workshops and the initiation of new actions,
- reorganization of CTC meetings by splitting them into technical and business sessions,
- preparation for the reorganization of the clusters,
- discussions on financing future activities such as expert meetings without support from EFONGA,
- monitoring the work and output of the TCs,
- motivating and supporting the TCs to improve the quality and effectiveness of their work.

The careful evaluation (review process of reports and output) and constructive feedback to the chair persons of the individual technical committees combined with a better monitoring of their deliverables resulted in an **improved work quality** of the TCs and an increased visibility of their actions and output. Furthermore, TC's were asked to prepare websites, several TC's present their programs and output on website accessible through: [www.icglass.org](http://www.icglass.org). Over a period of four years, the well established process, which is based on rules agreed by the CTC and TC chairs, has resulted in a continuous increase in the number of high quality reports. In 2008, 15 TCs out of 24 TCs were ranked at the top level for their performance, the highest number since the process was started.

... three new TCs are initiated

In the R&D activity field "Basics and Properties", three groups were officially created as Technical Committees, namely

- "Structure-Property Relations" (TC22) chaired by Georges Calas
- "Structure & Vibrations" (TC26) chaired by Bernard Hehlen
- "Atomistic Simulation" (TC27) chaired by John Mauro

... **Turner Award**

The WES Turner Award 2009 was presented in Vancouver to Wolfram Höland for manifold valuable actions in the ICG.

### ***ICG Glass Technology Roadmaps***

#### ***... new tool for future ICG direction***

Clear predictions on future needs in the field of glass science, glass technology and innovative applications of glass are difficult - but they are essential in particular in focusing future R&D efforts and ICG directions for congress topics and expert meeting and defining new technical committees. One of the most promising tools for the ICG is

the **expert meeting** that focuses on **trends** in different fields to create clearer pictures (roadmaps) and more precise perspectives on important topics for the glass community. Since the start of the roadmapping activities at ICG2007 in Strasbourg, France and the successful workshops in 2008 in Brig, Switzerland on “Advanced Materials and Innovative Glass Melting Technology in the Year 2020” the procedure and the technique has matured and is more accepted in the glass community.

In 2009, the following meetings were organized (under the auspices of the ICG and supported by EFONGA) with the aim of creating new roadmaps and improving existing ones:

- Expert meeting on “**Advanced Sensors and Process Control**” on 8. January 2009 in Offenbach Germany, guided by TC15,
- Expert meeting “**Glass Surface and Stress Corrosion Mechanism on Nanoscale**”, Montpellier, France, February 22 - 25, 2009,
- Expert panel “**Biomaterials Brig II**”, Schaan, Liechtenstein, February 27, 2009,
- Workshop on “**Glass and Entropy II**”, Aberystwyth, UK, April 22 - 24, 2009,
- EFONGA Workshop “**Summary and Roadmaps**”, Montpellier, France, May 6 - 8, 2009 with satellite expert panels on “**Glass Structure - Property relationships**”, “**Bioglass**” on May 7, 2009 and “**Material Design by Computation**” on May 6, 2009, and sessions on “**Innovation in Glass Melting**”,
- A meeting in Istanbul in co-operation with Glass Trend and TC18, TC14 and Şisecam on: “**Glass Melt Quality and Glass Defects**”, on 12 - 13 May 2009,
- CTC Tech meeting on “**R&D activity fields**”, Vancouver, June 1, 2009,
- Joint **ICG-PDA workshop** on “**The Future of Glass as Parenteral Primary Packaging: Issues and Challenges**”, Venice, Italy, October 26, 2009

The results indicated missing R&D platforms in the ICG and initiated new TCs. Reports and powerpoint presentations of the workshops are available at [www.icglass.org](http://www.icglass.org) and will be summarized in an ICG booklet.

### **ICG Glass Courses**

*... lectures attract many young scientists*

In 2009, the Technical Committee on “**Education & Training in Glass Science & Engineering**” (TC23) increased the visibility of the ICG among students and younger scientists in the field of glass by offering two special events:

- ICG/EFONGA “**Spring School on Glass Structure - Property Relationships**”, Montpellier, France, May 4 - 5, 2009 and
- ICG “**Tutorial on Thermodynamics & Chemical Technology in Glass Melting**”, Vancouver, June 2009

In addition, an ICG Training Team list (“rent a Prof”) was prepared, and includes 15 teachers that can offer training courses in different fields of glass.

### **Technical Committees (TCs)**

*... new young TC chairs installed in 2009*

In addition to the three chairs of the new TCs (see above), two new TC chairs took over existing TCs:

- Julian Jones, “**Glasses for Medicine and Biotechnology**” (TC04),
- Russell Hand, “**Mechanical Properties of Glass**” (TC06)

*... very active core groups within the TCs generated various highlights*

Please look for details in Section 2.

### **ICG annual meeting**

#### **... an excellent platform with busy days**

The core event of the year was the ICG annual meeting which took place in Vancouver from May 30 to June 6, 2009 in conjunction with the PACRIM meeting. 250 participants from 35 countries joined the ICG/GOMD symposium and had submitted 200 papers. During the opening session of the meeting, the **current and future activities of the TCs** were presented. In addition, various sessions of the congress were organized in co-operation with the TCs and the TC chairs chaired some of these sessions. For the first time, the CTC meeting was split into two parts, a business meeting and a technical meeting, the second being attended by the TC chairs.

### **EFONGA**

#### **... final actions and conclusions**

In the last five months of the project, several expert meetings and a spring school, all already presented above, were conducted. During these expert meetings, roadmaps for different fields were generated. The project finished at the end of May. A final report was prepared.

### **Plan 2010**

#### **... various actions are in the pipeline**

- Several topical sessions will be organized by the TCs at the XXIIth ICG Congress in Brazil,
- An ICG summer school will be held in Montpellier in July 2010,
- CTC business meeting in Mainz, Germany, on March 11,
- CTC Technology meeting and business meeting in Brazil (September 2010),
- A textbook “**Bio-glass: an Introduction**” will be published,
- An expert meeting on Glass Surfaces will be organized,
- A summary of roadmap activities from 2007 to 2009 will be published (in co-operation with Fraunhofer ISI),
- New project applications to the EC (COST program) are in preparation,
- A workshop on advanced sensors and process control, in combination with the roadmap process, will be organized.

## **2 Summary of R&D Activity Fields & TC Activities**

### **2.1 BASICS AND PROPERTIES**

#### Coordinator: R. Vacher

*The main lines of activities in this field are:*

- *Increasing understanding of the mechanisms of glass formation (TC08), glass stability and recrystallization (TC07), and of the microscopic structure of glasses (TC03, TC26, TC27),*
- *Improving the physical and chemical properties of glasses: chemical durability (TC02), mechanical (TC06), and optical properties (TC10),*
- *Understanding the structure-properties relationship (TC09, TC22).*

The highlights in this field were:

- **New TCs:** Basic glass science is one of the important axes that we want to develop. Three new TCs were created in this direction. The main goal of TC27 “**Atomistic simulation**” is to increase our knowledge of the microscopic structure of glass by numerical simulations. TC26 “**structure and vibrations**” concentrates on the investigation of the glass structure at the nanometric scale by analysis of the vibrational spectra, and also on the understanding of collective vibrations in glasses. TC22 aims at defining more precisely “**Structure-property relationships**”.
- **Expert meetings:** Meetings of experts to clarify the state of the art and define the important future actions on important problems in glass technology and production are essential to get a clearer picture of the development of the glass industry. TC09 was one of the main organizers of the workshop on “**Glass Surface and Stress Corrosion Mechanism on Nanoscale**”, held in Montpellier, France, in February 2009. TC08 organised the “**Workshop on Glass and Entropy II**” in Aberystwyth, UK, in April 2009. TC02, TC07, TC08, TC09, TC10, and the group subsequently forming TC27 were among the organizers of the EFONGA Workshop “**Summary and Roadmaps**”, which took place in Montpellier, France, in May 2009.
- **New directions:** A new research focus on the **crystallization of complex multi-component glass forming systems** has been implemented (TC07). A trend to more fundamental work to understand the underlying science is apparent (TC02, TC06 and TC10).

Joint actions of TCs

- a summary on the **fundamental crack propagation mechanism** was produced in 2008, and followed up by a workshop on “**Glass Surface and Stress Corrosion Mechanism on Nanoscale**” in 2009 (TC09 in collaboration with TC19)
- The EFONGA Workshop “**Summary and Roadmaps**” involved more than 10 TCs.
- Inside the frame of the EFONGA project, TC01, TC02, TC08, TC09, TC10, and TC23 organized the “**Spring School**” held in Montpellier, France, in May, 2009.

## 2.2 GLASS PRODUCTION

Coordinator: Ruud Beerkens

*Within the field of glass production, the technical committees focused on industrial glass melting, forming processes, and environmental issues of glass production (TC13).*

*This field includes:*

- *melting processes with focus on properties of glass forming melts and an increased focus on industrial energy efficient and environmentally sound melting processes (TC18),*
- *the application of sensors and advanced process control in glass furnaces and development of a roadmap for sensor developments (TC15),*
- *materials used for glass melting processes, focus on refractory - glass melt interaction and REACH (TC11),*
- *glass quality issues related to bubbles and dissolved gases in glass and analytical methods for gases in glass and bubble compositions (TC14),*
- *development of tools to simulate industrial glass melting processes by mathematical (CFD) models and validation of modeling software (TC21),*
- *comparison and testing simulation tools to describe important glass forming processes such as glass fiberizing, pressing and blowing processes (TC25),*

- *environmental aspects of industrial glass production with the focus on gaseous and particle emissions from glass furnaces and new legislations on emissions (TC13)*

TC11 and TC14 worked together in projects concerning formation of bubbles (blisters) at refractory surfaces in contact with molten glasses. TC18 communicates with most other TC's in the cluster to organize seminars and topical workshops in order to prepare roadmaps for innovation and developments in the fields of:

- Innovative glass melting concepts,
- Alternative raw materials and fast melting raw material batches / batch pretreatment,
- Recovery of energy from waste heat of glass production processes,
- Advanced sensors and Process Control in Glass Industry

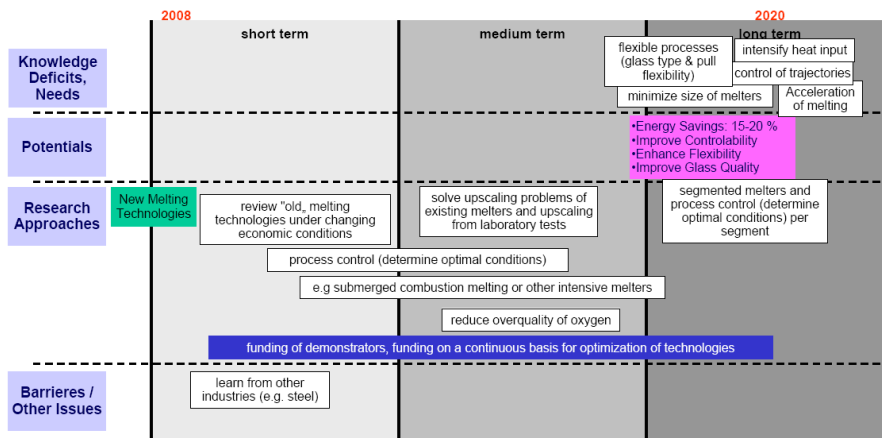


Fig. 2.2.1: Working document on new melting technologies

A Follow-up (from the BRIG expert meeting) meeting was organized on 8. January 2009 in Offenbach, Germany to discuss future activities for sensor development. It was decided to organize an international seminar (2-days) on Advanced Sensors and Process Control in the Glass Industry in 2009 or 2010. Probably the seminar will be organized in Maastricht, The Netherlands in Fall 2010.

A workshop on **Glass Melt Quality and Glass Defects** was organized in Istanbul on April, 13-14, 2009 (a co-operation between TC14, TC18, Glass Trend and Şisecam).

A report on method to determine the availability of glass constituents with regard to the European regulation REACH was prepared (TC13). This report will be published in an international journal and will be used for the exemption of glass types under REACH

A study on particle size distributions of dust in flue gases of glass furnaces was reported (TC13). A paper was presented at the 70<sup>th</sup> Conference on Glass Problems in Columbus Ohio at October 13-14, 2009: **Particle size measurements in the flue gas of glass melting furnaces**

The tutorial on “Thermodynamics & Chemical Technology in Glass Melting” in Vancouver on June 3, 2009 was supported by TC18 with a presentation on Fining Processes and Combustion Processes in Glass Furnaces.

The Round Robin test number 5 on modeling TV glass melting furnace and validation of modeling results with experimental data was continued (TC21)

A seminar on advanced sensors and process control is in preparation (TC15), probably for 2010 as an expert meeting and roadmap workshop.

TC13 supported, by studies on dust emissions and leaching of metals from glass, the legislation processes in the European Union of REACH and IPPC - Glass BREF. In the Glass BREF the Best Available Technologies for Integrated Pollution Prevention and Control are described for the glass industry.

## 2.3 SURFACES AND INTERFACES

*Coordinator: Klaus Bange*

*The R&D Activity Field “Surfaces & Interfaces” clusters the work of the TCs which develop thin films on glasses, investigating nanoscale phenomena with focus on surfaces and interfaces, supply input and support to standardization committees including CEN and ISO, and establish the most efficient, respective characterization technique for added value topics on glasses and films.*

The TC **Nanostructured Glass (TC16)** is working on glasses and coatings obtained by chemical nanotechnology. The main activities concentrated on: (1) finishing the EFONGA project ; (2) launching new activities. The new activities have been related to the study of sol-gel derived **nanostructured coatings for energy savings in buildings**, where some results have already been obtained by TC members working in Lisboa, Madrid and Padua. Some of the members of TC16 participated in a few meetings in 2009, namely two TC meetings in February (at ICV, in Madrid) and in August (during the Sol-gel 09 Conference in Porto de Galinhas, Brazil), plus the EFONGA Spring School and Workshop in May (in Montpellier). Some of the TC members also participated in the Pac-Rim conference in June (Vancouver), where TC16 organized a half-day **session on Nanostructured Glasses**.

The TC **Coatings on Glass (TC24)** proposes or executes necessary and important actions aimed at technical and industrial developments in the field of coatings on glass. The main areas of activity have been based around:

- self cleaning / reduced maintenance coatings,
- testing of pyrolytic coated transparent conductive oxide films (TCO).

The discussion on **self cleaning / reduced maintenance coatings** focused ongoing activities on the draft standard developed so far. A draft standard test was presented for consideration by CEN TC129 during the year. An agreed note was prepared and submitted into CEN TC129 who have kindly acknowledged receipt and have agreed to keep the ICG TC24 committee abreast of developments. The committee have also agreed to approach TC24 about further scientific evaluation work related to the standard which could be required. The standard will now be driven forward by CEN TC129.

Commercial available **TCO samples** were tested with a wide range of properties. Following the initial round robin, the committee highlighted significant variations in



measurements had been obtained by the institutes involved. Following evaluation of the results an expanded round robin tests has been established using a single layer transparent conductive oxide. It is hoped that this will confirm the key variability which influenced the round robin accuracy was related to film thickness measurement. Samples of the new TCO are now under evaluation at a range of sites. Results of this evaluation will be used to determine the next steps.

The TC **Glass Surface Diagnostics (TC19)** established the best and most effective methods of characterization of the topology, chemical composition and reactivity of surface and sub-surfaces of glass down to nanometer scale. In cooperation with TC09, TC19 organized an expert panel on "**Glass surfaces and stress corrosion mechanisms at the nanoscale**" on February 22-25, 2009 in Montpellier. Fifteen international experts with very special knowledge related to surfaces and strength of glass presented topics in their field of expertise. The discussions were focused on future aspects and resulted in a roadmap-report. In addition a **XRD-round-robin** was started, which deals with the determination of the **crystalline composition, glass/crystalline ratio** as well as the **lattice parameters** of glass ceramics using XRD. The status of this activity is available in a report.

Due to travel restrictions caused by the worldwide financial crisis the number of no TC meetings was fairly limited (in particular for TC19 and TC24) and the interaction of the members was mainly organized via Telecon and Email.

## **2.4 NEW APPLICATIONS**

Coordinator: R.K. Brow

*This research cluster includes technical committees concerned with the properties and performance of specialty glasses designed for a variety of applications. In many ways, these properties are much more important than product cost, and issues related to large-scale manufacturing processes are generally not a significant priority.*

Each of the three technical committees in this cluster were active, each with at least one business/technical meeting in 2009 in conjunction with the PacRim/ICG meeting in Vancouver, and each developing some collaborative activity within the respective TC.

The Technical Committee **Glasses for Medicine and Biotechnology (TC04)** initiated a round-robin test to construct a protocol and to assess the applicability of the protocol for the testing of bioactivity of glasses and their variants. Commercial glasses provided by five companies will be evaluated by up to ten labs. In addition a publisher for the textbook "**Bio-glass: an Introduction**" has been identified. The deadline for delivering the chapters to the publisher is February 2010.

The Technical Committee on **Nuclear and Hazardous Waste Vitrification (TC05)** completed the the round-robin evaluation of the liquidus temperature of model waste glasses. Five of the eight participating laboratories have already submitted their analyses and when the remaining results are received in early 2010, they will be used to adopt a new ASTM standard. In addition a symposium on **Glasses and Ceramics for Nuclear and Hazardous Waste Treatment** was organized for the PacRim/ICG meeting.

The Technical Committee **Glass for Optoelectronics (TC20)** organized a symposium on **Glasses for Optoelectronics and Optical applications** at the Meeting "Innovations in Glass Science and Technology" at the PacRim/ICG Meeting.

## 2.5 INFORMATION, COMMUNICATION, EDUCATION, HISTORY

Coordinator: J M Parker

*As other parts of this Annual Report demonstrate, the ICG is a vital player within the glass community, bringing together scientists and technologists from Industry, Academia and Research Institutes to share, discuss and solve common issues. This happens within its technical committee structure and via the conferences and congresses it sponsors. **Effective communications and information systems are needed to ensure that, on the one hand, the outcome of these deliberations enrich the wider community and that, on the other, the best workers are attracted to participate in these activities. TC01, TC12 and TC23 are particularly involved in these roles although many others within the ICG also play their part, particularly the Management Board, Steering Committee, CTC and the TC chairs. TC17, another important TC within this cluster, is rooted in glass history and brings aspects of Art and Archaeology to the ICG.***

Specifically TC01 is charged with maintaining a record of the CTC activities by minuting the meetings it holds. A record of TC activity is produced in the form of an Annual Report by the CTC Chair who has introduced major improvements in the quality and hence the value of this document. Much of this information is also published on the ICG web site, which also reports newsworthy developments as they happen. The importance of the latter media in communications is demonstrated by the rising traffic experienced by the site - a **tenfold increase in downloads** in four years, with **17000 visitors** in the last year. The maintenance of a record of ICG committee members, in the form of a database and as a leaflet listing key officers with their contact details, is also a key activity and requires updating annually. TC23 continues its work on a database of Universities involved in teaching Glass and interest is growing in the updating of its bibliography, now some 10 years old. As part of the process of record keeping an update to the ICG History book, last produced at the end of last millennium, is planned.

The EFONGA project finished in May 2009. As a concluding action TC23 ran a very successful 2 day workshop in Montpellier, France for young scientists in 2009 on the theme of Glass-Property relationships and, with the agreement of the CTC, has resolved to continue to organise such events, but to make them slightly longer and with a more focussed approach. TC23 also ran a half day workshop at the ICG Annual Meeting in Vancouver in June 2009 entitled **Tutorial on Thermodynamics & Chemical Technology in Glass Melting**. Another valuable TC23 activity has been the generation of a list of teachers available to offer technical courses in Glass Technology throughout the world; this now has 15 members.

This cluster has also taken on the role of publicising those attributes of glass, which can make a major contribution to solving the wider issues facing society: e.g. **sustainability and climate change**. TC12 (Glass for a Sustainable Society) is developing this role on an international scale by aiming to communicate the positive aspects of glass products to all stakeholders, especially those in a position to influence national policy. The committee membership is growing and 9 members met jointly with TC13 in Lyon on 13<sup>th</sup> May at the Glassman Exhibition; individual members participated the ICG Annual Meeting in Vancouver and final EFONGA meeting in Montpellier. They are developing their own web site and have recently included a section on environmental improvements related to automotive glass. Members see the potential for glass promotion but have expressed concern about resources. They are also sensitive to the very different priorities throughout the world where “sustainability” is concerned. In 2010 they aim to: provide

links to sites providing LCAs for container and flat glass, seek funding for promotional activity, and encourage members and specialists to participate in relevant events where the environmental benefits of glass can be promoted.

Another central theme within this cluster is that of **History and Art**. The purpose of TC17, unchanged since its inception in 1982, is to bring together glass scientists, archaeologists, museum curators, and conservators to discuss research on early glass and glassmaking, and on the conservation of historical glass objects. It also aims to stimulate and encourages glass scientists and historians in developing countries. Recent, valuable work by this committee has been to publish **two books** thought to be the first ever devoted to the study of glass found along the Silk Road.

The future for the glass community holds many exciting challenges. At one extreme these include the top-heavy age structure of the workforce in the glass industry in many developed countries that will require an increasing output from academia of enthusiastic, bright students educated in areas appropriate to the needs of the glass industry. At another extreme they involve a full, informed analysis of the positive roles that glass can play in a society where energy and raw materials are diminishing resources. For the ICG to play its role in solving these challenges requires the **maintenance of communication systems** that allows the ICG to operate efficiently, and its participants to develop clear insights into the most effective routes to achieve their aspirations.

- **Workshop on structure-property relationships** in Montpellier attended by over 60 young scientists and a **Tutorial on Thermodynamics & Chemical Technology in Glass Melting** at the Annual ICG Conference in Vancouver, Canada (TC23),
- A **doubling of the rate of information downloads** during the year from the ICG web site, exceeding 1Gb per month for the first time and with over 10 000 unique visitors (TC01),
- Paper on “**Glass: a small part of the climate change problem, a large part of the solution**” (TC12),
- Growing membership of TC12,
- Publication of **two books** thought to be the first ever publications devoted to the study of glass found along the Silk Road (TC17)

### 3 Organizational issues

The following table depicts the current situation (Dec. 2009) for members of the CTC and chairs of the TCs.

CTC/Coordinator/ TC	Name	2008	2009	2010	2011	2012	2013	2014
CTC-chair	R. Vacher		Start			1st TE		
CTC-Vice Chair								
CTC-Secretary	J. Parker				TE = term ends			
CTC	V. Rupertus		Start			1st TE		2nd TE
CTC	G. Albayrak		1st TE		2nd TE			
CTC	R. Brow			1st TE		2nd TE		
CTC	J. Qiu			1st TE		2nd TE		
CTC	J. Matsuoka			1st TE		2nd TE		
Information	J. Parker							
Basics & Properties	R. Vacher							
Interfaces	V. Rupertus							
Melting	R. Beerkens							
New Applications	D. Brow							
TC01	J. Parker			1st TE				
TC02	D Brochodt		1st TE					
TC03	J. Zw anziger (acting)							
TC04	J. Jones		Start			1st TE		
TC05	J. Marra		1st TE			2nd TE		
TC06	R. Hand		Start			1st TE		
TC07	E. Zanutto			2nd TE			3rd TE	
TC08	L. Wondraczek	Start			1st TE			
TC09	M. Ciccotti	Start			1st TE			
TC10	C. Anderson		2nd TE			3rd TE		
TC11	M Dunkl	Start			1st TE			
TC12	J. Stockdale	Start			1st TE			
TC13	G. van Marcke			2nd TE			3rd TE	
TC14	D. Koepsel	1st TE			2nd TE			
TC15	W. Linz		2nd TE			3rd TE		
TC16	R. Almeida			1st TE			2nd TE	
TC17	S. Koob			2nd TE			3rd TE	
TC18	R. Beerkens (a)		3rd TE					
TC19	V. Rupertus		2nd TE			3rd TE		
TC20	S. Tanabe	2nd TE			3rd TE			
TC21	E. Muijsenberg	Start			1st TE			
TC22	G. Calas		Start			1st TE		
TC23	R. Conradt			1st TE			2nd TE	2nd TE
TC24	K. Sanderson	Start			1st TE			
TC25	C. Berndhäuser		3rd TE					
TC26	B. Hehlen		Start			1st TE		
TC27	J. Mauro		Start			1st TE		

In 2009, three new Technical Committees had been installed which are:

- “Structure-Property Relations” (TC22)
- “Vibrations & Structure” (TC26)
- “Atomistic Simulation” (TC27)

The following CTC members started their **first 3-year term** in 2009:

- René Vacher (CTC Chair)
- Volker Rupertus (CTC)

The following 5 chairs started their **first 3-year term** in 2009:

- Julian Jones (TC04)
- Russell Hand (TC06)
- Georges Calas (TC22)
- Bernard Hehlen (TC26)
- John Mauro (TC27)

The **second term** started in 2009 for:

- Gulcin Albayrak (CTC)
- Dominique Brochot (TC02)
- James Marra (TC05)

The **third term** started in 2009 for:

- Charles Anderson (TC10)
- Winfried Linz (TC15)
- Volker Rupertus (TC19)

In 2009, Klaus Bange finished his second term as **CTC Chair** and decided to stop this activity. During his five years work, he was the major actor of very important improvements in the ICG activity: experts meetings, roadmaps, Speed project, CTC monthly telephone conferences, revision of the constitution. We gratefully acknowledge his invaluable contribution. We are also very happy that he agreed to continue helping the coordination of the TC work, and to participate in the work of the MB and of the CTC.

We gratefully **acknowledge** the very valuable contributions of:

- Matteo Ciccotti and Volker Rupertus for the very active expert meeting held in Montpellier.
- Lothar Wondraczek who organized the second Glass and Entropy workshop in Aberystwyth.
- John Parker and Reinhard Conradt for the excellent and very attractive Spring School organized in Montpellier.

For 2010, **decisions** on the following persons/functions have to be prepared:

- Following Officers have agreed to continue: R. Brow, J. Qiu and J. Matsuoka in the CTC, J. Parker, E. Zanutto, G. van Markle, R. Almeida, S. Koob, and R. Conradt as TC Chairs.
- In 2010 successors have to be selected and installed for Ruud Beerkens, Dominique Brochot and Christoph Berndhäuser.

For several years, the ICG travel budget has been significantly under-spent. Therefore, no table of grants to individual TCs will be published in the future. For 2010 the budget will be spent by allocating funds to

- activities which increase the quality of the work in the ICG
- the production of high quality ICG reports
- the organization of expert meetings
- the production of ICG PR material.

All TC chairs can apply for funding by submission of a list clearly describing their planned activities and the deliverables. The decisions will be made in the monthly teleco of the CTC.

## 4 Activities of the Technical Committees in Detail

### 4.1 R&D ACTIVITY FIELD “BASICS & PROPERTIES”

#### 4.1.1 BASIC GLASS SCIENCE (TC03)

<b>Chairman:</b>	<i>Josef W. Zwanziger (interim), Dalhousie Univ., Halifax, Canada</i>
<b>Vice-Chair:</b>	<i>Akira Takada, Asahi Glass, Japan</i>
<b>Secretary:</b>	<i>Natalia M. Vedishcheva, Inst. Silicate Chem., Russia</i>
<b>Members:</b>	<i>Rui Almeida, Inst. Superior Técnico, Lisboa, Portugal</i>
	<i>Alastair N Cormack, NYS College of Ceramics, USA</i>
	<i>Doris Ehrt, Otto-Schott-Institut, Germany</i>
	<i>Giuseppe Dalba, Univ. Trento, Italy</i>
	<i>Steven A. Feller, Coe College, USA</i>
	<i>Ulrich Fotheringham, Schott, Germany</i>
	<i>Ondrej Gedeon, Inst. Chem. Technol., Czech Repub.</i>
	<i>Efstratios I. Kamitsos, Nat. Hellenic Res. Found., Greece</i>
	<i>Marek Liška, Inst. Inorg. Chem., Slovak Repub.</i>
	<i>Qiming Liu, Wuhan University of Technology, China</i>
	<i>Oleg Mazurin, Thermex, Russia</i>
	<i>I. Yu. Mikhailenko, Chem. Technological Inst., Russia</i>
	<i>Francisco Muñoz, Instituto de Cerámica y Vidrio, Spain</i>
	<i>Hiromichi Takebe, Kyushu University, Japan</i>
	<i>René Vacher, Univ. Montpellier, France</i>
	<i>Adrian Wright, Univ. of Reading, UK</i>
	<i>Lothar Wondraczek, Corning Europe, France</i>
	<i>Edgar Zanotto, Fed. Univ. São Carlos, Brazil</i>

#### SUMMARY

While TC03 participation in meetings, production of scientific manuscripts, and generation of significant activities were all strong in 2009, the overriding event for the group was the creation of new TC's at the 2009 PacRim meeting with mandates that somewhat overlap the original Basic Glass Science TC. Due to frustration over these events Adrian Wright resigned as TC03 Chair after having served many years in this capacity, but we are pleased that he is still active within the TC. Josef Zwanziger agreed to serve as Interim Chair, a position which will continue until the 2010 ICG meeting in Brazil.

The CTC leadership made it clear that they felt that the Basic Glass Science mandate was too broad and was not being properly served by the TC. This led to extensive discussion amongst the TC03 members, with the consensus being reached that Glass Structure is probably a reasonable replacement mandate that could be focused on more profitably. It will be very important in the first half of 2010, before the ICG meeting, to finalize a proposal for the CTC and ICG board for the new title and aims of TC03.

#### **PLANS AND DELIVERABLES FOR 2009**

- 8<sup>th</sup> PACRIM Meeting, Vancouver, May 2009: TC03 members were active at this meeting, which included a TC03 membership meeting, and organizing several symposia sessions (Symposium 23, Glass Science, organizers Wondraczek, Wright, and Zwanziger, along with Pierre Lucas and Klaus Bange)
- 12<sup>th</sup> Physics of Noncrystalline Solids Meeting, September 2009, Iguassu Falls, Chaired by TC03 and TC07 Member Edgar Zanotto, with TC03 members on the International Advisory Board Adrian Wright, Doris Ehrt, Josef Zwanziger, Marek Liska, Natalia Vedisheva, Rui Almeida
- NMR Round Robin, organized by Josef Zwanziger

#### **ACTIVITIES in 2009**

The 8<sup>th</sup> PACRIM Conference on Ceramic and Glass Technology was held in Vancouver in 2009, and TC03 members organized several sessions focused on different aspects of Basic Glass Science. These included Structural Basis of Glass Properties, Glass Surfaces and Nanostructured Glass, Glass Formation and Relaxation Processes in Glass, and Glass in Canada. This last symposium is notable because it marked the formal (re)introduction of Canada as a member nation of ICG, which was approved at the end of 2008. TC03 members closely involved with this organization included Adrian Wright, Lothar Wondraczek, Josef Zwanziger, Akira Takada, and Rui Almeida. In addition at this conference a formal TC03 meeting was held, probably the last under the "Basic Glass Science" name.

The 12<sup>th</sup> Physics of Noncrystalline Solids Meeting in Iguassu Falls, Brazil, in September 2009 was organized by TC03 and TC07 member Edgar Zanotto, with many TC03 members on the international advisory board. At this meeting talks amongst the TC03 members present began in earnest as to the suitable future definition of TC03, given the CTC changes implemented at the Vancouver Pacrim meeting. In addition, formal plans for collaborative work between TC03 and TC07 on the structural basis of glass crystallization were discussed.

Concerning the NMR Round Robin, the point of this work is to establish the precision with which standard NMR parameters, such as the fraction of four-coordinate boron, can be determined using solid-state NMR. This method has become rather wide-spread but is not without its pitfalls. The experiment is proceeding by distributing blocks of glass cut from the same large, monolithic samples prepared by Schott in Jena and supplied by TC03 member Doris Ehrt. Josef Zwanziger has distributed these samples to a variety of well-known solid state NMR labs for independent analysis; when the results have been returned this will lead to a paper reporting the precision to be expected in glass science for standard methods of NMR analysis.

## PLANS FOR 2010 AND DELIVERABLE

The most important outcome for TC03 in 2010 will be to establish its new mandate and direction. As noted in the Summary above, 2009 has been a tumultuous and difficult year, although nevertheless the membership carried out a considerable amount of scientific work. It is our hope that with a somewhat more narrow focus, activities will be easier to plan and will be carried out with more alacrity than had sometimes been the case in previous years.

NMR Round Robin: We hope to have the experimental studies of the glass samples back from the different labs in Winter 2010 and the manuscript submitted for publication by August 2010.

ICG Meeting: At the 2010 ICG Meeting in Bahia, Brazil, TC03 is organizing along with TC07 a focused session on the structural basis of glass crystallization. This event will mark the first step in the formal collaboration between these two TC's on this important problem in glass science and glass ceramics.

## PUBLICATIONS AND OTHER CONTRIBUTIONS

The list of ten publications given in Annex 1 is merely representative of the published work of TC03 members over the last year, the total number of peer-reviewed publications and invited seminars is roughly 100.

### 4.1.2 ATOMISTIC MODELING AND SIMULATION OF GLASS (TC27)

**Chairman:** *John Mauro, Corning Incorporated, USA*  
*Ulrich Fotheringham, SCHOTT AG, Germany*

**Members:** *Douglas Allan, Corning Incorporated, USA*  
*Dipak Chowdhury, Corning SAS, France*  
*Phong Diep, Corning Incorporated, USA*  
*Jincheng Du, Univ. of North Texas, USA*  
*Neville Greaves, Aberystwyth Univ., UK*  
*Liping Huang, Rensselaer Polytechnic Institute, USA*  
*Ben Leimkuhler, Univ. of Edinburgh, UK*  
*Roger Loucks, Alfred Univ., USA*  
*Carlo Massobrio, IPCMS, France*  
*Matthieu Micoulaut, Univ. Pierre et Marie Curie, France*  
*Yunfeng Shi, Rensselaer Polytechnic Institute, USA*

## SUMMARY

The Technical Committee on "Atomistic Modeling and Simulation of Glass" was founded in 2009 and officially approved by ICG during the PACRIM conference in Vancouver, Canada. The focus of the new TC is on developing the theoretical foundation for advancing the modeling and simulation of glassy systems. The scope includes both the development of accurate interatomic potentials for multi-component glass-forming systems, as well as the development of new theoretical approaches and algorithms for overcoming the intrinsic time and length scale limitations of existing simulation techniques. The TC set off to a running start with the "Theory and Modeling" session organized by John Mauro and Ulrich Fotheringham at PACRIM in Vancouver. Topics covered during the session included energy landscape techniques, topological modeling



approaches, thermodynamic modeling, statistical mechanics, as well as advances in traditional molecular dynamics. Ulrich Fotheringham also chaired a preliminary roadmapping session for atomistic modeling of glass during a May EFONGA workshop in Montpellier. We will follow-up on this roadmapping session at the American Ceramic Society Glass and Optical Materials division meeting next year in Corning, NY. Emphasis will be on bringing the application-oriented glass simulation community together with the community working on the basic numerics for dynamic systems in order to establish a common strategic research agenda in the long run. Finally, Matthieu Micoulaut and John Mauro organized the “International Workshop on Topology, Structure, and Dynamics in Non-Crystalline Solids,” in September in Paris (together with Normand Mousseau of Université de Montréal).

#### PLANS AND DELIVERABLES FOR 2009

- Preliminary roadmapping session on “Atomistic Modeling and Simulation,” chaired by Ulrich Fotheringham at the EFONGA Workshop in Montpellier, France (May 5, 2009).
- Technical session on “Theory and Modeling” at PACRIM 8 in Vancouver, Canada (June 4, 2009), organized and chaired by John Mauro and Ulrich Fotheringham.
- *International Workshop on Topology, Structure, and Dynamics in Non-Crystalline Solids* in Paris, France (September 21-24, 2009), organized by Matthieu Micoulaut, John Mauro, and Normand Mousseau.

#### ACTIVITIES in 2009

##### *Roadmapping Session on “Atomistic Modeling and Simulation” (Montpellier)*

Glasses pose a particular challenge for atomistic modeling owing to the three *non*'s:

- Glass is *non-crystalline*, requiring large simulation cells and a great number of atoms to overcome finite size effects.
- Glass is *non-equilibrium*, so standard equilibrium thermodynamic and statistical mechanical techniques do not apply.
- Glass is *non-ergodic*, since the relaxation time scale is much longer than can be modeled directly with atomistic simulations.

The goal of our TC on “Atomistic Modeling and Simulation” is to develop the fundamental theories and algorithms necessary for overcoming these limitations. We held a preliminary roadmapping session on this topic at the EFONGA workshop in Montpellier, with Ulrich Fotheringham serving as chair and moderator.

The following key challenges were identified:

- Quality of interatomic potentials for realistic glass-forming systems
- Accessing long length and time scales
- Quantitative prediction of macroscopic properties

Potential breakthroughs include:

- Harnessing the broken ergodic nature of glass to access long time scales, e.g., using the energy landscape approach and partitioning of the landscape into metabasins.
- Topological modeling and constraint theory, which may provide a direct link between the atomic structure of a glass and its macroscopic properties.

Several solutions were identified on the short, medium, and long term scales.

Short term solutions:

- Improved techniques for mapping of enthalpy landscapes
- Increased understanding of glass structure and topology
- Accurate interatomic potentials silica

Medium term solutions:

- Accurate interatomic potentials for multicomponent silicates
- More routine use of landscape techniques to access long time scales

Long term solutions:

- Computational design of new glass compositions and thermal treatments
- Theory and modeling techniques
- Physics and chemistry

We will continue the roadmapping discussion at next year's American Ceramic Society Glass and Optical Materials Division meeting in Corning, USA (May 16-19, 2010).

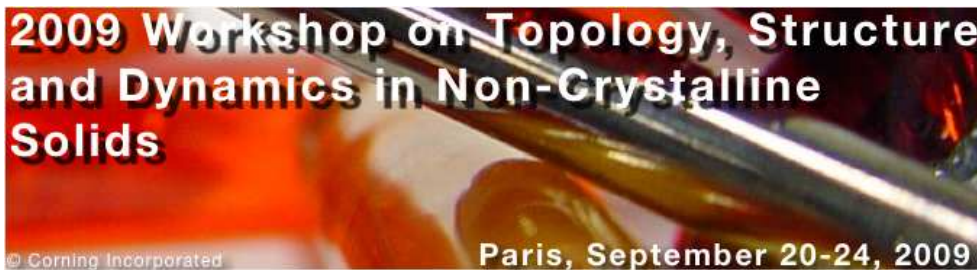
#### ***"Theory and Modeling" Session at PACRIM 8 (Vancouver)***

The focus of this session, organized and chaired by John Mauro and Ulrich Fotheringham, was on novel approaches for the modeling and simulation of glass. The presentations covered a wide range of modeling approaches, including energy landscapes, topological modeling, thermodynamic modeling, and advances in traditional atomistic techniques such as molecular dynamics. The session was well received, with several people commenting that it was one of the best sessions at PACRIM 8. The presentations were:

- "Anomalous Glasses and their Tendency Towards Irreversible Densification," L. Huang (Rensselaer Polytechnic Institute, USA) and J. Kieffer (University of Michigan, USA)
- "Forbidden Glasses and the Failure of Fictive Temperature," R. Loucks (Alfred University, USA) and J. Mauro (Corning Incorporated, USA)
- "Modeling of the Aqueous Dissolution Behavior of Zinc and Iron Phosphate Glasses," M. Schmitt and R. Brow (Missouri S&T, USA)
- "A Few Numerical Approaches for Preparing Atomistic Models of Glasses," N. Mousseau (Université de Montréal, Canada)
- "Topology of the Energy Landscape and Low-Frequency Vibrational Anomalies: Effects upon the Glass Transition," G. Naumis (UNAM, Mexico)
- "Exploring the Multi-Dimensional Compositional Space of Oxide Systems with Respect to Glass Formation Ability," R. Conradt (Aachen University, Germany)
- "Theoretical Analysis of the Relative Change of Glass Stability Parameters with the Application on Some Oxide and Chalcogenide Glasses from the System  $\text{Bi}_x(\text{As}_2\text{S}_3)_{100-x}$ ," A. Kozmidis-Petrovic, S. Lukic, and M. Siljegovic (Faculty of Sciences, Serbia)
- "Structure and Properties of Low Silica Yttrium Aluminosilicate Glasses: A Molecular Dynamics Simulation Study," J. Du (University of North Texas, USA)

A follow-up to this session will be held at the ACerS meeting next year in Corning.

*Workshop on Topology, Structure, and Dynamics in Non-Cryst. Solids (Paris)*



Many fundamental questions in condensed matter physics are tightly linked to the relation between the underlying atomic structure and its macroscopic properties. The goal of the *International Workshop on Topology, Structure, and Dynamics in Non-Crystalline Solids* was to bring together researchers from a variety of backgrounds (physics, chemistry, materials science) with a common focus on predicting macroscopic properties and behavior from the underlying glass structure. This workshop was organized by Matthieu Micoulaut, John Mauro, and Normand Mousseau, and featured four days of in-depth discussion among 60 experts in the field. The meeting was a great success, with the following speakers (invited speakers in bold):

**Michael Thorpe**, **Tanguy Rouxel**, Jean-François Joly, Dominique De Ligny, Thierry Deschamps, Grégory Tricot, Dominique Massiot, Richard Kerner, **Sandro Jahn**, Benjamin Cochain, **Carlo Massobrio**, Daniel Neuville, Anita Zeidler, **Sabyasachi Sen**, Ali Kerrache, Abdallah Chehaidar, **Ludovic Berthier**, Daniel Bonn, **Zorana Zeravcic**, Kenneth Desmond, Sergio Ciliberto, **Matthieu Wyart**, Albert Philipse, **Jean-Louis Barrat**, **Prabhat Gupta**, David Rodney, **Punit Boolchand**, **Pierre Lucas**, John Mauro, **Neville Greaves**, Vladimir Kolosov, François Sausset, **Frédéric Van Wijland**, François Ladieu, **Yuanzheng Yue**, Stephen Elliott, Stefano Mossa, **Asaph Widmer-Cooper**, Anne-Lise Faivre, John Fontanella, Benoît Rufflé, **Philip Salmon**, **Matthias Wuttig**, **Bernhard Roling**, Matthieu Micoulaut, Jacques Rault, Annie Pradel, Jean-Louis Auguste, Nadège Ollier, Cindy Rountree, and Sébastien Le Roux.

To view the complete program for the workshop, please see:

<http://riel.pmc.umontreal.ca/workshop2009/Program.html>

Of particular interest were advances in topological modeling techniques and the connection between the glass transition and jamming in granular media. A follow-up session on “Topological and Rigidity” will be held at next year’s ACerS meeting in Corning.

**PLANS FOR 2010 AND DELIVERABLES**



The focal point for our TC activities during 2010 will be the American Ceramic Society Glass and Optical Materials division meeting in Corning, NY on May 16-19, 2010. John Mauro is serving as Program Chair for the meeting, which will highlight a wide range of topics in glass science and technology, with emphasis on interdisciplinary studies incorporating physics, chemistry, materials science, mathematics, and engineering. Of particular interest to this TC will be:

- A detailed roadmapping session on “Atomistic Modeling of Glass” organized by Ulrich Fotheringham.
- A technical session on “Atomistic Modeling of Glass” organized by Ulrich Fotheringham and Jincheng Du. Invited speakers include Walter Kob, Andreas Heuer, Neville Greaves, and Guillaume Ferlat.
- A technical session on “Topology and Rigidity” organized by Matthieu Micoulaut and Normand Mousseau. Invited speakers include David Drabold, Carlo Massobrio, and Punit Boolchand.
- A technical session on “Glass Transition and Relaxation” organized by Prabhat Gupta and Roger Loucks. Invited speakers include James Phillips, Kostya Trachenko, Kia Ngai, Jonathan Stebbins, and Sindee Simon.

Another focus in 2010 will be on applying for research funding in both Europe and North America to support the efforts of the TC. In the United States we will apply for GOALI grants through the National Science Foundation. (A GOALI grant is specifically for collaborations between industry and academia). We will also explore funding opportunities in Europe.

## **PUBLICATIONS AND OTHER CONTRIBUTIONS**

A non-exhaustive list of publications by TC27 members is given in **Annex 2**.

### **4.1.3 VIBRATIONS AND GLASS STRUCTURE (TC26)**

**Chairman:** Bernard HEHLEN, Univ. Montpellier 2, France

**Vice-Chairs:**

**Members:** F.J. Bermejo, Instit. de Estructura de la Materia, Madrid, Spain

E.I. Kamitsos, TPCI/NHRF, Greece

A. Chumakov, ESRF, France

P. Simon, CNRS, France

D. Massiot, CNRS, France

I. Farnan, Univ. Cambridge, UK

M. Dove, Univ. Cambridge, UK

S.R. Elliott, Univ. Cambridge, UK

L. Cormier, Univ. Paris 6, France

A. Pasquarello, EPF Lausanne, Switzerland

W. Schirmacher, T.U. Munich, Germany

M. Foret, Univ. Montpellier 2, France

B. Rufflé, Univ. Montpellier 2, France

S. Ispas, Univ. Montpellier 2, France

G. Monaco, ESRF, France

## SUMMARY

This TC focuses on the nature of the vibrations in glasses and the structural information that can be gained using inelastic spectroscopy techniques: Infrared absorption, light scattering, Neutron and X-ray scattering, etc..., as well as numerical simulations of the vibrational properties. We concentrate mainly on i) the origin of the boson peak and its relation with the end of acoustic branches ii) the understanding of the optic modes of oxide glasses and their relation to the structure, and iii) the contribution of inelastic spectroscopies to the characterization of the structural properties of technological glasses.

## ACTIVITIES in 2009 (actions)

Creation of the TC. Call for membership. Definition of the workgroup.

## PLANS FOR 2010 AND DELIVERABLE

- Enlarge the workgroup to the industrial area.
- Meeting of the workgroup at the 11<sup>th</sup> International conference on the Structure of Non-Crystalline Materials (NCM11) in Paris, June 27<sup>th</sup>-July 2<sup>nd</sup> 2010.
- Meeting of the workgroup at the ICG conference in Brazil, September 20<sup>th</sup>-24<sup>th</sup> 2010.

The aim of these two TC-meetings will be to define short term and long term actions for the two main centers of interests of the workgroup: i/ the structural determination of glasses via inelastic spectroscopic techniques, and ii/ the understanding of the low frequency collective modes of vibrations (boson peak):

### Structural determination:

The first step will be to make an inventory of the state-of-the-art, by listing what is known and what is still under discussion in the vibrational “identity card” of a series of oxide glasses, and in particular on the main glass formers SiO<sub>2</sub>, B<sub>2</sub>O<sub>3</sub>, GeO<sub>2</sub>. The effort will then be focused on improving our knowledge of vibrations and their relation with structural characteristics.

In a second step, the spectral modifications induced in binary and ternary glasses will be followed. One of the goals will be to define a “toolbox” that relates the vibrational spectra to quantitative structural estimates such as Si-O-Si bond angle in silicates, modifier or compensator state of alkali ions, coordinance or redox in molar fraction, effect of water and corrosion process, density and elastic properties, ...

The participants will establish a series of questions to answer and define the priorities, motivated by both fundamental and industrial interests. Static methods that can help the vibrational analysis will also be included in the activity, together with numerical simulations of the vibrational spectra. Thus, this part will be separated in three subgroups:

1. Structural methods (X rays, neutrons, light, NMR)
2. Vibrational methods (IR, Brillouin, Raman, hyper-Raman, inelastic neutron scattering)
3. Simulations of the vibrational spectra.

#### Low frequency collective modes of vibration

The nature of low-frequency vibrational modes in glasses is still not clearly understood. Among the open questions is the nature of acoustic vibrations when the wavelength decreases in the nanometer range and the origin of the excess density of states (at the origin of the “boson peak”) observed in most glasses. The aim of this workgroup is to initiate a long-term discussion between researchers having different views on these topics, in order to see whether our understanding could converge towards a more unified interpretation. The questions to be addressed are, for example:

1. Is it possible to relate acoustic velocities with the boson peak frequency? What is the role of transverse modes in this process?
2. Could we unambiguously demonstrate, experimentally and by numerical simulation, that there exists low frequency optic-like vibrations in glasses?
3. Is the destruction of plane waves by structural disorder an efficient process? Could it explain the full excess of low frequency modes? Is the hybridization of acoustic and optic-like modes the dominant process leading to the boson peak? Can we build a model for this hybridization?

#### **PUBLICATIONS AND OTHER CONTRIBUTIONS**

None

#### **4.1.4 STRUCTURE-PROPERTY RELATIONSHIP (TC22)**

**Chairman:** *Georges Calas, Univ. Paris, France*  
**Members:** *Bruce G. Aitken, Corning, USA*  
*Harald Behrens, Univ. Hannover, Germany*  
*Richard K. Brow, Univ. Missouri-Rolla, USA*  
*Marie-Hélène Chopinet, Saint-Gobain Recherche, France*  
*Giuseppe Dalba, Univ. Trento, Italy*  
*Alicia Duran, ICV/CSIC, Spain*  
*Laurence Galoisy, Univ. Paris, France*  
*Neville Greaves, Univ. Wales, Great Britain*  
*Scott Kroeker, Univ. Manitoba, Canada*  
*Jacques Lucas, Univ. Rennes, France*  
*Pascal Richet, IPGP, Paris*  
*Jonathan Stebbins, Univ. Stanford, USA*  
*Akira Takada, AGC, Japan*  
*Joe Zwanziger, Univ. Dalhousie, Canada*

#### **SUMMARY**

2009 Activity Report

TC22 was created at the annual meeting in Vancouver in June 2009.

The activities proposed by the new Technical Committee “Structure-property relationships in glasses” for 2010-2012 will be based on joint technical workshops, joint organization of specialized sessions in international meetings and coordinated work on materials chosen for their interesting properties and raising unsolved issues concerning their structure.

For 2010, we will have two main meetings, which will be a good starting milestone to gather most members of the TC:

- the 11<sup>th</sup> conference "Structure of non-crystalline materials". This conference will provide the possibility of having not only world-class specialists, but also young researchers interested in this fast expanding domain of glass science.
- we have proposed the organization of a 1-day Session on this topic at ICG 2010, scheduled by the organizing committee.

During these meetings, we will discuss the feasibility of joint measurements between some groups in the 2010-20102 period. This will justify the organization of workshops between the participating TC members. The most mature topics will concern optical properties, mechanical properties, durability of glasses (including waste glasses).

#### **4.1.5 GLASS TRANSITION (TC08)**

**Chairman:** *Lothar Wondraczek, Univ. Erlangen-Nürnberg, Germany*

**Vice-Chairs:** *Sabyasachi Sen, Univ. California at Davis, USA*

*Yuanzheng Yue, Aalborg Univ., Sweden*

**Members:** *Isac Avramov, Bulgarian Academy of Science, Bulgaria*

*Victor N. Bogdanov, St. Petersburg State Univ., Russia*

*Ulrich Fotheringham, Schott AG, Germany*

*Neville Greaves, Univ. of Wales, UK*

*Prabhat K. Gupta, Ohio State Univ., USA*

*Andreas Heuer, Univ. of Münster, Germany*

*Ian Hodge, RIT, USA*

*Pierre Lucas, Univ. of Arizona, USA*

*Jun Matsuoka, Shiga Univ., Japan*

*John Mauro, Corning, Inc., USA*

*Gregory B. McKenna, Texas Tech Univ., USA*

*Paul F. McMillan, Univ. College. UK*

*Sergei V. Nemilov, St. Petersburg State Univ., Russia*

*Kristine Niss, Roskilde Univ., Denmark*

*Benoît Rufflé, Univ. of Montpellier 2, France*

*Srikanth Sastry, JNCASR, India*

*Juern W. P. Schmelzer, Univ. of Rostock, Germany*

#### **SUMMARY**

In 2009, work of TC08 was building on the 2008-efforts on "Glass and Entropy" and related topics. In summary, major actions include edition of a special issue of the Journal of Non-Crystalline Solids (published in April 2009), successful conduction of the Second International Workshop on Glass and Entropy in Aberystwyth, UK, in April 2009, organization of a symposium on Glass Formation and Relaxation Phenomena in Glasses at ICG's annual conference in Vancouver, CA, active participation in the EFONGA closing and roadmapping workshop in Montpellier (May 2009) and the start of first concrete cooperative efforts as a follow-up to the workshops and discussions that were held in the last two years.

## ACTIVITIES in 2009

While 2008 was mainly dedicated to the creation of the TC, the main objective of 2009 was to further deepen the focus on concrete cooperative work. In the following, the main activities are briefly summarized:

### **(A) Second International Workshop on Glass and Entropy**

The second International Workshop on Glass and Entropy was held from April 22 - 24, 2009, in Aberystwyth, United Kingdom. This round of discussions was organized by G. Neville Greaves, Martin Wilding and Lothar Wondraczek and endorsed by ICG and TC08. Sponsored by the EU-FP6-initiative EFONGA (European Forum on New Glass Applications), 28 papers were presented by scientists from all over the world. Whereas the first meeting concluded on the note that there is still a need to specify a common nomenclature (e.g. characteristic temperatures, definition of entropy, etc.) and to design experiments that will be accepted as decisive by the broad community, the participants in the second workshop agreed to jointly pursue three types of experiments in particular: dissolution calorimetry (having identified model glasses); measurements of the electromotoric force in glass-crystal galvanic cells and vapour pressure measurements. "Glasses under extreme conditions" was identified as a key new area of specific interest, with a special emphasis on the role of high pressures on the structure and dynamics of glass-forming systems.

In the meantime, plans to hold a third workshop in Nuremberg, Germany, in 2011 are already underway. Here, all parties have expressed their hope that it will be possible to maintain momentum, and build on it as the basis for a new, more complete understanding of the glassy state.

### **(B) Contributions to EFONGA closing and roadmapping activities**

TC08 was actively participating at the EFONGA closing and roadmapping workshop in Montpellier, May 2009, representing in the area of Basic Glass Science the field of Relaxation and Fundamental Aspects of the Glass Transition. During the initial spring school, two lectures, "Thermodynamic aspects of the Glass Transition" and "Rheology" were held. On May 6<sup>th</sup>, during the core meeting, a three-hour session was held in order to contribute to the road-mapping process. Invited experts were Profs. Greaves, Richet and Conradt, with overview presentation on the previously identified topics "Glasses under Extreme Conditions", "Experimental Thermodynamics, Relaxation, Glass Transition and Absolute Zero", and "Thermochemistry of Glasses". While it is clearly agreed that fundamental research, due to its exploratory and individual-driven character, can not be road-mapped, some key areas were determined according to the following criteria:

- scientific potential, unanswered questions
- potential relations / closeness to applications or technical problems
- size of the interested community
- potential for new insights (with respect to novel developments in experimental equipment / approaches, synergy from other TCs / communities, ...).

With respect to these criteria, it was concluded that a general understanding of the behaviour of glasses and liquids under "extreme conditions" may be such a key topic. Here, the term "extreme conditions" involves high and very high pressure, polyamorphism, extreme cooling rates (both fast and slow) and, e.g., extreme chemical conditions (compositions at the edge of glass forming regions, extreme external



conditions / corrosion and dissolution). As noted by several of the participants, both in Montpellier and previous meetings, from a fundamental point of view, glasses should be studied closer to their principle nature - as materials out of thermodynamic equilibrium - whereas today, research and applications often focus on the opposite ("well-relaxed glasses", as-low-as possible difference from equilibrium, etc). It was understood that progress on this field would enable not only a better understanding of basic aspects of the glass transition, but that, eventually, direct consequences could be draw for, e.g., corrosion and other technical problems. In this context, the already discussed issue of potential and commonly accepted experimental approaches deserves particular interest. Furthermore, a special role will also be occupied by simulation tools and their advancement, respectively.

### **(C) Symposium at ICG/PACRIM, Vancouver**

The following topics were presented at the session on "Glass formation and Relaxation Processes in Glasses" that was held within symposium A "Glass Science" of the 8<sup>th</sup> Pacific Rim Conference on Ceramic and Glass Technology:

- Two Factors Governing Fragility: Stretching Exponent and Configurational Entropy (J. Mauro)
- Impact of Fragility on Enthalpy Relaxation in Glass (R. Loucks)
- Modelling the Nonequilibrium Viscosity of Glass (D. Allan)
- Structural Evolution in Al<sub>2</sub>O<sub>3</sub>-SiO<sub>2</sub> Liquids and Glasses (R. Weber)
- Boson peak, structural homogeneity and relaxation of borosilicate glasses with different thermomechanical histories (L. Wondraczek)
- Mechanical relaxation below and at the glass transition (B. Ruffle)
- Molecular tumbling dynamics in supercooled glycerol: Effect of nano-confinement (S. Sen)
- Excess of vibrationnal density of states in densified glasses (B. Champagnon)
- Glass Formation and Effects of Temperature on Order/Disorder of Oxide Melt Structures (J. Stebbins)
- Relaxation features of both strong and fragile glass systems (Y. Yue)
- Low entropy glasses from super strong zeolite amorphisation (G. Greaves)

### **(D) Cooperative actions**

As the main objective of the workshops on glass and entropy, some concrete cooperative actions were started, e.g.:

*"Development of electrochemical methods for the determination of the thermodynamic properties of vitreous non-metallic and metal / metalloid systems"*

(presently involving University of Erlangen and Bulgarian Academy of Science, financially supported by the German Academic Exchange Office for the period 2010-2011)

*"The configurational Prigogine-Defay ratio"*

(involving University of Grenoble, Institute Néel / CNRS, University of Erlangen)

*Review on "Glass and Entropy"*

(Wondraczek/Conrad/Mauro, delayed in 2009; anticipated submission date April 2010)

## PLANS FOR 2010 AND DELIVERABLES

- a) A technical session on “Rheology” will be organized at the 2010 GOMD meeting in Corning, NY.
- b) The feature article for J. Am. Ceram. Soc. On “Glass and Entropy” shall be finalized as a summary of the 2007 and 2008 workshops.
- c) Preparation of the third workshop on glass and entropy in Erlangen/Nuremberg, to be held in 2011, will be started. In particular, funding shall be secured, a list of potential participants be prepared, and the first call for papers be issued in late autumn 2010.
- d) Additionally to the already launched projects, further initiatives shall be started.

## PUBLICATIONS

- L. Wondraczek, R. Conradt (Eds.): *Glass and Entropy*. J. Non-Cryst. Solids **355**, (10-12), Elsevier, Amsterdam (2009) ISSN 0022-3093.
- ICG Press Release “International Workshop Series on Glass and Entropy”, June 2009

### 4.1.6 NUCLEATION, CRYSTALLIZATION & GLASS-CERAMICS (TC07)

**Chairman:** Edgar Dutra Zanotto, Fed. Univ. São Carlos, Brazil  
**Vice-Chair:** W. Höland, Ivoclar Vivadent, Liechtenstein  
**Members:** A. Sakamoto, NEG, Japan  
T. Komatsu, Nagaoka Univ., Japan  
I. Donald, United Kingdom (retired this year)  
M. Budd, consultant, Norway  
R. Hill, Imperial College, UK  
R. Müller, BAM, Germany  
M.J. Pascual, ICV, Spain  
G. Völksch, Otto-Schott Institute, Germany  
J. Deubener, TU Clausthal, Germany  
F. Gabel, SCHOTT AG, Germany  
J. Sestak, Science Academy, Czech Republic  
M. Davis, Schott, USA  
M.O. Prado, CNEA, Argentina  
V.M.Fokin, Vavilov Optics Institute, Russia  
G. Querel, St-Gobain, France

## ACTIVITIES OF THE TC 7 IN 2009

### EXECUTIVE SUMMARY

2009 has been a very active year for the TC07, with two business meetings, in different countries. The first took place in Vancouver, Canada, June 1. 7 members participated. The second meeting took place in Iguaçu Falls, Sept. 11. Eleven members participated. Overall, of the 17 members, 13 participated in one or another meeting, while several

participated (or were represented by some colleague) in both. This is direct indication that most members are quite active regarding the TC activities.

The attendees of those two meetings presented current work of high scientific quality on the new TC07 focus: nucleation-crystallization-microstructure-properties of multi-component systems. Due to the lack of space we cannot discuss details of the presentations, which are, however, available in CD-ROM. As an example we show below a photograph of T. Komatsu's work on laser patterning on glass.

Self-organized periodic domain structure for second harmonic generation in ferroelastic  $\beta'$ -(Sm,Gd)<sub>2</sub>(MoO<sub>4</sub>)<sub>3</sub> crystal lines on glass surfaces”

Finally a prestigious symposium - the *9th International Symposium on Crystallization in Glasses and Liquids*” - Crystallization 2009 ([www.pncs-crystallization.com.br](http://www.pncs-crystallization.com.br)) was successfully organized by this TC. Last, but not least, various crystallization related publications were authored by TC 7 members.

### Final Report

## SUMMARY

Two successful business meetings (one in Canada and one in Brazil) of the committee members demonstrated that the TC07 chair and most members were very active in 2009. The new focus of the TC07, the study of crystallization of complex multi-component glass forming systems and properties of glass-ceramics, was initiated. An international symposium - Crystallization 2009 - was successfully organized ([www.pncs-crystallization.com.br](http://www.pncs-crystallization.com.br)). Last, but not least, various crystallization related publications were authored by TC 7 members. These provide experimental evidence that this is indeed a very active TC.

## PLANS AND DELIVERABLES FOR 2009

In 2009 the TC 7 planned to focus on the organization of the “Crystallization 2009 - the *9th International Symposium on Crystallization in Glasses and Liquids*”.

Deliverable: symposium successfully organized.

Strategies to foster joint research between TC07 members should be discussed. Some key issues of nucleation and crystallization in glasses were already identified in the 2008 meeting and a *road map* was drafted. The main *road map* markers so far recognized were nucleation and crystallization studies to develop glass-ceramics focused on:

- tough and strong : 2009 - 2011
- sealing and sintering: 2009 - 2010
- nano crystal formation: 2009 - 2012
- composites (interfaces): 2012 - 2015

In addition to these main research directions, specific points should be discussed by the TC 7 members in more detail. A special subject in the research activities regarding tough glass-ceramics will be the relationship between nano-phases and toughness.

Deliverable: report on the new, focused research activities of the TC 7 members.

The annual business meeting in 2009 should take place during the crystallization conference in Brazil, September 2009 (confirmed). Possibly a second meeting could be arranged during the ICG meeting in Vancouver, Canada, in May 2009 (depending on the number of attendees).

Deliverable: One or two formal meetings successfully take place; reports sent to the CTC.

#### **ACTIVITIES IN 2009**

2009 has indeed been a very active year for the TC07, with two business meetings, in different countries:

- In Vancouver Canada, on June 2, 2009 : see detailed report in **Annex 3**;
- in Iguazu Falls, Sept 2009: see detailed report in **Annex 4**.

#### **PLANS AND DELIVERABLES FOR 2010**

Two annual meetings are planned for 2010. The first should take place during the GOMD of the Acers, to be held in Corning, USA, May 2010. A second is planned for the International Congress on Glass, to be held in Salvador, Brazil, September 2010. This strategy will hopefully maximize the number of attendees, because it is quite likely that all members will take part in one or another of these meetings.

Deliverables: One or two formal meetings successfully take place; reports sent to the CTC.

The TC 7 / TC 3 are planning to co-organize a one-day symposium on “Structural basis of glass crystallization” during the ICG 2010 ([www.icg2010.com.br](http://www.icg2010.com.br))

Deliverable: Symposium successfully organized.

#### **PUBLICATIONS**

J. Sestak has been working on a new book project with E.D. Zanotto and V.M. Fokin entitled: “Thermodynamic, structural and behavioral aspects of amorphous materials”

The TC07 members published several papers in ISI journals focusing on different aspects of glass crystallization in 2009 (See **Annex 5**). This excellent record corroborates our opinion that they have been quite active.

#### **4.1.7 NANOMECHANICS (TC09)**

**Chairman:** *Matteo Ciccotti, Univ. Montpellier 2, France*

**Members:** *S M Wiederhorn, NIST, USA*  
*M Tomozawa, Rennsealer, NY, USA*  
*T Rouxel, Univ. Rennes 1, France*  
*C Pantano, Lehigh, PA, USA*  
*D Green, Pennstate Univ., PA, USA*  
*A Cormack, Alfred Univ., USA*  
*G.D Sorarù, Univ. of Trento, Italy*  
*E. Barthel, CNRS-Saint Gobain, France*  
*T.I Suratwala, Livermore, USA*  
*R J Hand, Sheffield Univ., UK*  
*S Yoshida, Univ. of Shiga, Japan*

## SUMMARY

The mission of TC09 is to promote cooperative research activity on the comprehension of recent advances in the observations by local scanning probe techniques of the fundamental crack propagation mechanisms acting at the nanoscale in glass and glass-ceramics. We can cite the debated observations on the presence of plastic deformation near the crack tip, as well as the manifestation of stress induced ion migration in the neighbourhood of the crack tip, but also the subtle details of the diffusion and interaction of water molecules with the glass network. The TC joins experts in different domains of the glass community (fracture, physical-chemistry, structural relaxation, surface properties, scanning probe microscopies, numerical simulation) with the aim of discussing how to put together different evidences in order to gain new insights in the relationship between the glass composition, nanostructure and mechanical properties. This interdisciplinary activity also benefits from collaboration under development with other TCs, such as TC2, TC3, TC6, TC7, TC14 and TC19.

The year 2009 has been a very rich and active year. Starting with the organization in collaboration with TC19 of an expert workshop on “Glass surfaces and stress corrosion mechanisms at the nanoscale” that was held in February 2009 in Montpellier, France. This action was financed in the frame of the EFONGA project and has brought together 16 international experts in the glass community that presented talks focused on their own expertise and to support a roadmap process for surface related phenomena for glass/glassceramics. A physical TC meeting has been held at the same occasion in order to plan the follow up actions.

Another important moment has been the Final EFONGA Meeting that was held in May 2009 in Montpellier, where TC09 has contributed to the Student Workshop “Glass Structure-Property relation” and to the Expert Workshop “Current Status and Future of Glass” where an important roadmapping activity was held. This was also the occasion for a core TC meeting.

The overall intense activity has been the subject of several invited contributions at international conferences, reports and a press release.

## PLANS AND DELIVERABLES FOR 2009

- Organization of the EFONGA workshop on “Glass surfaces and stress corrosion mechanisms at the nanoscale” to be held in February 22-25, 2009 in Montpellier, France.
- The results of the workshop were planned to be:
  - Presented at the final meeting of the EFONGA project to be held in may 2009 in Montpellier
  - Presented at the “Strength of Glass” symposium at the conference PAC RIM 2009 in Vancouver in June 2009
  - Published on a scientific journal
- Participation to the organization of the Student Workshop: “Glass Structure-Property relation” to be held jointly with the final EFONGA meeting in Montpellier in May 2008, where several oral contributions from TC09 members are scheduled.
- Organization of a joint TC09/TC19 RRT on the investigation of the nature of the first tens nanometers below the glass surface after different kinds of advanced polishing.

- Physical TC09 meetings were scheduled at the EFONGA workshop in Montpellier in February 2009, at the Final EFONGA meeting in May 2009 in Montpellier and at the PAC RIM 2009 Conference in Vancouver in June 2009.
- Definitions of priorities for the future actions and research activity of TC09.

#### ACTIVITIES in 2009

- The EFONGA workshop on “Glass surfaces and stress corrosion mechanisms at the nanoscale” was organized in collaboration with Volker Rupertus (Chair of TC19) and was held in February 22-25, 2009 in Montpellier, France. This action was financed in the frame of the EFONGA project and has brought together 16 international experts in the glass community that presented talks focused on own expertise and to support a roadmap process for surface related phenomena for glass/glassceramics. Several contributions came from members of TC09, TC19 and TC06. A web page for this event was created at:

<http://w3.lcvn.univ-montp2.fr/~ciccotti/TC09/EFONGAWorkShop2009.html>



A snapshot of the EFONGA Workshop (Montpellier, February 2009)

- A physical TC meeting has been held at the same occasion in order to plan the follow up actions (Participating members: M. Ciccotti, T. Rouxel, R. Hand, E. Barthel, A. Cormack, M. Tomozawa, S. Wiederhorn, C. Pantano).
- In order to animate the workshop discussions, the chair Matteo Ciccotti has written a review on the “Stress-corrosion mechanism of silicate glasses” that has been later published (J. Phys. D: Appl. Phys, Vol 42, Art.n 214006, 2009). The article can be find on:

<http://hal.archives-ouvertes.fr/docs/00/37/23/69/PDF/CICC1223.pdf>

- The results of the workshop have been later on
  - Resumed in an activity report including the scientific presentations and roadmapping activity, which was joined to the final report of the EFONGA Project. The slide presentations are joined into a CR-Rom.
  - Presented at the final meeting of the EFONGA project that was held on May 6-8 2009 in Montpellier.
  - A press release has been written and published on the Bulletin of the American Ceramic Society (Vol 88, Issue 7, August 2009). Title: “ICG workshop focused on surface strength at the nanoscale”.

- Presented in an invited talk at the “Strength of Glass” symposium at the conference PAC RIM 2009 in Vancouver in June 2009.
- The publication of the results into an international journal is being considered.
- The roadmapping activity is being included into the ICG document “ICG Road Map 2020”.

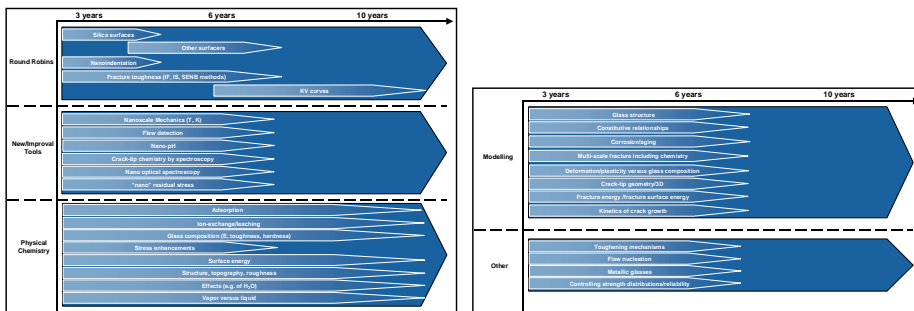


Fig. 4.1.1: Sketch of the roadmap for the “Glass surface and stress corrosion mechanisms”

- Participation to the organization of the EFONGA Student Workshop : “Glass Structure-Property relation” that was held in Montpellier on May 4-5<sup>th</sup> 2009. Contribution of M. Ciccotti on the topic: “Mechanical processes and glass surfaces: stress-corrosion mechanisms and AFM studies of glass surfaces”.
- Organization of the session “Nanomechanics” in the EFONGA Workshop “Current Status and Future of Glass” Montpellier Mai 6-8<sup>th</sup> 2009. Two oral contributions from TC09 members (M. Ciccotti and T. Rouxel).
- A core TC meeting has been held in the same occasion to discuss future projects and actions (Participating members: M. Ciccotti and T. Rouxel).
- The advancements on the project on the joint TC09/TC19 RRT test on the investigation of the nature of the first tens nanometers below the glass surface after different kinds of advanced polishing were discussed, especially concerning the choice of the standard sample and the protocols for its conditioning during the tests and transfers between different laboratories.

#### PLANS FOR 2010 AND DELIVERABLE

- The interesting results of the activities of 2009 on glass strength related phenomena have motivated the proposal of organizing a follow up workshop in a larger format to be held likely in 2011. The workshop will be organized jointly by TC09, TC06 and TC19 and will join 50-80 experts for 5 days.
- The publication of the results of the EFONGA workshop into an international journal will be tackled in 2010.
- The joint TC09/TC19 RRT on the investigation of the nature of the first tens nanometers below the glass surface after different kinds of advanced polishing should turn to action in 2010. The samples have been prepared and will be shipped through 13 laboratories and the results will be joined and analyzed.
- A teleconference TC meeting is being organized for spring time.
- The location for a physical TC meeting is being discussed. Likely places are GOMD meeting in USA, ESG meeting in Germany or ICG meeting in Brasil.

## PUBLICATIONS AND OTHER CONTRIBUTIONS

- As a personal action of the chair Matteo Ciccotti has written a review on the “Stress-corrosion mechanism of silicate glasses” that has been later published (J. Phys. D: Appl. Phys, Vol 42, Art.n 214006, 2009). The article can be find on: <http://hal.archives-ouvertes.fr/docs/00/37/23/69/PDF/CICC1223.pdf>
- A press release on the EFONGA Workshop was published on the Bulletin of the American Ceramic Society (Vol 88, Issue 7, August 2009). Title: “ICG workshop focused on surface strength at the nanoscale”.

The results of the workshop have been presented and published at different locations (cf. section Activities in 2009).

### 4.1.8 MECHANICAL PROPERTIES OF GLASS (TC06)

<b>Chairman:</b>	<i>Jim Varner, NYS College of Ceramics, Alfred Univ., USA (until 6.2009), Russell J. Hand, Dept. of Engineering Materials, Univ. of Sheffield, UK (from 6.2009)</i>
<b>Vice-Chairs:</b>	<i>Suresh Gulati, Corning, Inc., USA (until 9.2009), Paul D. Warren, Pilkington, UK (from 9.2009)</i>
<b>Members:</b>	<i>V. Pukh, A. F. Ioffe Physical Technical Institute, Russian Academy of Sciences, Russia Jun Matsuoka, School of Engineering, The Univ. of Shiga Prefecture, Japan Rene Gy, Saint-Gobain Recherche, France E. Magnato, Sperimentale del Vetro, Italy Reha Akcakaya, Turkiye Sise ve Cam Fabrikalari A.S., Turkey Kurt Nattermann, Schott - Germany Jorma Vitkala, Glaston, Finland John Helfinstine, Corning, Inc., USA Matteo Ciccotti, LCVN, Univ. Montpellier II, France Lothar Wondraczek, Inst. für Werkstoffwissenschaften 3, Univ. Erlangen-Nürnberg, Germany Jian (Jimmy) Yang, Dept. of Civil Engineering, Univ. of Birmingham, England</i>

## SUMMARY

There has been a change of Chair and Vice-Chair during the year and the Committee would like to acknowledge the sterling work of both Jim Varner and Suresh Gulati in their roles as Chair and Vice-Chair over the last 9 years.

Conference Activity: (1) The then TC06 Chair Jim Varner and Co-Chair Suresh Gulati were members of the Task Force which organized symposium on glass strength that will be held during PacRim 8, June 2009, in Vancouver, Canada (which was also the ICG Annual Meeting). (2) TC06 member Matteo Ciccotti organised the EFONGA workshop on Glass surfaces and stress corrosion mechanisms at the nanoscale. (3) TC06 members were involved in organising and giving the ICG Short Course on Glass Strength and the Fractography Course May 2009.



## PLANS AND DELIVERABLES FOR 2009

- TC06 meeting - in conjunction with PacRim 8 (31 May-5 June 2008)
  - Deliverable - meeting minutes; tasks
- Symposium at PacRim 8 on Strength of Glass - participate in organizing and carrying out this meeting
  - Deliverable - participants; ideas for future TC06 work
- EFONGA meeting in February - participation by several TC06 members
  - Deliverable - participants; ideas for future TC06 work; collaboration with other TC's
- ICG short course on strength of glass; fractography course - participation by several TC06 members
  - Deliverable - number of course participants
- Decide on several projects and begin work on the selected projects
  - Possible projects include
    - Edge strength of glass (focus on how edge flaws are made and what happens to them)
    - Effects of surface flaws in glass fatigue (stress corrosion) (compare fracture mechanics tests with static/dynamic fatigue tests)
    - Ways to improve edge strength of glass
  - Deliverables - identified projects; work started

## ACTIVITIES in 2009

- EFONGA meeting held in Montpellier, France 23-24th February. Formally speaking this meeting was a collaboration between TC9 and TC19 but there was significant TC06 involvement in the meeting (TC06 members Ciccotti, Gy, Hand and Nattermann all participated in the meeting).
- ICG Short Course on Strength of Glass and the Fractography Course were held in Erlangen, Germany 25.5-26.5.2009. Four TC06 members Hand, Nattermann, Varner and Wondraczek were involved in giving lectures and/or the organization of the course. 30 delegates attended the short course on Strength of Glass and 28 delegates attended the short course on Fractography.
- A symposium on the Strength of Glass was held at PacRim 8 in Vancouver, 31.5.-5.6.2009. TC06 members (Gulati and Varner) participated in organizing this meeting. A follow-up session the morning after the formal session included TC06 members Gulati, Matsuoka and Varner. In total about 15 people were involved in this session. In the US the session has led to follow-up activity led by GMIC and which has involved TC06 member Gulati. Hand has also been involved in a teleconference with GMIC. The emphasis on these follow-up sessions has been towards producing stronger glass. Quite apart from being involved in research towards this end TC06 needs to ensure that a meaningful of stronger glass is used.
- A first TC06 teleconference is currently being arranged. This should start to address item 1 below.

## PLANS FOR 2010 AND DELIVERABLES

- Agree projects to be worked on. Possible projects include
  - Agreeing best practice for edge strength measurements
    - Deliverable: follow-up publication to ICG Kyoto proceedings CD publication
  - Hot strength of glass and the origin of strength controlling defects
  - Possible joint activity with GMIC in the form of a specialist meeting
  - Possible joint activity with TC09 in the form of a specialist session
  - Quality of glass data
  - Definition of glass strength to enable meaningful discussions of glass strengthening
- Agreement on projects to be delivered via
  - Teleconferences (1 or 2)
  - Face to face meetings to be held at ESG, Magdeburg, Germany (30.5.-2.6.2010) and ICG, Bahia, Brazil (20.9.-25.9.2010)
    - Deliverables - meeting minutes; programme of work
- Revamp TC06 website

## PUBLICATIONS AND OTHER CONTRIBUTIONS

There were no TC06 publications in 2009. The contributions of TC06 to the EFONGA meeting and PacRim 8 (session on glass strength were included above).

### 4.1.9 OPTICAL PROPERTIES (TC10)

<b>Chairman:</b>	<b><i>C. Anderson, Saint-Gobain Recherche, France</i></b>
<b>Vice-Chairs:</b>	<b><i>P. van Nijnatten, OMT Solutions bv, The Netherlands</i></b>
<b>Minutes Secretary:</b>	<b><i>H.R. Wilson, Fraunhofer, Germany</i></b>
<b>Members:</b>	<b><i>F. Akmaz, Turkiye sise ve cam Fabrikalari A.S, Turkey</i></b>
	<b><i>S. Aldrich, Corning INC, USA</i></b>
	<b><i>J. Bretschneider, Flachglas Pilkington, Germany</i></b>
	<b><i>A. Daneo, Stazione Sperimentale del Vetro, Italy</i></b>
	<b><i>A.V. Dotsenko, Corning Scientific Center, Russia</i></b>
	<b><i>G. Flaman, BBR, Belgium</i></b>
	<b><i>G. Gagliardi, Pilkington-SIV, Italy</i></b>
	<b><i>A. Goussarov, SCK•CEN, Belgium</i></b>
	<b><i>Gurianov, Institute of High Pure Compounds, Russia</i></b>
	<b><i>Guorong Chen, Institute of Inorganic materials, China</i></b>
	<b><i>T. Hofmann, Centrosolar Glas GmbH &amp; Co KG, Germany</i></b>
	<b><i>M.G. Hutchins, Sonnergy LTD., England</i></b>
	<b><i>J. Jonsson, Lawrence Berkeley Laboratory, USA</i></b>
	<b><i>O. Kappertz, Interpane, Germany</i></b>
	<b><i>T. Kinoshita, Nippon Sheet Glass, Japan</i></b>
	<b><i>I. Marenne, AGC flat glass europe-R&amp;D Centre, Belgium</i></b>
	<b><i>F. Olive, CSTB, France</i></b>
	<b><i>C. Ottermann, SCHOTT AG, Germany</i></b>
	<b><i>G. Rossi, Istituto Elettrotecnico Nazionale, Italy</i></b>
	<b><i>A. Roos, Uppsala University, Sweden</i></b>
	<b><i>T. Saito, Asahi Glass CO., LTD, Japan</i></b>
	<b><i>J. Simons, INISMA, Belgium</i></b>

*Long Zhang, Shanghai Institute, China*

**Guests:** *J. Farmer, Pilkington Technology Centre, England*  
*I. Stemmler, Perkin Elmer, Germany*  
*M. Mika, vscht, Czech Republic*

#### **SUMMARY:**

During the year 2009 two meetings were held. The first meeting was held in Murano at SSV on the 27<sup>th</sup> of March. The second meeting was held in Prague on the 25<sup>th</sup> of September. Major topics of these meetings were:

- Progress on the optical characterization of diffusing and patterned glass products
- Determination of the dispersion functions of bare glass substrates
- Discussion for a new inter laboratory comparison on optical performance of glass products as a function of incidence angle
- TC 10 website

Also, during the year TC 10 membership added 6 new members:

- Scott Aldrich, CORNING, Inc, USA replaced Mr. Bucher.
- Antonio Daneo from SSV
- A.N. Gurianov from Institute of high pure compounds, Russia
- Jacob Jonsson, Lawrence Berkeley Laboratory, USA replaced Mike Rubin
- Olivier Kappertz from Interpane, Germany
- Taito Kinshita from Nippon Sheet Glass, Japan

New guests included:

Mr. I. Stemmler from Perkin Elmer, Germany: Mr. Stemmler represents the first guest that is a producer of optical spectrophotometers.

Mr. M. Mika: vscht (Institute of Chemical Technology, Prague) hosted the TC 10 meeting held in Prague in September.

Finally, TC 10 continued its collaboration with the CEN and ISO working groups via several several members of TC 10 who are also members of the WGs.

#### **PLANS AND DELIVERABLES FOR 2009**

Inter laboratory comparison for the optical characterization of diffusing and patterned glass products Different ideas were tested to decrease the scatter of measurement results among participants including the diffusing the incident light before the sample, an initial investigation in the integrating sphere design. Profilometry/rugosimetry measurements of the samples were performed but Monte Carlo modeling has not yet been performed to use these measurements. Hopefully, a better understanding of this topic will allow CEN/TC129/WG9 to consider changes to EN 410.

Maintenance on the TC 10 website was performed to increase the ease with which documents can be uploaded and viewed. Most results of the year were added.

The study on dispersion functions of bare glass substrates has been delayed in order to allow full resources to be applied to the inter laboratory comparison for the optical

characterization of diffusing and patterned glass products. This study will continue in 2010.

## ACTIVITIES in 2009

Inter laboratory comparison for the optical characterization of diffusing and patterned glass products: Several points for this study have been advanced. Theoretical limits on the transmission and reflection of patterned glass: Samples of the original glass charges for five different types of the patterned glass were ground to remove the pattern and then measured. The transmittance and reflectance results indicate theoretical limits for the patterned samples, including the effect of light incident obliquely on the glass surface. Results indicate that the agreement among participants and with the theoretical values is good for the flat and the "slightly rippled" samples, but that there can be significant deviations for the other sample types. Measurements using differently aged white standards to cover the direct reflectance traps indicate that differences between the white standard and the sphere wall coating are probably one cause of the deviation. Differences in baffle configurations may well be another cause. Profilometry/rugosimetry measurements will also provide useful information on the structure profile, which could be used in further analysis such as Monte Carlo modeling. Images of a laser beam in a translucent sphere after transmission or reflection by the samples give a qualitative indication of the spatial inhomogeneity of the light to be measured in the sphere.

The effects of translating and rotating the different samples were presented at meeting 1. In general, the effect of translating the sample was  $< 0.2\%$ . This leads to the conclusion that sufficient spatial averaging over sample inhomogeneity is achieved with the used beam cross-sections, and that the search for positions with minimum and maximum intensity is useful as a check but is not necessary within the round robin. The effect of rotation is significant for sample types 1 and 2. This is assumed to be a combination of the effects of polarisation and inhomogeneous light distribution within the sphere.

Measurements with tracing paper in front of the samples were performed. Initial results were presented at meeting 1 Photogoniometric scans were made at 550 nm. Screen images of white light transmitted by samples (beam cross-section 1 cm x 1 cm) were recorded, with and without tracing paper. The images with tracing paper are almost radially symmetric. A correction factor was derived by increasing the distance between the glass sample and paper. This corrects for multiple reflections between the paper and glass, but assumes all reflections to be for near-normal incidence, so the corrected value is still too high for flat glass. The tracing paper virtually eliminates the effect of the transmission trap losses. Using the tracing paper can help to improve the agreement between measurements for the samples with low-angle forward scattering, but not necessarily Albarino P (where sample variation may be a significant additional problem). It was decided to search for other scattering materials in order to optimize this technique

Due to the requests of several members and interest shown by CEN/TC129/WG9 TC 10, has started an inter laboratory comparison for optical characterization at non oblique angles. At the second meeting of the year, sample selections and decisions concerning wavelength and angular ranges were made.

## PLANS FOR 2010 AND DELIVERABLES

The inter laboratory comparison for the optical characterization of diffusing and patterned glass products will continue but with a reduced working group to investigate the possibilities to further understand the problems concerning this type of measurement. It is hoped that by September a measurement configuration and procedure can be formulated that will allow members of TC 10 to greatly reduce the dispersion of measurement results.

The inter laboratory comparison for variable angle measurements should progress with the samples cut, measured and distributed by the middle of March. Initial results should be available by September.

## PUBLICATIONS AND OTHER CONTRIBUTIONS

An interim report for the inter laboratory comparison for the optical characterization of diffusing and patterned glass products was written and delivered for the EFONGA project during the summer of 2009. This report is available on the public section of the TC10 website.

A summary of the work will be presented in a poster session at:

OTTI-Symposium Thermische Solarenergie  
05-07 May 2010. Kloster Banz, Bad Staffelstein, Germany.

In addition the work will be presented at

Solar Energy Society PVSAT-6 conference in Southampton in March.

A paper concerning the design of integrating spheres resulting from this investigation will be presented at the same conference.

### 4.1.10 CHEMICAL DURABILITY AND ANALYSIS (TC02)

**Chairman:** *Dominique Brochot, Corning SAS CETC, Avon, France*  
**Vice-Chair:** *Maria Malheiro, Saint-Gobain Recherche, Aubervilliers, France*  
**Secretary:** *Peter Sundberg, Glafo, Växjö, Sweden*

**Members:** *Ryouji Akiyama, Asahi glass, Yokohama, Japan*  
*Ayse Kerestecioglu, Sisecam, Istanbul, Turkey*  
*Elke Chorus, Saint-Gobain Deutschland, Herzogenrath, Germany*  
*Martina Scarpa, Stazione Sper. Vetro, Venezia, Italy*  
*Leos Bauer, Glass Institute, Hradec Kralove, Czech Republic*  
*Isabelle Lesieur, Isover Saint-Gobain, Rantigny, France*  
*Maria Malheiro, Saint-Gobain Recherche, Aubervilliers, France*  
*Heinrich Kipphardt, BAM, Berlin, Germany*  
*Ralf Eiden & Christine Strubel, Schott, Mainz, Germany*  
*Dominique Michiels, AGC Flat Glass, Jumet, Belgium*  
*Carolina Brillante, Philippine*  
*Scott Clemons, Corning INC, Corning, NY, USA*  
*José Simons, INISMa, Charleroi, Belgium*

*Stuart Jamieson, NSG Group, Lathom, UK*  
*Daniel Capon, GTS, Sheffield, UK*  
*Tepiwan Jitwatcharakomol, Glass Tech Centre. Bangkok, Thailand*  
*Sjaak Smolders, Philips Research, Eindhoven, The Netherlands*  
*Tatiana Antropova, Institute Silicate Chemistry, St Petersburg, Russia*

**Hon. Members :** *Emanuel Guadagnino*  
*Orhan Corumluoglu*

## SUMMARY

**Membership:** Mr Sam Leese (Sibelco, UK) will join the group and Mr JM Carpentier (INISMa, Mons, Belgium ) will replace Dr J. Simons end of next year. Mr D. Brochot will step out as Chairman of the TC02. We propose that he will be replaced by Mr S. Jamieson (NSG Group ). Philippe Pradeau ( from Corning SAS CETC ) was invited as a guest.

**Meetings:** TC2 met twice in 2009, in St Helens (UK) on April 2 - 3 (14 members in attendance) and in Mainz (Germany) on November 5-6 (13 members and 3 guests)

**Activity:** Still focused on Proficiency Tests and Rounds Robins (iron in low iron content sand, traces of mercury in glass, sulphide-sulphur determination in amber glass, major elements of the CRM BAM S005). End of our important work on SAC (Surface Ablation Cell), final manuscript nearly published in Glass Tech. More links with other TC's (C/S/N in AZS refractory for TC11 and TC14 and discussions with TC13 about lixiviation tests made by TC2 members for REACH glass exemption). Exploration of new techniques (quantification of lithium in glass ceramics using LIBS) Initiation of new and interesting topics e.g. the analysis of a glass ceramic working standard (lack of reference material on the market) and very low levels of iron in quartz, limestone and dolomite.

Communication:

- "Handbook of Recommended Analytical Methods by ICG TC2" printed and distributed (publication supported by EFONGA).
- EFONGA Montpellier Workshop ( May 2009 ) : "Presentation of TC2 work" - D. Brochot and "SAC Presentation" - Dr Sundberg

## PLANS AND DELIVERABLES FOR 2009

- SAC (Surface Ablation Cell) : finalization of the manuscript and publication
- Sulphur/sulphides in amber glass : compilation of additional results
- C/S/N in AZS refractory (in collaboration with TC11 and TC14)
- Proficiency Test : iron determination in low iron sand
- Main elements in CRM BAM S005
- Handbook of Recommended Analytical Methods by TC2

## ACTIVITIES in 2009

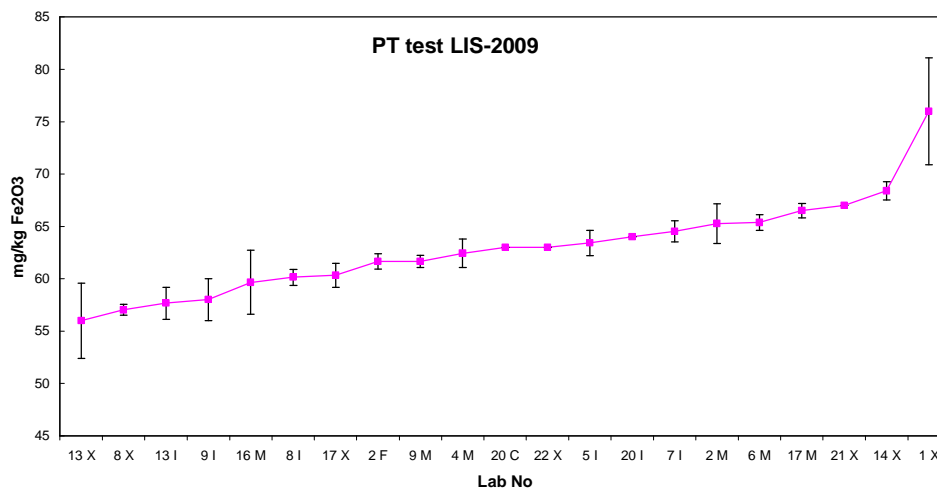
TC2 met first in St Helens (UK) hosted by NSG Group at the kind invitation of Mr S. Jamieson. The following topics were discussed:

- EFONGA project latest activities : presentation of the “Handbook of Recommended Analytical Methods by TC2” and preparation of the Montpellier workshop
- Glass ceramic as a working standard : discussion to find the right sample ( without competition problems )
- Mercury in glass (Directive 94/62/EC on packaging and packaging waste): need to get a new glass sample with sufficient Hg content
- C/S/N in AZS refractory (origin of bubbles in glass?). Presentation of Dr Köpsel (TC11) and initiation of the study (4 members agreed to participate using different techniques)
- Collaboration on sand analysis (BS2975-2-2008) and progress report on PT low iron sand from SIBELCO (LIS-2009) :



INTERNATIONAL COMMISSION ON GLASS  
A SOCIETY OF SCIENTIFIC AND TECHNICAL ORGANISATIONS  
TC 2 - Technical Committee 2

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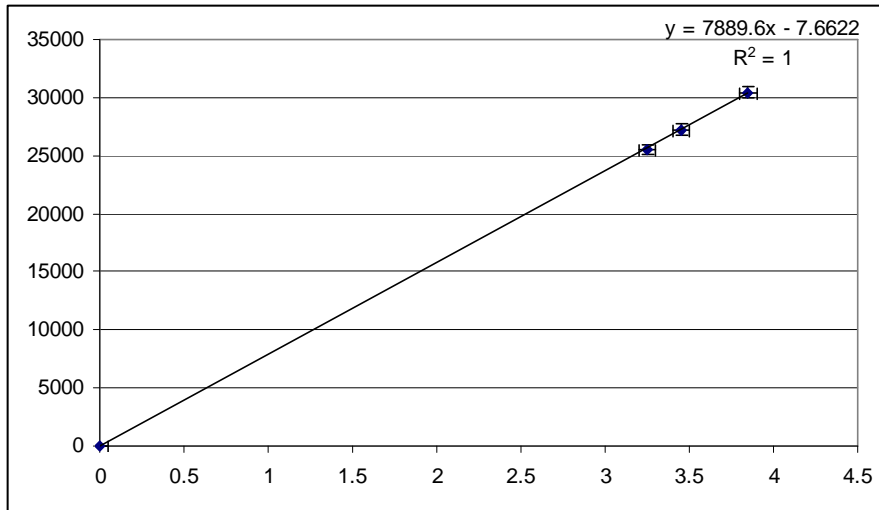


TC2 met again in Mainz (Germany) at the invitation of Schott.

The following items were discussed:

- End of EFONGA project and Montpellier workshop (presentations of D. Brochot and Dr Sundberg )
- Dr T. Hünlich from Schott presented a report from TC13 in relation to REACH. We discussed the lixiviation test protocol and lack of precision for key parameters.
- C/S/N in AZS refractory (links with TC11 and TC14): results obtained by combustion methods and GDMS were presented. More results needed but GDMS seems to be the best technique to achieve the low detection limits required.
- Arsenic leached from pharmaceutical containers: Dr Sundberg proposed to study the level of arsenic present in containers and the amount extracted.
- Low iron measurements in limestone and dolomite : PT tests will be initiated ( SIBELCO will provide samples )

- Collaborative works have been reviewed (Hg traces in glass, sulphide/sulphur in amber glass, proficiency testing of sand, major elements in CRM BAM S005)
- LIBS with the presentation of the work done by IVEA (a French supplier) on lithium determination in glass ceramics : interesting quantitative results obtained on pristine surface after 40 pre-shots @ 812.691 nm ( counts = f (Li<sub>2</sub>O content ) :



New topics : in addition to the glass ceramic working standard

(samples distributed during the meeting) many new topics were proposed by members including the determination of high level fluorine concentrations in special optical glasses, a glass with Hg in 10 to 50 ppm range (for XRF use), glass with increased durability and arsenic in pharmaceutical containers...

Impressive list of documents issued in 2009:

- ICG/TC2/08-1502: Press release Nov 2008
- ICG/TC2/08-1503: Total sulphur
- ICG/TC2/08-1504: Sulphide Sulphur
- ICG/TC2/08-1505: Annual Report 2008
- ICG/TC2/08-1506: AZS refractory presentation (Dr Köepfel)
- ICG/TC2/08-1507: RR77 circular letter PT on sand LIS 2009
- ICG/TC2/08-1508: Calling notice and preliminary agenda St Helens meeting
- ICG/TC2/08-1509: Sulphide Sulphur by ISE (Dr Bauer)
- ICG/TC2/08-1510: Draft International Standard ISO DIS 4802-1
- ICG/TC2/08-1511: Draft International Standard ISO DIS 4802-2
- ICG/TC2/08-1512: Results from RR77 PT on sand LIS-2009
- ICG/TC2/08-1513: EFONGA presentation of TC2 work (Mr Brochet)
- ICG/TC2/08-1514: Report from the 91<sup>st</sup> meeting in St Helens (UK) on April 2-3, 2009
- ICG/TC2/08-1515: Presentation on preparation of glass with Hg traces (Mrs Scarpa)



ICG/TC2/08-1516: Determination of sulphides and total sulphur in glass by ICP (Dr Simons)

ICG/TC2/08-1517: Draft manuscript: Surface Analysis of float glass using SAC

ICG/TC2/08-1518: Action sheet arising from 91<sup>st</sup> meeting in St Helens

ICG/TC2/08-1519: Final manuscript: Surface Analysis of float glass using SAC

ICG/TC2/08-1520: Draft agenda

ICG/TC2/08-1521: Instructions and results sheet RR78: "Analysis of Hg in glass"

ICG/TC2/08-152: Instructions and results sheet RR79: "Main elements in CRM BAM S005A/B"

ICG/TC2/08-1523: Invitation to Sam Leese

ICG/TC2/08-1524: TC13 report: Preliminary report on availability of glass constituents with regard to the European regulation REACH

ICG/TC2/08-1525: Determination of Sulphide Sulphur by titration (Dr Bauer)

ICG/TC2/08-1526: RR78: Total Sulphur and Sulphide Sulphur Determination in glass

ICG/TC2/08-1527: Results sheet for Chinese Glass ceramic RR80

ICG/TC2/08-1528: Outcome from collaborative work on fusions with mercury

ICG/TC2/08-1529: Outcome from collaborative work on BAM CRM S005

ICG/TC2/08-1530: Homogeneity test of glass plates located at SSdV (Dr Smolders)

ICG/TC2/08-1531: XRF analysis of pieces given during St Helens meeting ((Mr Brochot)

ICG/TC2/08-1532: Low Iron Sand - Update results

ICG/TC2/08-1533: Elements to quantify in vitreous ceramic sample BD 2009-1 "Novatec"

ICG/TC2/08-1534: Homogeneity test of 5 glass plates from SSdV (Dr J. Simons)

ICG/TC2/08-1535: Low iron measurements in limestone and dolomite (J. Jamieson)

ICG/TC2/08-1536: C and S quantification in refractory block (Dr S. Smolders)

ICG/TC2/08-1537: Mercury level in glass decrease with time (Mrs M. Scarpa)

ICG/TC2/08-1538: Sand homogeneity in big-bag (Dr D. Michiels)

ICG/TC2/08-1539: EFONGA Montpellier / Presentation of SAC (Dr Sundberg)

ICG/TC2/08-1540: Report of the 92<sup>nd</sup> meeting of TC2 held in Mainz, November 2009

ICG/TC2/08-1541: Action sheet arising from 92<sup>nd</sup> meeting of TC2 (Mainz/Nov. 2009)

## PLANS FOR 2010 AND DELIVERABLES

- Finalization of 2009 topics :
  - SAC publication, Hg in glass, sulphide and sulphur in amber glass, PT on low iron sand, main elements in BAM S005, C/S/N in AZS refractory
- New topics launched :
  - Analysis of DB 2009-1 Novatec Glass ceramic to be used as working standard
  - Determination of low level iron in a quartz
  - Low iron measurements in limestone and dolomite
- Future topics
  - F determination in high fluorine content glass ( fluoro-phosphate glass )
  - Hg in glass in the range of 10-50 mg/kg ( to be used as XRF standard
  - Glasses with increased durability
  - Arsenic determination in pharmaceutical containers
- Spring meeting will be held in Växjö ( Sweden ) on April 8-9, 2010 at the kind invitation of Glafo
- Fall meeting will take place at Miplaza ( Philips Research ) in Eindhoven ( The Netherlands )

## PUBLICATIONS AND OTHER CONTRIBUTIONS

\* “Handbook of Recommended Analytical Methods” by ICG TC2 Chemical Durability and Analysis (prepared by E. Guadagnino and O. Corumluoglu)

## 4.2 R&D ACTIVITY FIELD “GLASS MELTING”

### 4.2.1 GLASS MELTING (TC18)

**Chairman:** *Ruud Beerkens, TNO, Eindhoven, Netherlands*  
**Vice-Chairs:** *Reinhard Conradt, RWTH, Aachen (TC23)*  
**Members:** *Hande Sengel, Sisecam, Turkey*  
*Hayo Mueller-Simon, HVG, Germany*  
*Detlef Koepsel, Schott AG Germany (TC14)*  
*Masataka Kawaguchi, NEG, Japan*  
*Shige Oaki, NEG, Japan*  
*Oleg Prokhorenko, Russia*  
*Ulrich Roger HVG, Germany*  
*Yasushi Kii NEG, Japan* **NEW MEMBER**  
*Satoshi Yoshida, Univ. Shiga Prefecture, Japan*  
*Neill McDonald, Saint Gobain, France* **NEW MEMBER**  
*Leena Hupa, Åbo Akademi Univ., Finland*  
*Alix Clare, Alfred Univ., USA*  
*Harrie Stevens, Alfred Univ., USA*  
*Wilfried Linz, Schott AG, Germany (TC15)*  
*Edward Boulos Ford-retired, USA*  
*Wolfgang Muschick, Schott AG, Germany (TC21)*  
*Erik Muijsenberg, Glass Service, Czech Republic (TC21)*  
*Thomas Pfeiffer, Schott AG, Germany*  
*John Buckett, NSG/Pilkington, UK (TC14)*  
*Nobuyuki Kido Asahi Glass Ceramics, Japan*  
*Marie-Helene Chopinet, Saint Gobain Recherche, France*  
*Gulcin Albayrak Şişecam, Turkey*  
*Kaj Karlsson, University Åbo Akademi, Finland*  
*Christina Stålhandske Glafo, Sweden*  
*Christopher Berndhäuser, Schott AG, Germany (TC25)*  
*Jan Hermans, Philips Lighting, The Netherlands.*

### SUMMARY

TC18 organized in co-operation with other TC's (TC11, TC14, TC21, TC25) a workshop in Montpellier on 7. and 8. May 2009. The workshop addressed activities performed on glass melting projects within the EU EFONGA project between 2005-2009.

A seminar was organized in Istanbul on Glass Quality and Glass Defects (12-14 May).

TC18 met in Vancouver Canada at the ICG-2009 annual meeting on the 1<sup>st</sup> of June. Important points of the annual meeting were the follow-up activities of the 2008 BRIG expert meeting on Innovative Glass Melting concepts for the year 2020. TC18 will co-organize with other organizations workshops in 2010 and 2011 on new technologies for improving glass melting efficiency.

TC18 runs a Round Robin Test on thermodynamic modeling of multi-component silicate melts and the participants in the Round Robin project have been discussed.

TC18 published in the year 2008 a paper on liquidus temperature measurements in Glass Technology.

Furthermore, TC18 plans to meet in 2010 in Magdeburg at the DGG-ESG-GlassTrend conferences from 30. May-2. June 2010.

#### **PLANS AND DELIVERABLES FOR 2009**

In 2009 TC18 met in Vancouver, minutes of the meeting have been prepared. The meeting was attended by 12 members. Topics during this meeting: Catalogue of facilities/laboratories for measuring glass melt properties, Updated WebSite of TC18, a discussion on: "Roadmap process - where should glass melt technology heading for" and 3 oral papers were presented: Oral Presentations after the end of the regular meeting:

- Reinhard Conradt: Thermodynamic modelling of silicate systems, the TC18 Round Robin Test
- Yasushi Kii: Study of Sulfate Decomposition Behavior in Silicate Melts by Differential Pulse Voltammetry with in-site Observation
- Ruud Beerkens; Hans van Limpt: Evaporation studies of glass melts containing sodium oxide, sulfates and borates, derivation of chemical activities of volatile glass compounds

TC18 organized the Montpellier workshops on Glass Production 7. and 8. May 2009 with a CD ROM of collected power point presentations, see annex 1.

Furthermore a seminar on Glass Melt Quality and Glass Defects was organized and the abstracts of presented papers & presentations (power points) have been collected.

#### **ACTIVITIES in 2009**

- A meeting was held at HVG in Offenbach, Germany on 8. January 2009 to discuss follow-up activities derived from the BRIG expert meeting on "Innovation in Glass Melting for the Year 2020". It was decided during this meeting to start the organization of a 2-days seminar/workshop on sensors for glass production.
- Organization of a workshop-seminar on EFONGA activities between 2005 and 2009 on 7. and 8. May 2009 in Montpellier France (see annex 1). During this workshop 14 papers have been presented. 7 of these papers were contributed by TC18 members.
- In co-operation with GlassTrend, a seminar on: Glass Melt Quality & Glass Defects was organized in Istanbul, 12-14 May 2009 with about 50 participants.



- A roadmap vision on developments for glass melting processes from 2009 - 2020 was discussed on 8. May.
- An annual meeting of TC18 was organized in Vancouver Canada on 1. June in connection to the ICG annual meeting.
- A Round Robin Test on Thermodynamic Modelling of Multi-Component Glass Melts is progressing

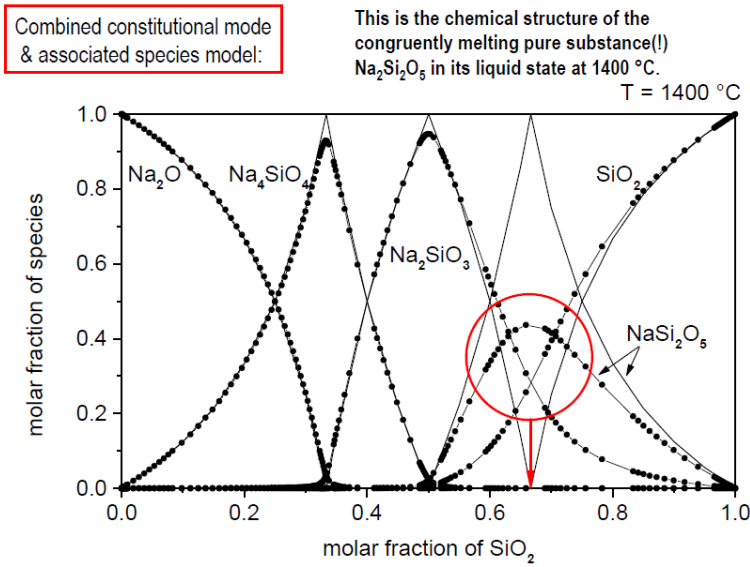


Fig. 4.2.1: Thermodynamic modelling of sodium-silicate system (R. Conradt, RWTH)

- Preparation of a seminar/workshop on Advanced Sensors and Process Control for 2010 have started
  - Contributions concerning work package 3.1 have been delivered in May/June for the final report of EFONGA project
  - Submission of proposal for organizing 4 workshops in the COST program: Glass Melting - proposals for workshops on:
    - Sensors & Process Control
    - Heat Recovery from Waste Gases of Glass Furnaces
    - Innovative furnace designs / segmented melters / rapid melters
    - Pre-treatment of Raw Materials and Reactive Batches
- See ANNEX2: Glass Melts projects in COST (seminars & topical roadmaps for glass melting)

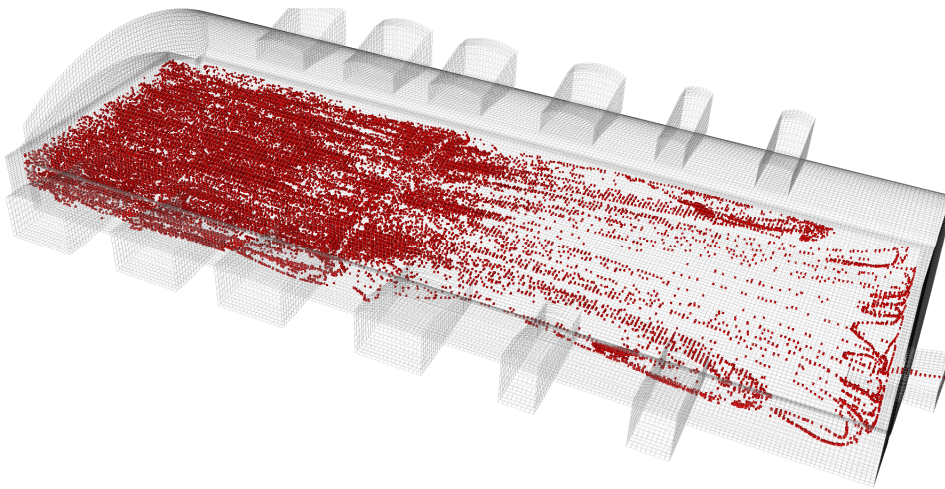


Fig. 4.2.2: Patterns of refractory related defects in glass melting tank (Glass Furnace Simulation Models)

#### PLANS FOR 2010 AND DELIVERABLES

- TC18 plans to organize an annual meeting in Magdeburg at the ESG-DGG-GlassTrend conferences from 30. May - 2. June 2010. Deliverable: the minutes of the meeting and power point presentations.
- A seminar on “Glass Furnaces & Refractory Materials” will be organized in Magdeburg (25 papers) in co-operation with TC11 (Materials for Glass Manufacturing). Deliverable: program, abstracts booklet and collection of presented power points.
- A seminar on Advanced Sensors and Process Control will be organized in the 3<sup>rd</sup> or 4<sup>th</sup> quarter of 2010 in co-operation with TC15 (Sensors and Advanced Control) and GlassTrend. Preferred location: Maastricht, The Netherlands. Deliverable: program, abstracts booklet and collection of presented power points. Further deliverable: Summarized roadmap for sensor development for glass furnaces: 2010-2020.
- Continuation of Round Robin Test on Thermodynamic Modelling of Multi-Component Glass Melts. Deliverable in 2010 or 2011 a report of results of this Round Robin Project.

*\*Unfortunately, participation in the project is limited to about 4 or 5 parties, because of limited resources on laboratories or institutes to participate.*

#### PUBLICATIONS AND OTHER CONTRIBUTIONS

No publications but collections of power point presentations of:

- Montpellier EFONGA workshop: 7. - 8. May 2009
- Seminar on *Glass Melt Quality & Glass Defects* on 12.-14. May 2009
- Experts Meeting on Conditioning of Glass Melts and Forming of Glass Products, ICG Expert Meeting DGG Journal 8 (2009) nr. 4. pp. 37-38 (Expert meeting TC18 and TC25 in November 2008).
- Beerkens, R.; Bange, K.; Duran, A.: *Glass-the Challenge for the 21th century*. Bol. Soc. Esp. Ceram. V. 47, 6 (2008), pp. 366-370
- *Glass Trend- Siseecam Glass Quality Workshop*, Glass Worldwide July/August 2009, pp. 58

- Ruud Beerkens: *Industrial Glass Melting Today: An Analysis and Recommendations for New Melting Concepts*. Glass Machinery plants & accessories 3/2009 pp. 70-73

#### **4.2.2 MODELLING OF GLASS MELTING PROCESSES (TC21)**

**Chairman:** *Erik Muijsenberg, Glass Service, Maastricht, Netherlands*

**Members** *Wolfgang Muschick, Mainz, Germany*  
*Uwe Krieger, University of Ilmenau, Germany*  
*Lale Onsel, Sisecam, Istanbul, Turkey*  
*Sanjay Somany, HNG, India*  
*AC Jain, HNG, India*  
*Aaron Huber John Manville, USA*  
*Bob Kosmyna, OI, USA*  
*Kenji Oda, AGC Japan*  
*Fabrice Fasilow, AGC, Belgium*  
*Laurent Pierrot, Saint Gobain, France*  
*Christian Müller, Schott AG, Germany*  
*Stanislav Kasa, ICT Prague, Czech Republic*  
*Menno Eisenga, Glass Service, Netherlands*  
*Graham Unwin, Pilkington, UK*  
*Adriaan Lankhorst, TNO, Netherlands*  
*Dries Hegen, TNO, Netherlands*  
*Gerd Philipp, JSJ-Jodeit, Germany*  
*Otto Hofmann Jena, Germany*  
*Wolf Kuhn, Stein Heurtey, France*  
*Robert Markiewicz, Videocon, Poland*  
*Matthias Lindig, Sorg, Germany*  
*Camille Moukarzel, Stein Heurtey, France*  
*Klaus Jochem, Schott, Germany*  
*Zeynep Eltutar, Sisecam, Turkey*  
*Ozel Sinem, Sisecam, Turkey*  
*Fabien Bouillet, Saint Gobain, France*  
*Didier Bessette, Fluent, France*

#### **SUMMARY**

TC21 main activity is to improve quality and reliability of glass furnace simulation modelling and optimization of software packages of different suppliers and glass producing factories. The most effective way to understand the strong and weak points is by simulating glass melt flows, heat transfer and temperatures of typical glass melting furnaces with the models of different participants. The same and well defined typical glass furnace is modelled and results of this modelling are preferably compared with actual measured and validated data on the same furnace. This allows the different participants to compare and validate results with each other and also with real measured data. Such a comparison activity is usually referred to as Round Robin Test (RRT). In the past, TC21 has used several different so called RRT's and now reached definition RRT5. The RRT 5 is based on a TV panel glass melting furnaces that has been existing and for which measured data of temperatures, residence times are available. The previous RRT 4 and 4a will be reported in 2009.

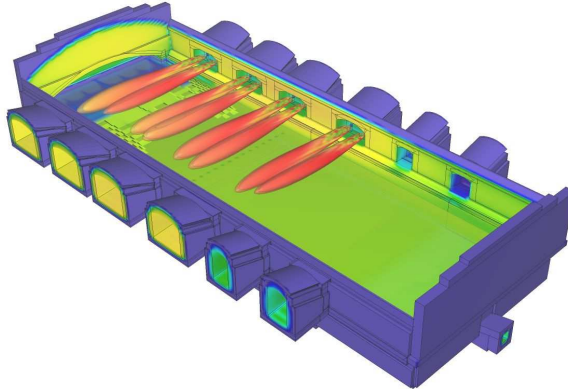


Fig. 4.2.1: 3D picture of TV panel melting furnace RRT5  
Input data collected and supplied by TNO

#### PLANS AND DELIVERABLES FOR 2009

1. Preparation of report on the RRT 4-4a results
2. Gather and discuss results of RRT 5 and improve definition
3. General discussion about future of modelling of glass melting processes

#### ACTIVITIES in 2009

1. TC21 annual report
2. Minutes of meetings on the 16 June 2009 meeting in Velke Karlovice Czech Republic
3. Discussion and comparison of results of RRT5 during TC21 meeting in Czech Republic. 4 participants presented their 1<sup>st</sup> results of RRT5. The agreement till now seems promising and closer to each other than what was achieved with RRT4. More results and data are expected to be reported during 2010.
4. Discussion on further improvements of definition of the RRT5 case (boundary conditions, assumptions to be made).
5. Draft report on RRT 4-4a prepared

#### PLANS FOR 2010 AND DELIVERABLE

1. Organize a TC21 meeting most likely during ICG meeting in Brasil 2010.
2. Discuss further and more results of RRT5.
3. Organize in cooperation with TC14, special lecture session during the ICG congress in Brazil on the topic modelling of bubble behaviour in glass melts.
4. General (Overview) Lecture during ICG about activities and results of TC21.
5. Progress report on RRT5.

#### PUBLICATIONS AND OTHER CONTRIBUTIONS

Lecture about TC21 activities over last year and at present during 10<sup>th</sup> Conference of Simulation of Glass Melting Processes held in June 2009 in Velke Karlovice, Czech Republic.

#### 4.2.3 MODELLING OF GLASS FORMING (TC25)

<b>Chairman:</b>	<i>C Berndhäuser, Schott AG, Germany</i>
<b>Vice-Chair:</b>	<i>D Locheignies, Univ. Valenciennes, France</i>
<b>Core Group:</b>	<i>D Hegen, TNO, The Netherlands</i> <i>M Hyre, Virginia Military Institute, USA</i> <i>A Karadag, Sisecam, Turkey</i>
<b>Members:</b>	<i>S Aoki, NEG, Japan</i> <i>C Bajart, ARC International, France</i> <i>Y Cai, Johns Manville, USA</i> <i>J H Chumley, Logotec Constr., Inc., USA</i> <i>O Fontaine de Ghelin, AGC FlatGlass - Belgium</i> <i>R Koch, GS Improve, The Netherlands</i> <i>T Marchal, Polyflow, Belgium</i> <i>D Martlew, Pilkington, UK</i> <i>I Matousek, Univ. Liberec, Czech Rep.</i> <i>A Moeller, No Grid, Germany</i> <i>M Moravsky, 2M-Consulting, Slovak Rep.</i> <i>P Moreau, Univ. Valenciennes, France</i> <i>K Oda, Asahi Glass Company, Japan</i> <i>R Penlington, Univ. of Northumbria, UK</i> <i>S Primdahl, Rockwool Intl., Denmark</i> <i>O Prokhorenko, Lab. Glass Properties, Russia</i> <i>S Rekhson, Cleveland State Univ., USA</i> <i>C Richards, PPG Industries Inc, USA</i> <i>M van Iseghem, France</i> <i>R von der Ohe, St Gobain Recherche, France</i> <i>P Vrabel, Rona Crystal,</i> <i>A Yi, Ohio State University, USA</i> <i>Y Youmani, Air Liquide, France</i>
<b>Guests:</b>	<i>P Ngankeu, Emhart Glass, USA</i> <i>E Muijsenberg, Glass Service, The Netherlands</i>

TC25 haven't had a meeting this year - partly due to the worldwide financial crisis it was not possible to get at least a handful of members joining the meeting scheduled for Vancouver. A meeting is planned for 2010.

#### 4.2.4 MATERIALS FOR GLASS MANUFACTURING (TC11)

<b>Chairman:</b>	<i>Michael Dunkl, Dr. M. Dunkl Consulting, Germany</i>
<b>Vice-Chairs:</b>	<i>Nobuyuki Kido, AGC CERAMICS CO., Ltd, Japan</i>
<b>Secretary:</b>	<i>Jean-Pierre Meynckens, AGC Flatglass Europe, Belgium</i>
<b>Members:</b>	<i>Esref Aydin, Sisecam, Turkey</i> <i>Janusz Zborowski, SCHOTT AG, Germany</i> <i>Michel Gaubil, Saint Gobain CNEE-SEFPRO, France</i> <i>Rongxing Bei, RHI AG, Germany</i> <i>Roland Heidrich, RHI REFEL, Germany</i> <i>Chris Windle, DSF</i> <i>Anne Jans Faber, TNO, The Netherlands</i> <i>Bernhard Fleischmann, DGG, Germany</i>



*Simon Petro di Pierro, Saint Gobain Recherche, France*  
*Michel Maquet, Saint Gobain, France*  
*Sandro Hreglich, Stazione Sperimentale del Vetro, Italy*  
*Roel van Herten, Philips Lighting, The Netherlands*  
*Larry Kotaska, CORNING*  
*Detlef Koepsel, SCHOTT AG, Germany*  
*Wilfried Linz, SCHOTT AG, Germany*  
*Jean Louis Heitz, CRITT, France*  
*Dilip Patel, NARCO*  
*Hans-Peter Martins, PLANSEE*  
*John Buckett, Pilkington, UK*  
*Brian Harris, Pilkington, UK*  
*Mariano Velez, MOSCI*  
*Amul Gupta, RHI MONOFRAX*  
*Mathi Rongen, TNO, The Netherlands*  
*Mustfa Oran, SISECAM, Turkey*  
*Samir Tabloui, FIVES STEIN*  
*Noriyuki Yoshida, NEG, Japan*  
*Jaroslav Klouzek, Institute of Chemical Technology, Czech Republic*

#### **SUMMARY**

In the framework of the TC11/TC14 round robin test (Blister in Glass from Refractory Interaction), Nobuyuki Kido from AGC Ceramics carried out a further dynamic blister test (glass melt - tank refractory interaction) under the same conditions, as described within the procedure worked out from Michael Dunkl. The results of the Round Robin Tests between Tank Refractory-Glass Melt of the laboratories of the companies: AGC Ceramics and SCHOTT will be compared and discussed in 2010. Unfortunately, the scheduled TC11 and joint TC11/TC14 meetings during the Refractory Colloquium in Aachen in September 2009 did not take place regarding the world wide crisis (lack of participants).

#### **PLANS AND DELIVERABLES FOR 2009**

Regarding the worldwide crisis (severe travel ling restriction for most of the TC11 members), no group activities of the TC 11 took place in 2009.

#### **ACTIVITIES in 2009**

For the joint TC11/TC14 round robin test, Nobuyuki Kido from AGC Ceramics carried out a further dynamic blister test based on the same conditions as described within the procedure worked out from Michael Dunkl. The results of the Round Robin AGC and SCHOTT will be further compared and discussed in 2010, to find out what was the reason of the differences of the results of previous dynamic blister tests (performed at different conditions? Or different observation tools?). If the results of the both tests are similar, the other RRT (static crucible test HTO test) can be start probably involving more laboratories. TC11 is involved in organizing a seminar on Glass Furnaces & Refractory Materials to be held in Magdeburg in June 2010.

#### **PLANS FOR 2010 AND TARGETTED DELIVERABLES**

1. TC 11 meeting during 10th ESG Conference together with the 84. Glastechnische Tagung (German Glass Society meeting), Glass Trend seminar on Glass Furnaces & Refractory Materials and with the DGG-Symposium, Novel Optical Technologies in June 2010.
2. Joint TC11/TC14 meeting during the 10th ESG Conference with the presentation of the repeated dynamic blister test results from AGC CERAMICS and SCHOTT AG. Determination of further steps of the TC11/TC14 RRT.
3. TC 11 and joint TC 11/TC14 meetings during the ICG 2010 Congress in Salvador Bahia Brazil (September 2010).
4. Within the ICG 2010 Congress, a one day symposium will be scheduled: "Blister formation from refractory - glass melt interfaces, organized by TC14 & TC11". Organisation by: Detlef Köpsel, Jean Pierre Meynckens, Michel Gaubil and Michael Dunkl.
5. A presentation of TC11 activities (overview) at the conferences on 31. May - 2. June 2010 in Magdeburg.

One deliverable in 2010 might be a draft report of the comparable results of the RRT on "Blisters in Glass from Refractory Materials".

Another deliverable in 2010 might be a kind of roadmap, with a proposed schedule of activities of TC 11 in the next 3-5 years.

#### **PUBLICATIONS AND OTHER CONTRIBUTIONS**

During the 10th ESG Conference together with the 84. Glastechnische Tagung (German Glass Society congress) the Glass Trend Seminar „Glass Furnaces and Refractory Materials“ and the Plansee Seminar „Refractory Metals for the Glass Industry“ takes place. Several refractory related papers from TC 11 members are scheduled.

For the **one-day symposium** during the ICG 2010 Congress "Blister formation from refractory - glass melt interfaces / TC14 & TC11", the following possible topics are scheduled:

- Experimental methods to characterize the blister formation in glass melts at refractory interfaces;
- Gases in blisters in glass from refractory interaction;
- Understanding blister formation mechanisms;
- Relationship between corrosion of refractories and blister formation;
- Strategies for the selection of refractory materials from the viewpoint of blister formation potential;
- Development of refractory material with low blister formation potential;
- Refractories for new glass melting concepts.

#### **4.2.5 SENSORS AND ADVANCED CONTROL (TC15)**

**Chairman:** W. Linz, SCHOTT AG, Germany  
**Vice-Chairs:** K. Oda, AGC, Japan  
**Members:** A. Huber, Johns Manville, USA  
K. Kono, Nippon Electric Glass Co, Ltd., Japan  
J. Plodinec, SRNL, USA  
P. H. Guering, St. Gobain, France

**New Members:**

- I. Solis, Vitro, Mexico*
- B. Purnode, Owens Corning, USA*
- C. Wright, NSG/Pilkington, UK*
- M. Demeyere, AGC Flatglass Europe, Belgium*
- H. Müller-Simon, HVG, Germany*
- P. Laimböck, Readox, Netherlands*
- E. Muijsenberg, GS, Netherlands*
- A.M.Kondurin, Novocherkassk Polytechnic Inst., Russia*

#### **SUMMARY**

A meeting of the core group took place at HVG in Offenbach in Jan. 8, 2009 discussing and preparing a proposal for a R&D project "Sensors and advanced model based predictive control (MPC) for industrial glass production". Because of the worldwide economic situation no further meetings were held in 2009. Further planning was made concerning a seminar/workshop/expert-meeting in 2010 on Advanced Sensors & Process Control in the Glass Industry (probably Maastricht, Netherland sponsored by SenterNovem in co-operation with TC15 of the ICG, DGG and Dutch NCNG).

#### **PLANS AND DELIVERABLES FOR 2009**

The planned activities to initiate a R&D-Project (as spin-off from the BRIG expert meeting 2008) and to apply for national or international funding was carried out, but to apply for funding through European Union was not possible because at the end the frame did not fit with the criteria. The planned TC15-meeting in Velke Karlovice, Czech Republic was cancelled because of the world wide economic situation.

#### **ACTIVITIES in 2009**

A meeting of the core group took place at HVG in Offenbach, Germany on 8. January 2009, discussing and preparing a proposal for a R&D project "Sensors and advanced model based predictive control (MPC) for industrial glass production".

Objectives: Development of a system of sensors and model based predictive control (MPC) software and its tests under industrial conditions. Detailed descriptions of work packages and activities with correlated timetable (milestones), proposed partners from industry, suppliers and university institutes and a table with related costs and possible funding were worked out. (Focus on: Sensors for foam thickness and sensors monitoring flue gas composition). Because of the worldwide economic situation no further meeting were held in 2009. Further planning was made, concerning a seminar/workshop/expert-meeting in fall 2010 on Advanced Sensors & Process Control in the Glass Industry (probably Maastricht, Netherland supported by SenterNovem).

#### **PLANS FOR 2010 AND DELIVERABLE**

Organisation of and preparation for a seminar/workshop/expert-meeting on: "Advanced Sensors & Process Control in the Glass Industry" with experts and their input also from outside glass industry.

A TC15 core group meeting is planned to be during the ESG-/DGG-Conference and Glass Trend Seminar in Magdeburg (Germany) from 30. May till 2. June, 2010.

A TC15 meeting will take place in connection with the planned seminar/workshop/expert-meeting in Maastricht (Oct. 2010).

#### 4.2.6 GASES IN GLASS (TC14)

**Chairman:** *Detlef Koepsel, Schott AG, Germany*  
**Vice-Chair:** *Noriyuki Yoshida, NEG, Japan*  
**Secretary:** *John Buckett, Pilkington Group Limited, UK*  
**Members:** *Marie-Helene Chopinet, St.Gobain Recherche*  
*Yukihito Nagashima, NSG, Japan*  
*Jaroslav Klouzek, ICT Prague, Czech Republic*  
*Fritz Krämer, Schott (retired, Germany)*  
*Hayo Müller Simon, HVG-DGG, Germany*  
*Jan Hermans, Philips, Netherlands*  
*Ruud Beerkens, TNO, Netherlands*  
*Stefano Maurina, SSV, Murano, Italy*  
*Martin Gaber, BAM Berlin, Germany*  
*Ralf Mueller, BAM Berlin, Germany*  
*Jiri Ullrich, Glass Service, Vsetin, Czech Republic*  
*Lubomir Nemeč, ICT Prague, Czech Republic*  
*Harald Behrens, University of Hannover, Germany*  
*James E. Shelby, Alfred University, USA*  
*Juergen Daniel, ZGU Ilmenau, Germany*  
*Mustafa Oran, Sisecam, Turkey*  
*Leonid Glebov, University of Florida, USA*  
*Klaus Heide, Friedrich-Schiller University Jena, Germany*  
*Hande Sengel, Sisecam, Turkey*  
*Wolf S. Kuhn, Stein-Heurtey, France*

#### **SUMMARY**

The main lines of activities in this of Gases in Glass field of TC14 are:

- Determination of IR spectroscopic absorption coefficients due to water in borosilicate glasses
- Determination of the blistering rate of AZS refractories in glass melt contact in order to work out a standard test method (in collaboration with TC 11)
- Understanding the mechanisms of deposit formation in bubbles in float glass

The highlights in these fields were:

- With additional ERDA (Elastic Recoil Detection Analysis) analysis the deviations in water content analysis in borosilicate glass observed between the NRA and VHE measurements are now better understood. These deviations are caused by the formation of HBO<sub>2</sub> during the Vacuum High Temperature Extraction, which cannot be analysed quantitatively with mass spectrometer.
- The differences found in the RRT on determination of the blistering rate of refractory material in contact with molten glass are now understood. They are caused by the different resolution of the camera and optical system used.
- The main mechanism of deposit formation is now understood. Deposits are formed by the disproportionation of SO<sub>2</sub> in a bubble during cooling of the glass and reaction with alkali oxides at the bubble boundary.

In 2009 2 meetings have been organised:

- TC 14 meeting in Istanbul with 10 participants on 14. May, 2009

- TC14 seminar in co-operation with GlassTrend on Glass Melt Quality & Glass Defects on 13. and 14. May 2009 in Istanbul
- Joint meeting of TC 2 and TC 14 in Mainz with 1 participant of TC 14.

## PLANS AND DELIVERABLES FOR 2009

### a) Water in borosilicate glasses

In addition to measurements undertaken in 2007 and 2008, the absolute value of the water concentration in borosilicate glass samples has been analysed with an additional method - Elastic Recoil Detection Analysis (ERDA). The results on the variation of the absorption coefficient for water in a range of borosilicate glass compositions as determined, using the five different methods are summarised in figure 1 below. Inspection of the figures shows that within the range of experimental error the NRA, ERDA and KFT techniques agree in the variation of absorption coefficient as a function of glass composition. The VHE technique consistently evolved slightly lower amounts of water and hence would give a higher water absorption coefficient. Some water from borosilicate glass melts may be evolved in the form of HBO<sub>2</sub> vapor, which cannot be quantitatively analysed using mass spectroscopy.

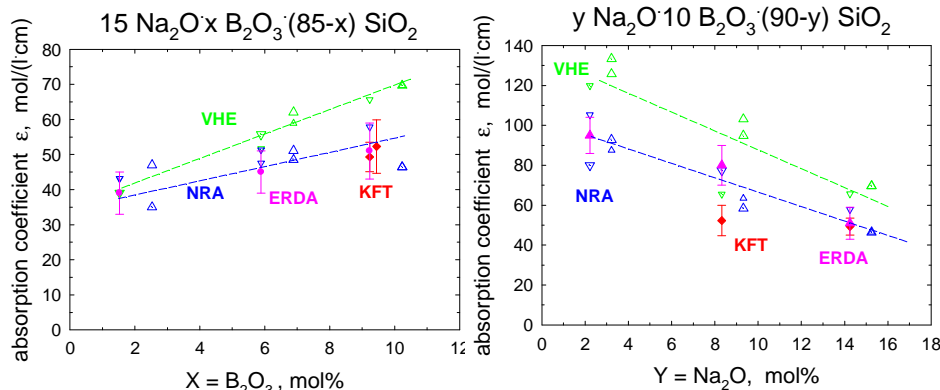


Fig. 4.2.1: absorption coefficient relating to water content for the band at 2.8  $\mu\text{m}$  in borosilicate glasses, determined with 4 different analytical methods for water content in borosilicate glass samples.

### b) Refractory blisters (in collaboration with TC 2 and TC 11)

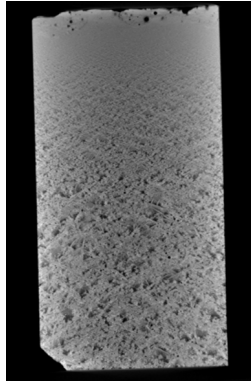
The round robin test on the determination of the blistering rate from refractory material in direct contact with molten glass with the dynamic blister test has been repeated three times using fused cast AZS refractory material. The differences found in round 1 and 2 are caused by the difference in the optical resolution of the camera systems used by the two participants.

In order to understand the mechanisms of blister formation not only the analysis of the gas content of freshly formed blisters at the refractory - glass melt interface is important, but also the analysis of impurities in the refractory material exposed to the molten glass. Therefore, it was decided to broaden the focus of this activity by analysing the impurities in the refractory material such as carbon, sulphur and nitrogen (nitrides) contents. First results (3 of 6 participants), show that the sulphur concentration in all samples is very low (< 10 ppm-wt). The values carbon and nitrogen are higher, but have a higher range of deviation.

Additionally, the structure of the AZS refractory was explored using Computer Tomography (CT).

Inspection of the CT pictures shows that the AZS refractory contains many pores that could potentially be responsible for blister generation when in contact with a glass melt. An initial investigation into the chemistry of the gas trapped in the refractory pores has been undertaken:

N2	CO2	Ar	H2	CH4
42.1	17.3	0.0	0.0	40.6
11.8	25.4	0.0	0.0	62.8
15.4	10.3	0.0	45.3	27.3
11.3	22.7	0.0	0.0	66.1
8.4	4.5	0.1	53.0	34.0
31.4	22.7	0.6	0.0	45.3
44.6	17.5	0.6	0.0	37.4
37.5	41.1	0.0	0.0	21.5
37.2	62.7	0.0	0.0	0.0
9.4	28.8	0.0	0.0	61.8
26.0	23.2	0.0	0.0	50.8
26.9	37.6	0.0	0.0	35.5
38.0	35.6	0.4	0.0	26.0



The initial results are somewhat surprising, showing the presence of reactive gases such as hydrogen and methane. Further information on the gas chemistries of the pores will be afforded following analysis by other TC11 and TC14 members. The results will be discussed at future meetings.

**c) Sulphur deposits in bubbles**

The gas content of bubbles with deposits and the deposits themselves have been analysed with 2 different methods (SEM/EDX and Raman spectroscopy).

The investigated bubbles contain mainly N<sub>2</sub> and some Ar, SO<sub>2</sub>, CO<sub>2</sub> (N<sub>2</sub> > 90%, Ar ≈ 1, CO<sub>2</sub> < 6%, SO<sub>2</sub> < 2%). The deposits consist mainly of sulphur and/or sulphur compounds (SEM/EDX). With the help of Raman spectroscopy sulphate (Na<sub>2</sub>SO<sub>4</sub>) and sulphur (fig. 2) have been found.

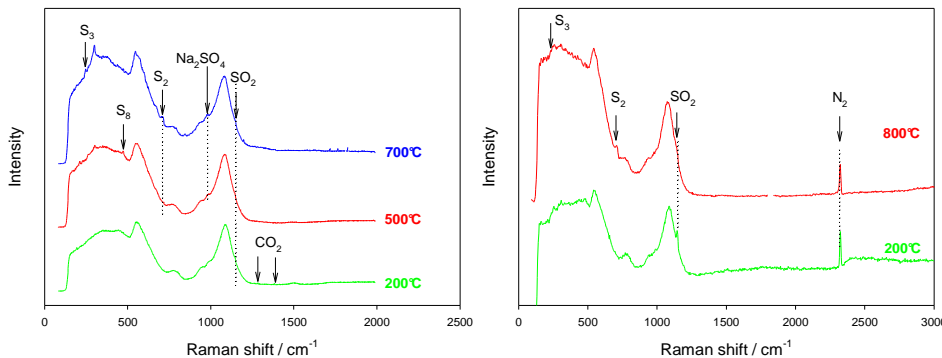
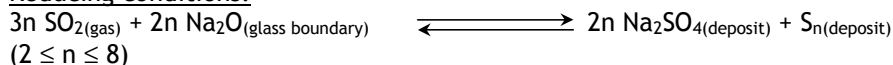


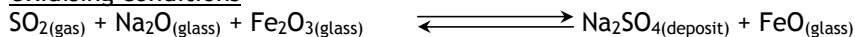
Fig. 4.2.2: Raman spectra of the gaseous species and the deposits at the bubble boundary (left: float glass, Sisecam, nitrogen peaks not shown, right: float glass, NSG/Pilkington)

It is assumed that the deposits are formed at the bubble boundary during cooling of the glass samples according to the following reactions:

#### Reducing conditions:



#### Oxidising conditions



It was decided to investigate the influence of the redox conditions on the deposit formation as a next step.

#### **ACTIVITIES in 2009**

Meeting	Date, Place	Topics	Participants
TC 14 meeting	May 14/15, 2009 Istanbul, Şisecam	<ul style="list-style-type: none"><li>• Discussion of new results on water in glass (by ERDA method)</li><li>• Refractory blisters: Discussion of gases in closed pores of refractory material used in tests, and next steps (impurity analysis)</li><li>• Discussion of joint seminar/session of TC14+TC21 during the ICG congress in Brazil, 2010</li><li>• Condensates in bubbles -next steps: Preparation of synthetic bubbles (in oxidized and reduced molten glasses) in order to investigate the influence of redox conditions on types of deposits in bubbles</li></ul>	10
TC2/TC14 meeting	Nov 5/6, 2009 Mainz, Schott	Presentation and discussion of the first results on impurities in AZS refractory	1 of TC 14

#### **PLANS FOR 2010 AND FORESEEN DELIVERABLES**

##### **a) Water in borosilicate glasses**

Further work to be conducted at BAM in Berlin in order to assess whether HBO<sub>2</sub> can be quantitatively measured using mass spectroscopy

##### **b) Refractory blisters (in collaboration with TC 11)**

In order to understand the mechanism of blister formation additional investigations have to be undertaken:

- analysis of the gas content of freshly formed blisters;
- analysis of the gas content of “pores” in the refractory material;
- analysis of impurities in the refractory and their influence on blister formation (support of TC 2).

##### **c) Sulphur deposits in bubbles**

The influence of the redox conditions on the deposit formation has to be investigated. Therefore, bubbles with deposits have to be collected from furnaces running under oxidising and reducing conditions. Additionally, bubbles in a glass with low iron content have to be analysed.

##### **d) Preparation of a session/seminar during the next ICG congress in Brazil in 2010**

The TC14 and TC 21 decided to prepare a seminar on modelling of bubble formation, bubble behaviour, fining and refining during the next ICG congress in Brazil in 2010.

## **PUBLICATIONS AND OTHER CONTRIBUTIONS**

none

### **4.2.7 ENVIRONMENT (TC13)**

**Chairman:** *Guy Van Marcke, AGC, Belgium*  
**Secretary:** *Simon Slade, NSG, England*  
**Vice-Chairs:** *Andreas Kasper, St. Gobain, Germany*  
**Members:** *Ruud Beerkens, TNO, The Netherlands*  
*Petr Beranek, Glass Services Inc, Czech Rep.*  
*Dilek Bolcan, Şişecam, Turkey*  
*Karlheinz Gitzhofer, HVG, Germany*  
*Denis Lalart, Arc Intl., France*  
*Gyorgy Liptak, GE, Hungary*  
*Nicola Favero, SSV, Italy*  
*John Stockdale, British Glass, England*  
*Lucien Belmonte, Abividro, Brazil*  
*Thomas Hunlich, Schott, Germany*  
*Hans Van Limpt, TNO, The Netherlands*  
*Phil Ross, GICI, USA*  
*Hugues Abensour, St. Gobain. France*  
*Etienne Senechal, Arc Intl. France*

## **SUMMARY**

Since the last annual report, the TC13 has met three times:

- 17/12/2008 at HVG in Offenbach, with 13 participants
- 13/5/2009 at Glassman in Lyon, with 13 participants
- 6/10/2009 at Schott AG in Mainz, with 13 participants

A range of subjects were discussed covering: global environmental regulations; emission formation and emission characterisation; primary emission control; and both existing and emerging secondary air pollution control plants. Briefing papers have been written, including the "Particle size range in waste gas of flat glass furnaces" recently published in Glass International, Vol.32, No.9, pp 29 – 34 and presented at the 70<sup>th</sup> conference on Glass Problems in Columbus OH, USA.

## **PLANS AND DELIVERABLES FOR 2009**

The TC13 plans to meet twice per year, normally in spring and autumn. The range of subjects covers all technical matters dealing with glass and the environment. Deliverables are a publication: "Particle size range in waste gas of flat glass furnaces" recently published in Glass International (2009), Vol.32, No.9, pp 29 – 34

## **ACTIVITIES in 2009**

The 2009 autumn meeting held in Mainz hosted by Schott covered a range of subjects, with a focus on the leaching of heavy metals from glass. The results of the round robin



assessment on the leaching analysis methodology were presented by Denis Lalart from Arc International. The test, designed to determine acceptability for landfill, will provide a suitable method to assess leaching (availability of metal components from glass) and thus support the exemption of glass from the REACH regulation. Further related work was presented by Simon Slade from NSG, who reported the initial results of a study on antimony leaching from rolled plate glass for the solar market. The results indicate that the glass would be “non-dangerous waste” in relation to landfill, thus also supporting the REACH exemption for this glass. Other subjects covered during the meeting were the installation and operating experience of air pollution control plants, developing regulatory pressure, and the revision of the Glass BREF document. The committee members enjoyed a short visit to one of Schott’s optical glass furnaces.

The committee members were pleased to note that their study on “particle size range in waste gas of flat glass furnaces” was published in Glass International, Vol.32, No.9, pp 29 – 34. The following notes summarise the paper.

The figure below shows an SEM image of furnace waste gas particulate matter collected on an inert furnace placed in the chimney base.

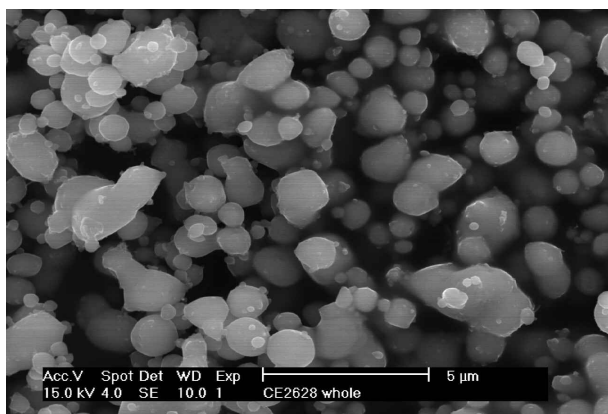


Fig. 4.2.3: Particles collected from the main flue gases of a float glass furnace

Using a so-called dust cascade impactor, the TC13 members working on the topic were able to measure the size range of the dust particles in the flue gases . Samples were assessed in the flue system before and after any pollution control equipment. The following figure shows an example of the size distribution before the PCP (pollution control plant).

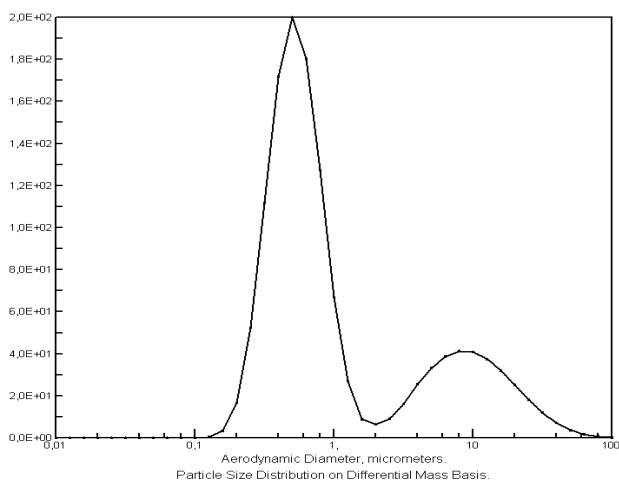


Fig. 4.2.4: Size distribution of dust particles in the waste gases of a flat glass furnace. On the vertical axis is the mass-% scaling.

The main conclusion of the study was that it reconfirmed that EPs (Electrostatic Precipitators) are effective techniques for greatly reducing the emissions of particulate matter and collecting the reaction products of acid gas scrubbers. It also showed that the particles in the emissions are very small (PM<sub>2.5</sub>), and that EPs do not preferentially collect any particular size fraction of particles. The paper demonstrated that mass median diameter of particles in the waste gas stream after an EP is the same as in the untreated emissions: about 1.4 micrometres. The results showed that particulate matter in untreated waste gas combines with scrubber reaction products and is very effectively removed by an EP, leaving a waste gas with a greatly reduced burden of dust, but almost with the same particle size distribution as in the untreated gas.

The spring 2009 TC13 committee meeting was held in Lyon, France, in conjunction with the Glassman exhibition. As well as combining a visit to the exhibition, the venue was chosen because it was a relatively convenient place for most members to travel. The exhibition organisers provided a room to hold the meeting.

The meeting typically covered a range of very important and topical subjects in environmental technology and provided a platform to exchange information concerning changes in both technology and environmental legislation. Additionally, the committee reviewed developments for the new TC13 website.

The meeting concentrated on two main areas of TC13 activities. The first covered the development of a test to support the exemption of glass from the REACH regulation. This requires that an acceptable method to assess the potential leaching of heavy metal components from glass sent to landfill is developed. The results of a round-robin test of such a method were reported.

The second key area discussed at Lyon was the on-going assessment of the size range of dust particles present in waste gas emissions from glass furnaces. The work done by the members was reviewed, and how it would be presented to appropriate audiences was discussed. The study was presented in October 2009 at the 70<sup>th</sup> conference on Glass Problems in Columbus, OH, USA.

The second TC13 committee meeting held in 2008 was hosted by HVG, in Offenbach, Germany. As usual, it was very useful and interesting. Analytical techniques such as that for analyzing the presence and concentration of  $\text{Cr}^{6+}$  were discussed as was the introduction of novel air pollution control techniques, such as the cloud chamber scrubber. Emission factors for different pollutants under different furnace operating conditions were presented, and problems associated with the recycling of EP dust were discussed. Results of the practical work using a cascade impactor to assess the size range of particulate matter emitted by glass furnaces were presented.

The important new work area dealing with the development of a good assessment method for the potential of certain compounds to leach from glass was first discussed at this meeting. This was initiated because of the proposal to use a leaching test to support the determination of whether glass should be exempt from REACH. The meeting also included an interesting tour of the HVG facilities.

### PLANS FOR 2010 AND DELIVERABLE

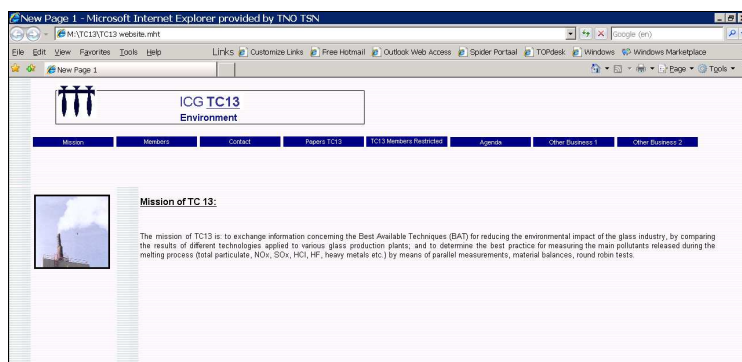
The TC13 will meet twice in 2010, hosted by SSV in Italy and British Glass in England. The broad range of subjects covering all aspects of environmental technology will be covered. The focus will be on completing the report in the metal leaching methodology in support of the REACH exemption, and reporting the use of the technique to assess leaching of various components from different glass types. Initially, antimony leaching from rolled flat glass for the solar market will be assessed, and this will probably be followed by an assessment of selenium leaching from tinted float glass.

The performance of novel emission control techniques applicable in glass production will also be discussed.

### PUBLICATIONS AND OTHER CONTRIBUTIONS

An article entitled „*Particle size range in the waste gas of flat glass furnaces*“ has recently been published in *Glass International*, Vol.32, No.9, pp 29 – 34.

The TC13 website has been initiated and contains many useful documents.



TC13 website

### **4.3 R&D ACTIVITY FIELD “SURFACES & INTERFACES”**

#### **4.3.1 NANOSTRUCTURED GLASS (TC16)**

**Chairman:** *Rui M. Almeida, IST / ICEMS, Portugal*  
**Vice-Chair:** *Alex Martucci, Univ. Padova, Italy*  
**Members:** *Sidney Ribeiro, Univ. Araraquara, Brazil*  
*Kiyoharu Tadanaga, Osaka Pref. Univ., Japan*  
*David Levy, ICMM-CSIC, Spain*  
*M. Clara Gonçalves, IST / ICEMS, Portugal*  
*Luís Carlos, Univ. Aveiro, Portugal*  
*Mario Aparicio, ICV, Spain*  
*Yolanda Castro, ICV, Spain*  
*Hui Yang, Zhejiang Univ., China*  
*Jian Xu, Univ. Ningbo, China*

#### **SUMMARY**

The activities of TC16 during 2009 were concentrated mostly on: (1) finishing the EFONGA project; (2) launching new activities. The new activities have been related to the study of sol-gel derived nanostructured coatings for energy savings in buildings, where some results have already been obtained by TC members working in Lisboa, Madrid and Padua. Some of the members of TC-16 participated in a few meetings in 2009, namely two TC meetings in February (at ICV, in Madrid) and in August (during the Sol-gel 09 Conference in Porto de Galinhas, Brazil), plus the EFONGA Spring School and Workshop in May (in Montpellier). Some of the TC members also participated in the Pac-Rim conference in June (Vancouver), where TC-16 organized a half-day session on Nanostructured Glasses.

#### **PLANS AND DELIVERABLES FOR 2009**

TC16 planned to discuss new topics to work on during 2009 and, with that in mind, a TC meeting was organized in February in Madrid, where it was decided that the work in the near future would concentrate on the topic of nanostructured coatings for solar control (low-emissivity coatings on glass windows) to improve the energy efficiency in buildings. In particular, it was planned to work on nanostructured, TiO<sub>2</sub>-based functional coatings, simultaneously with solar control and self-cleaning properties (using the photocatalytic effect).

#### **ACTIVITIES in 2009**

The research activities concentrated on the preparation and development of sol-gel derived nanostructured coatings based on TiO<sub>2</sub>, for energy savings in buildings, in order to improve the thermal efficiency of the existing low emissivity coatings on glass windows. The work program involved the preparation ZnO:Al (Al-doped) nanoparticles (NPs) for subsequent doping of these NPs into anatase-based thin films, prepared by sol-gel processing. Anatase is the low temperature allotropic form of crystalline titania, which also happens to possess photocatalytic properties that make it a suitable material for self-cleaning coatings on glass windows. The UV-visible-IR reflectivity of anatase films has been measured in Lisbon (IST/ICEMS) and their refractive index and thickness were measured by spectroscopic ellipsometry in Madrid (ICV); it is desirable that such coatings have good visible transparency, while exhibiting high reflectivity in the near-UV

and especially in the near-IR. The photocatalytic properties of these coatings will be tested at a later stage.

At the University of Padova, the main activity was devoted to the synthesis of nanocomposite films for solar control applications. The main objective was the synthesis of aluminum doped zinc oxide (AZO) nanoparticles. (NPs) to be used for doping polymer coatings in order to obtain transparent nanocomposite film showing high reflectivity in the IR and high transparency in the VIS. Alternatively, AZO NPs can be mixed with  $\text{TiO}_2$  NPs, in order to obtain a nanostructured coating showing both photocatalytic properties and high reflectivity in the IR.

ZnO was obtained by colloidal chemistry at low temperature. ZnO NPs were then successfully doped with Co, Ni and Mn (Fig. 1), while problems have been found in doping with Al. From the literature review, it seems necessary to have a calcination step to obtain AZO NPs. Further experiments are now being done. Meanwhile AZO and ZnO- $\text{TiO}_2$  films have been synthesized by sol-gel technique (Fig. 2). The optical properties and photocatalytic activity of these films are presently being studied.

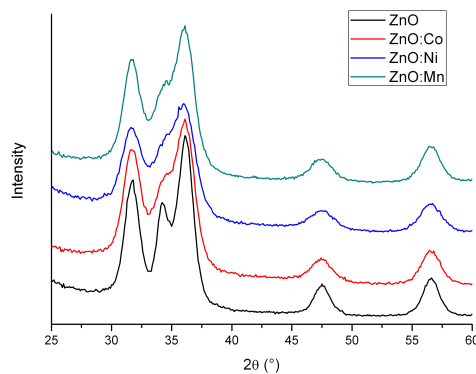


Fig.4.3.1: XRD patterns of ZnO NPs: pure and doped with 3 mol% of Co, Ni or Mn.

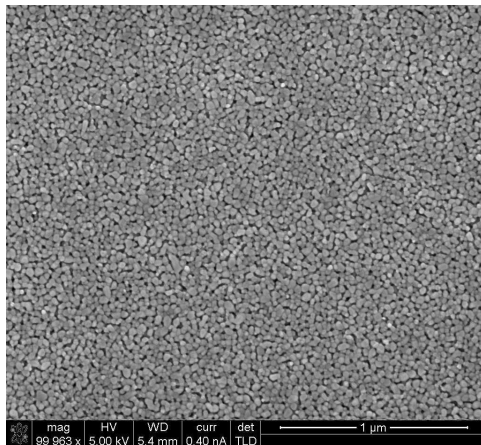


Fig. 4.3.2: SEM image of pure ZnO nanostructured sol-gel film annealed at 500 °C.

In Lisbon, some titania films have been prepared. Usually, the anatase phase is obtained by heat treatment of the sol-gel derived films at  $\sim 400$  °C. Fig. 3 shows a simulation of a Bragg mirror structure with 3 pairs of alternating silica ( $n = 1.45$ ) and titania ( $n = 2.2$ ) films, exhibiting a high reflectivity stop band between  $\sim 800 - 1700$  nm. Fig. 4, on the on

the other hand, shows the reflection spectrum of a single titania film consisting of five layers deposited in sequence. There is significant reflectivity between ~ 1 - 3 microns.

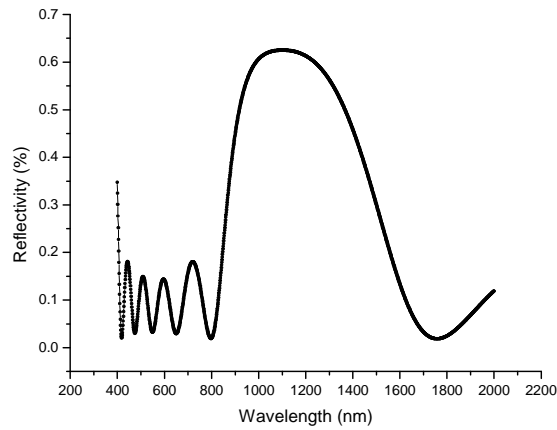


Fig. 4.3.3: Simulation of reflection band for a Bragg mirror structure with 3 pairs of alternating silica and titania films deposited by sol-gel.

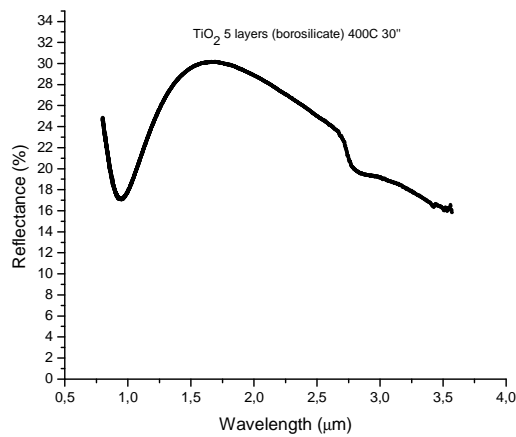


Fig. 4.3.4: IR reflectivity spectrum of a single titania film deposited on a borosilicate glass substrate, after heat treatment at 400 °C for 30 minutes.

At ICV (in Madrid), the TiO<sub>2</sub> coatings prepared at IST (in Lisbon) have been characterized by spectroscopic ellipsometry in order to determinate their thickness (e) and refractive index (n), using a variable angle *spectroscopic ellipsometer* (Fig. 5). This method is a non-destructive and powerful technique to characterize thin and transparent films and recently it has been adapted to measure the porous structure of coatings.



Fig.4.3.5: Spectroscopic ellipsometer WVASE32.

Two types of TiO<sub>2</sub> samples were provided, some on a silicon wafer substrate (treated at 900 °C) and others deposited on a glass slide (treated at 400 °C). These coatings had 1 or 5 layers. Table 1 summarizes the values of thickness and refractive index. In general, the thickness increased with the number of layers, with a constant and high index near that of dense TiO<sub>2</sub>. This indicates that these coatings were not porous or that their porosity was very low. This represented a limitation in order to determinate their adsorption-desorption isotherms by spectral poro-ellipsometry, since it was not possible to measure the variation of “n” and “e” of the film with the partial pressure of water vapor (Fig. 6).

	Silicon-TiO <sub>2</sub> - 1 layer	Silicon-TiO <sub>2</sub> - 5 layers	Glass-TiO <sub>2</sub> - 1 layer	Glass-TiO <sub>2</sub> - 5 layers
Thickness (nm)	54.5	142.4	30.2	220.6
Refractive index	1.92	2.41	1.94	2.14

Table 1: Thickness and refractive index of Lisbon samples.

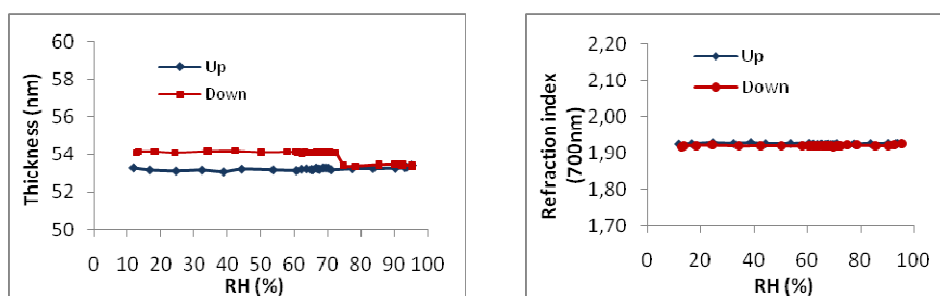


Fig. 4.3.6: Thickness and refractive index as a function of RH for TiO<sub>2</sub>-1 layer on Si.

The thickness was different for glass slide and silicon wafer substrates. This behaviour has been observed in other systems and could be associated with the wettability of the sols on the different substrates.

In addition, members of TC-16 participated in the EFONGA meetings in Montpellier, from 4-8 May, where the TC chair gave two lectures in the EFONGA Spring School and the TC also organized a short session on Nanostructured Glasses in the EFONGA Workshop, with three invited talks. TC-16 also organized a one-morning session on Nanostructured

Glasses during the PAC-RIM meeting in Vancouver (Canada) from 1-5 June (Symposium 23, organized in collaboration with ICG).

#### **PLANS FOR 2010 AND DELIVERABLE**

We plan to continue the study of glass window coatings with solar control and self-cleaning properties for improved energy efficiency in buildings. TC-16 will also organize a one-day symposium on Nanostructured glass coatings by sol-gel, during the International Glass Congress in Brazil in 2010, where a TC-16 meeting will also take place. Deliverables will include the conference presentations by TC-16 members and meeting reports.

#### **PUBLICATIONS AND OTHER CONTRIBUTIONS**

A paper is being drafted on nature of the ITO coating-aluminosilicate glass interface based on previous EFONGA work.

#### **4.3.2 COATINGS ON GLASS (TC24)**

**Chairman:** *K. Sanderson, Nippon Sheet Glass, UK*  
**Vice-Chairs:** *M. Andreasen, AGC, USA*  
**Members:** *H. Weis, Interpane E&B, Germany*  
*A. Piers, TNO, The Netherlands*  
*A. Durandeau, Saint Gobain, France*  
*C. Wagner, Velux A/S-Panes, Denmark*  
*A. Parlar, Sisecam, Turkey*  
*L. Hupa, Abo Academy University, Finland*  
*P. Van.Nijnatten, TNO, The Netherlands*  
*P. Bastianen, Vindico Surface Technologies BV, The Netherlands*  
*R. Pylkki, Aspen Research, USA*  
*T.Belgardt, Interpane E&B, Germany*  
*A. Roos, University of Uppsala, Sweden*  
*D. Sheel, University Salford, CVD Technologies, UK*  
*D. Coster, ACG, Belgium*  
*F.Creuzet, Saint Gobain, France*  
*F.van.Milligen, OCLI, JDC Uniphase, USA*  
*J.Puetz, Leibnitz INM, Germany*  
*J.Vitkala, Tamglass Engineering, Finland*  
*K.Makita, Central Glass, Japan*  
*T.Kaelber, SCHOTT AG, Germany*  
*K.Hartig, Cardinal Glass Industries, USA*  
*K.Suzuki, Surftech Transnational/Consultant, Japan/Belgium*  
*M.Hirata, Nippon Sheet Glass, Japan*  
*K.Myli, Cardinal Glass, USA*  
*S.Suzuki, Asahi Glass, Ltd.*  
*M.Mitterhuber, ETC Products, Germany*

#### **SUMMARY**

The TC24 committee has unfortunately had reduced activity this year with only one formal meeting held in May 2009, impacted both by availability and reduced travel budgets which has made attendance difficult. The main areas of activity have been based around:



- Self cleaning / reduced maintenance coatings
- Testing of pyrolytic coated transparent conductive oxide films (TCO)

#### **PLANS AND DELIVERABLES FOR 2009**

The work plan for 2009 focused around several key work areas.

- Continuation of the work program on self cleaning / reduced maintenance glass which has been run by the committee for several years.
- Characterisation of transparent conductive oxide coatings based on pyrolytic deposited SnO<sub>2</sub>:F films
- Identification of new potential work areas.

#### **ACTIVITIES in 2009**

##### **Self Cleaning Reduced Maintenance**

- Following several years of evaluation work within the committee and work with the European funded (Framework 6) project on the draft self cleaning / reduced maintenance glass standard test this standard was presented for consideration by CEN TC129 during the year. TC24 has been evaluating this standard since its initial development and this has allowed input into the testing by a broader range of participants including members from Japan and N.America. As such it was felt essential that TC24 should provide a formal detailed scientific input into the evaluation summarising the key results and areas of on going work. An agreed note was prepared and submitted into CEN TC129 who have kindly acknowledged receipt and have agreed to keep the ICG TC24 committee abreast of developments. The committee have also agreed to approach TC24 about further scientific evaluation work related to the standard which could be required.
- As the standard will now be driven forward by CEN TC129 discussions have been held about other key activities of scientific interest which could be undertaken in this area. An area of expanding interest to many of the committees membership is in the area of green energy generation and the use of coated glass in such applications. A detailed relationship between the performance of collector systems and photovoltaic devices with cleanliness and the influence of coated products was raised. A proposed work program to evaluate how the self cleaning glass test may be modified to assist in such an evaluation has been made and a work program around this item has obtained preliminary approval from the committee members. A detailed work program discussion in this area is planned for a future meeting.

##### **Transparent Conductive Oxides**

- Following an initial round robin on a transparent conductive oxide last year the committee highlighted significant variations in measurements had been obtained by the institutes involved. Following evaluation of the results an expanded round robin tests has been established using a single layer transparent conductive oxide. It is hoped that this will confirm the key variability which influenced the round robin accuracy was related to film thickness measurement. Samples of the new TCO are now under evaluation at a range of sites. Results of this evaluation will be used to determine the next steps.
  - Measurements being evaluated
    - Traditional Optical Measurements
    - Haze
    - Thickness
    - Sheet Resistance
    - Hall Effect

- Carrier Concentration
  - Mobility
- An area of increased interest expressed during discussions at TC24 was the relevance of angular spectroscopic measurements to thin film coatings on glass. With the increasingly diverse applications of thin films on glass, knowledge of the angular dependence of the films spectroscopic properties is being increasingly discussed in the literature. It was agreed that all parties would be interesting in evaluating the reproducibility of angular spectroscopic measurements. A round robin evaluation has therefore been commenced to run in parallel with the TCO evaluation. Two samples have been prepared - one based on a sol gel coating and the second a traditional transparent conductive oxide coating based on SnO<sub>2</sub>:F. Samples will be measured using
  - Angular Spectroscopy at 30°, 45°, 75° and 90°
  - Atomic force microscopy using 1 micron square measurement area

#### **Other Areas of Interest**

- A key objective of the year has been to also expand the areas of interest of TC24 Coatings on Glass. Several areas of interest have been discussed and will be followed up with committee members willing to give an overview at upcoming meetings so that discussion of scientific areas of investigation can be identified. These include
  - Antibacterial coatings
  - Antimicrobial coatings
  - Hybrid / polymer derived coatings.

#### **PLANS FOR 2010 AND DELIVERABLE**

Key activities planned for 2009 include:

- Next meeting to be in Q1 2010. Location to be agreed.
- Continuation of the activities on self cleaning and reduced maintenance glass through links to CEN TC129 who are progressing the adoption of this standard.
  - Objective is to expand scientific interest in test and evaluate whether the work done on standardisation testing may also be applicable to testing of cleanliness of photovoltaic applications.
- Continue to develop technical understanding of transparent conductive oxide coatings through the use of round robin testing and new tests aimed at developing an understanding a relationship between the properties of the films for different technical applications.
- Expand the interests of TC24 to include scientific evaluation of hybrid and polymer coatings on glass.
- Expand interests of TC24 into the scientific evaluation of antimicrobial / antibacterial coatings.

#### **PUBLICATIONS AND OTHER CONTRIBUTIONS**

- No formal publications were made by the committee during the year.

A formal note on the activities of ICG TC24 was supplied to CEN TC129 to review our activities and assist with the development of the standard on self cleaning glass. Formal exchanges between the two committees going forward have been agreed.

### 4.3.3 GLASS SURFACE DIAGNOSTICS (TC19)

**Chairman:** *Volker Rupertus, Schott AG, Mainz, Germany*  
**Vice-Chairs:** *Mark Farnworth, Pilkington Technology, UK*  
*Herve Montigaud, Saint Gobain Recherche, France*  
**Members:** *Vladimir Balek, Nuclear Research Institute Rez, Czech Republic*  
*Klaus Bange, Schott AG, Mainz, Germany*  
*Renzo Bertinello, Dep. Inorganic Chemistry, Padua, Italy*  
*Elzbieta Greiner-Wronowa, Univ. of Krakow, Poland*  
*Ales Helebrant, Inst. of Chem. Technology, Czech Republic*  
*Philippe Le Coustumer, CDGA, France*  
*Paolo Mazzoldi, University of Padua, Italy*  
*Carlo Pantano, Pennsylvania State University, USA*  
*I. Sokmen, Sisecam, Turkey*  
*Nobuyuki Tadokoro, Hoya Corporation, Japan*  
*Y.Yamamoto, Asahi Glass Co Ltd, Japan*

#### SUMMARY

In 2009 TC19 organized

1. an expert panel within the workframe of the EFONGA-project together with TC09 titled "***Glass surfaces and stress corrosion mechanisms at the nanoscale***" located in Montpellier, February 22-25, 2009. Fifteen international experts with special topics related to surface or strength of glass presented topics of their field of expertise. The discussions were focused in future aspects and resulted in a roadmap-report.
2. a XRD-round-robin, which deals with the determination of the crystalline composition, glass/crystalline ratio as well as the lattice parameters of glass ceramics using XRD. The status of this activity was fixed in an report.

Due to travel restrictions caused by the world wide financial crisis no common TC19-meeting took place. The interaction of the members was mainly organized via Telecon and Email. TC19 was represented also at EFONGA advisory board meetings and at the final EFONGA-Workshop "**Current Status and Future of Glass**", Montpellier, May 6-8, 2009.

#### PLANS AND DELIVERABLES FOR 2009

- Report about the status of the "XRD"- round robin
- Report about the WS "Glass surfaces and stress corrosion mechanisms at the nanoscale"
- Press release about the WS "Glass surfaces and stress corrosion mechanisms at the nanoscale"
- Final report of the EFONGA-activities of WP 4.3

#### ACTIVITIES in 2009

##### 1. Round robin "XRD"

The aim of this round robin is the characterization of two sample types in each participating laboratory with their individual measurement and quality procedures. So the employed different techniques can be compared with their power and their limits.

The results are focused on:

- phase analysis
- quantification of the crystal phase

- crystal size
- lattice parameters

For that task two different sample types were chosen:

Type 1: Commercially available Ceran Suprema glass ceramic (one piece).

Type 2: MAS- (MgO-Al<sub>2</sub>O<sub>3</sub>-SiO<sub>2</sub>) glass ceramic powder, produced with a laboratory melt process.

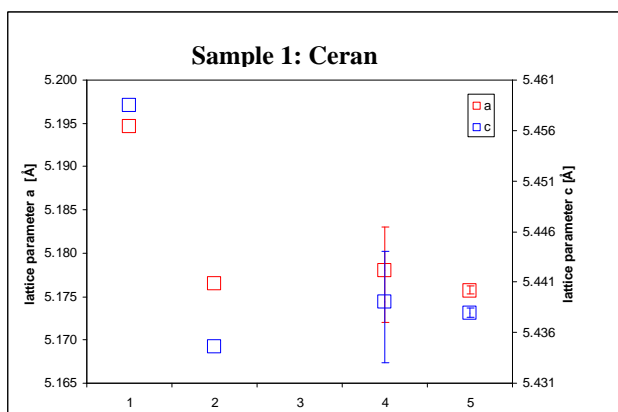


Fig. 4.3.7: Lattice parameter of Sample 1

As can be seen in Fig.1, the results, obtained in the different laboratories, show a distribution, which has to be proved. Therefore the XRD-round robin is not yet finished and will continue up to 2010.

## 2. Workshop “Glass surfaces and stress corrosion mechanisms at the nanoscale”

On 22. - 25. February 2009, the chairmen of the technical committees "Surface Diagnostics" and "Glass Micromechanics" organized an expert meeting in the framework of EFONGA (WP1.1 and WP4.3), inviting a selection of international experts on "glass surfaces and stress corrosion mechanisms at the nanoscale", in Montpellier, France. Fifteen international experts with special topics related to surface or strength items in the field of the material glass were invited. The reaction mechanisms on the glass surface become more and more important, especially for subsequent processes like surface conditioning or coating to optimize the properties of the material. Corrosion processes in the nanoscale are well known since many years but up to now not fully understood. There exist lots of data, experimental results and computer models to describe corrosion and strength related phenomena for special parameters or applications/materials. Especially the mechanisms of crack propagation and driving forces in the nanometer scale are still under discussion.

Therefore, it was the aim of this workshop, to cover the existing knowledge and start a discussion on the future work, which has to be done to a clear understanding of the mechanism on stress corrosion in the nanometer scale, which should be resulting in a task list of items to be solved in the next years called "Roadmap".

Participants and their main topics are listed in the following table:

Carlo G Pantano:	Surface Chemistry Effects in the Strength and Fracture of Silicate Glasses
Russel J Hand:	Silicate glass, hydration, chemistry and defects
Matthieu George:	Local probe investigation of glasses
Tanguy Rouxel:	The incidence of the glass composition on the contact damage behavior - A Vickers indentation study
Etienne Barthel:	Plastic deformation of silicates and tensile strength
Elisabeth Bouchaud:	Scaling properties of fracture surfaces
Minoru Tomozawa:	Fictive temperature of silica glass fracture surface
Giuseppe Pezzotti:	Visualization of highly graded stress gradients in glassy and crystalline materials and in their hetero-structures
Kurt Nattermann:	Lifetime statistics and durability under environment
Walter Kob:	Computer Simulations of Glasses
Alastair N Cormack:	Atomistic Simulations of the Mechanical Properties of Silicate Glasses, and of their Interaction with Water
Sheldon M Wiederhorn:	Dependence of the Strength of glass on Mobile Ions in the Glass Network
René Gy:	Ion Exchange for Glass Strengthening
Uwe Rothhaar:	Durability of and adlayer formation at glass surfaces in “wet” environment
Joachim Deubener:	Enhancement of glass surface quality by sol-gel coatings

A lot of topics were discussed related to the headlines:

- main key challenges related to surface stress corrosion mechanisms
- exceptional success items related to surface stress corrosion mechanisms
- key breakthrough items related to surface stress corrosion mechanisms
- Application items related to surface stress corrosion mechanisms

Details can be found in the WP4.3 report No 5. An example is depicted in Fig.2:

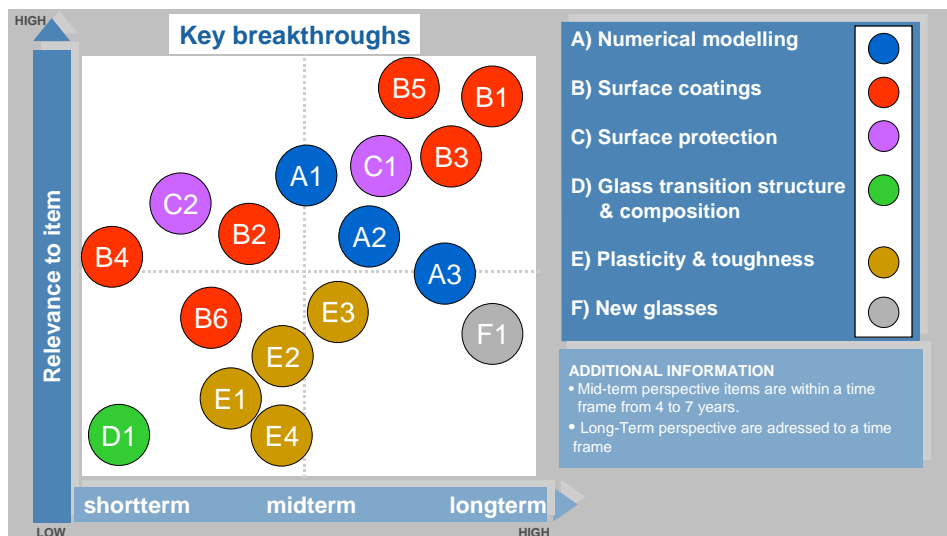


Fig. 4.3.8: Key breakthroughs for the glass surfaces and strength related items

#### A Numerical Modelling

- **A1** Ab initio simulation of 10 million particles.
- **A2** The ability to perform routine classical atomistic simulations of 100,000 atoms or more.
- **A3** The ability to perform routine quantum mechanical simulations on thousands of atoms routinely.

#### B Surface coatings

- **B1** *Development of active coatings for healing cracks on glass surfaces (2025).*
- **B2** *Self-healing sol-gel coatings for glass surfaces.*
- **B3** Implementation of the controlling parameters of crack propagation in glasses by sol-gel coatings (2021)
- **B4** Low cost hermetic, hard, lubricious multi-functional coatings (now).
- **What is the limit of sol-gel systems in terms of mechanics (does one need high temperature condensation and sintering) ?**
- **B5** "Active" coating materials with self-healing properties for glass surfaces by sol-gel technology. Localized reactions in the film/glass interface induced by stress corrosion.
- **B6** Improvement of surface quality by "passive" protective coatings.

#### C Surface protection

- **C1** Nano-crystalline materials with adequate properties vs. glasses.
- **C2** 2009...2012: Improving methods for the separation of failure causes by statistical analyses of fracture data ("multimodal fracture").

#### D Glass Transition structure and composition Prio B

- **D1** Understanding the mechanism responsible for the slowing down of glass-forming systems and thus the glass-transition (now). TASK for TC08

**E Plasticity and toughness**

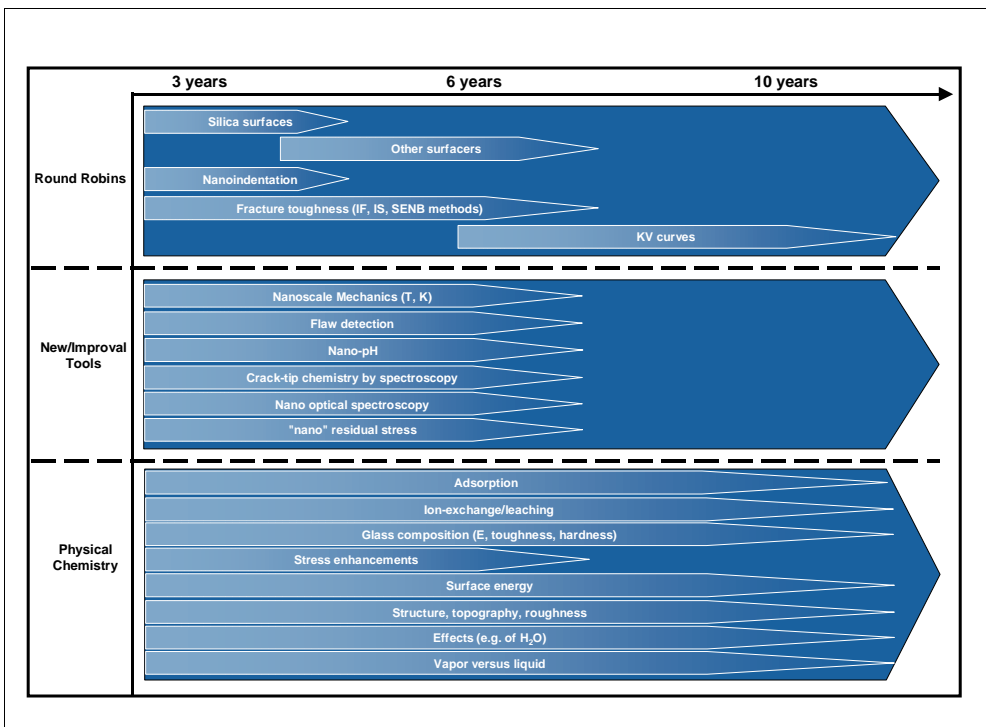
**Prio B**

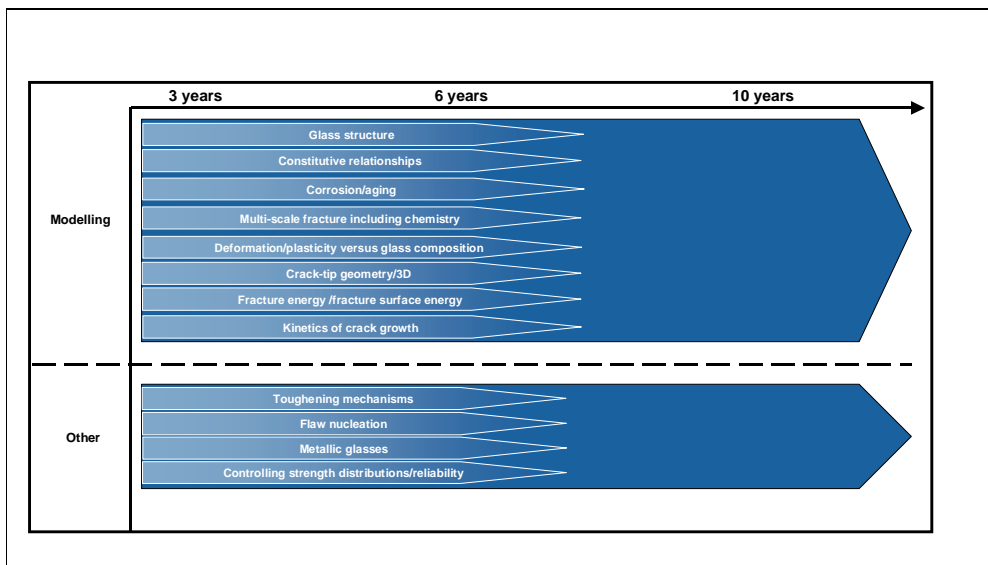
- The field of plastic deformation of amorphous systems is very active. The case of silicates is a (small) subset. To support these claims let us mention :
  - **E1** BMGs (Bulk Metallic Glasses): very different materials but they show the way in terms of plastic deformation in amorphous systems
  - **E2** Modelling at various length scales of disordered materials. For multi-scale modelling amorphous materials are an opportunity because fewer length scales are involved.
  - **E3** A number of recent experiments on plastic deformation of silicates
  - **E4** The opportunity of using new micromechanics tools

**F New glasses**

- **F1** Preparation of oxide glass surface which is immune to water or moisture.

At least a roadmap was created:





As a last deliverable a summary of all the activities of TC19 related to EFONGA-project are listed and interpreted in EFONGA WP4.3 report No 6.

#### PLANS FOR 2010 AND DELIVERABLE

Planned Meetings:

2 TC19-meetings and 2 Core-group-meetings

Planned Issues:

- Paper at an int. Journal about the “Quantification by EDS/SEM”- round robin
- Finishing of the round robin “Glassceramic determination via XRD”
- Start of a new round-robin (2 projects are in preparation)
- Discussion about the next steps within TC19

#### PUBLICATIONS AND OTHER CONTRIBUTIONS

EFONGA-project:

Contributions about the results of WP4.3 (Montpellier)

Press release about the Workshop “Glass surfaces and stress corrosion mechanisms at the nanoscale”

EFONGA Reports No 4; No 5; No 6 of WP 4.3

### 4.4 R&D ACTIVITY FIELD “NEW APPLICATIONS”

#### 4.4.1 GLASSES FOR MEDICINE AND BIOTECHNOLOGY (TC04)

**Chairman:** *Julian Jones*  
**Vice-Chairs:** *Alexis Claire, Wolfram Holand*  
**Members:** *Delbert Day*  
*Enrica Verne*  
*Aldo Boccaccini*  
*Robert Hill*



*Carlo Pantano*  
*Bob Baier*  
*Sam Conzone*  
*Alastair Cormack*  
*Matthew Hall*  
*David Greenspan*  
*Akiyoshi Osaka*  
*Leena Hupa*  
*Larry Hench*  
*Kai Karlsson*  
*Matthew O'Donnell*

#### **SUMMARY**

In May 2009, Alexis Clare handed the Chair of TC04 to Julian Jones. Alexis will remain as a vice-chair. Wolfram Höland agreed to be the other vice-chair. The aims for 2009 were to progress the TC04 book, to construct a protocol for the testing of bioactivity of glasses and their variants and to begin an international round robin test to assess the applicability of the protocol. Another aim was to obtain funding for the biomedical glass area, to enable international meetings and roadmapping to take place in 2010 and beyond.

#### **PLANS AND DELIVERABLES FOR 2009**

- Hold a meeting at PACRIM meeting in Vancouver, May 2009
- GLASS FOR MEDICINE AN BIOTECHNOLOGY BOOK- chapters contributed by members of TC04
- Road-mapping activities related to biomaterials for the EFONGA project
- Initiation of the Bioactivity project
- Obtain funding to replace the EFONGA project

#### **ACTIVITIES in 2009**

A biomaterials session was held in Montpellier in May 2009 as part of the EFONGA meeting. The session highlighted bioactive glass and biomedical (including dental) glass-ceramic research in Europe and opened the discussion of protocol for the round robin bioactivity testing.

A meeting was held in Vancouver in May 2009, which was used to discuss future plans. Wolfram Holand's contribution to the TC over the past 2 years was recognised. The definition of bioactivity was discussed. The protocol for testing bioactive glasses in the round robin test was finalised. Delbert Day was very active in the discussion and is thanked for his contribution and in having MO-SCI provide many of the glass samples for the testing, and providing them so efficiently. It was agreed that the bioactivity testing should be done only on commercially produced glasses at this stage. The progress of the TC4 book was discussed and the contents page adjusted to improve the content and enable timely delivery. The book will be co-edited by Clare and Jones. New chapters were requested from Jonathan Knowles.

Since May, most Chapters have been delivered to the editors. Julian Jones has secured a publisher in Wiley. The ICG has also agreed to co-finance the book to enable to keep the price of the book down and to allow ICG to offer it for sale. The book has been re-titled "Bio-glasses - An Introduction".

The round robin test is underway. Julian Jones received all the glass samples from 5 different companies (NovaBone, Vivoxid, Mo-Sci, MedCell and Bioceramic Therapeutics).

All are thanked for their contributions. Julian Jones has distributed the samples to participants.

An application was made by Julian Jones to the COST proposals for international collaborative research (€100k) in October 2009, but unfortunately it was unsuccessful.

#### **PLANS FOR 2010 AND DELIVERABLES**

The deadline for the TC04 book is 1<sup>st</sup> February 2010

The bioactivity testing round robin experiments are due to finish in July 2010

The data will be sent to Julian Jones for compilation

The TC04 annual meeting will be in Brazil in September at the meeting organised by Edgar Zanotto

TC04 will also be hosting a bio-glasses symposium at the meeting

The results of the tests will be discussed at the September meeting and a draft of the co-authored publication will be put together, with a view to submission by the end of 2010

The bioactivity testing will then progress to in vitro cell culture experiments.

To collaborate with TC07 and review biomedical glass-ceramics led by Wolfram Höland and Joachim Deubener.

To produce a review of the latest coating technologies for coating prosthesis with bioactive glasses - led by Aldo Boccaccini

#### **PUBLICATIONS AND OTHER CONTRIBUTIONS**

To come in 2010:

Bio-glasses for beginners textbook

Bioactivity testing of glasses and their variants, a journal article

A review of bioactive glass-ceramics

#### **4.4.2 NUCLEAR AND HAZARDOUS WASTE VITRIFICATION (TC05)**

**Chairman:** J. C. Marra, Savannah River National Laboratory, U.S.A.  
**Vice-Chair:** R. DoQuang, Areva, Inc. France  
**Secretary:** D. K. Peeler, Savannah River National Laboratory, U.S.A.  
**Members:** A. Boccaccini, Imperial College London, UK  
T. Bessman, Oak Ridge National Laboratory, US  
D. Davidson, Areva, Inc., U.S.A.  
W. Ebert, Argonne National Laboratory, U.S.A.  
C. Fillet, Commissariat à l'Énergie Atomique, France  
R. Hand, University of Sheffield, U.K.  
M. Harrison, National Nuclear Laboratory, U.K.  
M. Kovacova, Slovak Republic  
W. Lee, Imperial College London, U.K.  
C. Leonelli, University of Modena and Reggio Emilia, Italy  
R. Monteiro, Nova. University of Lisbon, Portugal  
M. Ojovan, University of Sheffield, U.K.  
M. J. Pascual, Ceramic and Glass Institute, ICV, Spain  
J. Rincon, Inst. E. Torroja de Ciencia y Tecnología de la Construcción, CSIC, Spain  
C. Scales, National Nuclear Laboratory, U.K.  
S. Stefanovsky, SIA Radon, Russia

*P. Stoch, Institut of Atomic Energy Swierk, Poland*  
*C. Veyer, Consultant, France*  
*J. Vienna, Pacific Northwest National Laboratory, U.S.A.*  
*S. Weisenburger, Institut für Nukleare Entsorgung, Germany*

## **SUMMARY**

The Technical Committee on Nuclear and Hazardous Waste Vitrification was approved by the ICG Coordinating Technical Committee (CTC) and the Steering Committee (SC) in 2006. TC05 has been very successful in involving technical committee members and sharing technical information during its first three years of existence.

The vision and mission of the committee are as follows:

- The vision of this committee is to establish a forum to present, discuss and disseminate technical information on waste glass chemistry, vitrification processes, vitrification melter technologies, and waste glass environmental performance.
- The mission and goals of the committee are to facilitate the dissemination of technical information through promoting programming at technical conferences, conducting technical workshops and facilitating publication of information through established channels. Promoting the exchange of technical data is also a goal of this committee.

The technical committee held one “face-to-face” meeting and two teleconference meetings in 2009. The face-to-face meeting was held at the joint American Ceramic Society Pacific Rim/International Commission on Glass Conference in Vancouver, Canada. The highlights of TC05 activities in 2009 were conducting round-robin testing and organizing a symposium at the PacRim/ICG meeting. The round-robin testing was conducted using an isothermal liquidus temperature ( $T_L$ ) determination method developed for waste glasses by Pacific Northwest National Laboratory in Richland, WA U.S.A. The round-robin testing was conducted to evaluate the accuracy and reproducibility of the liquidus measurement procedure. Testing is being conducted by 8 laboratories from 5 different countries. To date, 5 laboratories have completed measurements and transmitted data. Once all data are received, the data will be statistically evaluated. The symposium **Glasses and Ceramics for Nuclear and Hazardous Waste Treatment** was organized and conducted by TC05 at the PacRim/ICG meeting. A total of 17 papers were presented in the symposium. These papers will be included in a **Ceramics Transactions** conference proceedings volume.

## **PLANS AND DELIVERABLES FOR 2009**

In 2008, TC05 members identified a common need for test method development as it related to waste glass properties. Liquidus temperature ( $T_L$ ) is an important glass property for vitrification processing regardless of the melter technology being used or glass system being employed for waste immobilization and is, therefore, of world-wide interest. However, waste glasses are often opaque, making  $T_L$  measurements problematic. An isothermal  $T_L$  determination technique was developed at Pacific Northwest National Laboratory (under the direction of a TC05 member) that appeared to be repeatable and accurate. Round-robin testing was needed to verify and validate the experimental technique for eventual adoption as an ASTM procedure. Two glasses were sent to 8 laboratories for isothermal  $T_L$  measurements. A procedure was sent to each

laboratory for isothermal  $T_L$  measurements using two test method variations. Of the 8 laboratories, 5 laboratories conducted the testing and provided test data. It is anticipated that all laboratories will complete measurements by early 2010. The data will be statistically analyzed to evaluate the accuracy and precision of the method.

Another primary objective for 2009 was to organize and conduct technical programming at the ACerS PacRim/ICG meeting in Vancouver, Canada. Technical programming was conducted by TC05 in 2008 at the Materials Science and Technology conference in the U.S.A. and in 2007 at the ICG meeting in France and the Materials Research Society meeting in England. These technical programming efforts were highly successful so a continued programming effort was deemed to be worthwhile to further communicate the activities of TC05 members and the work of the waste vitrification community to a broader audience. The symposium was successfully organized and was well attended. A total of 12 oral presentations (two oral papers were withdrawn) and 5 poster presentations were presented in the symposium.

At the 2008 Materials Science and Technology Conference, TC05 organized a **Waste Glass Leach Testing and Performance Modeling Forum**. The forum included 5 invited speakers representing three countries. Each speaker made a presentation on a specific topical area regarding waste glass performance testing and modeling. The speakers then participated in an open forum discussion with members of the audience. A CD was compiled containing slides from the invited presentations as well as a summary of the forum discussions. In 2009, the CDs were distributed to TC05 members and other interested parties.

#### **ACTIVITIES IN 2009**

The technical committee held one “face-to-face” meeting and two teleconference meetings in 2008.

The teleconference meeting held in February 2008 focused on planning for the upcoming technical programming to be conducted at the PacRim/ICG conference. At the teleconference the status on the liquidus temperature round-robin testing was discussed including a summary of the testing to be conducted and the laboratories participating in the testing.

A face-to-face meeting was held at the PacRim/ICG meeting in Vancouver, Canada with six TC05 members in attendance. At the meeting, the liquidus temperature round-robin was discussed extensively. Participants discussed some of the issues that they were facing in the testing as well as suggestions for improving the study. These discussions were summarized by two participants at the meeting and distributed to members of TC05 and round-robin participants. This resulted in some e-mail dialog among the participants. Based on this, a suggestion was made for setting up a “users forum” website for future round-robin testing initiatives conducted by TC05. The participants at the meeting also discussed presenting and/or publishing the results of the round-robin. All agreed that this would be worthwhile and plans are to present and publish the results in 2010. At the meeting in Vancouver, the technical program at the PacRim/ICG meeting was reviewed. It was agreed that there was continued interest in technical programming in these areas and that TC05 should plan to organize technical programming at the 2010 International Congress on Glass meeting in Brazil. Aldo Boccaccini and Jim Marra will serve as lead organizers for symposium at the 2010 ICG meeting. The participants also discussed collaborating on a book on hazardous waste

vitrification. Finally, collaboration with other ICG technical committees was discussed. All participants thought that this would be worthwhile.

A final teleconference meeting was held in December 2009. Discussions on the round-robin testing, technical programming at the 2010 ICG meeting and other 2010 initiatives were discussed.

TC05 leadership also identified a candidate interested in becoming a member of the technical committee. The candidate is as follows:

Mr. Michael La Robina (Director, Extreme Science Pty. Ltd, Australia)

This candidate will be forwarded to the Chair of the Coordinating Technical Committee for consideration for membership.

### Details of Activities

#### Liquidus Temperature Round-Robin

In waste glass processing, there are product and process constraints that must be met to assure successful vitrification operations. One constraint deals with avoiding crystal accumulation in the melter that may lead to processing issues or plugging of the melter discharge system. The liquidus temperature is defined as the maximum temperature at which crystals can co-exist with the melt in thermodynamic equilibrium. Figure 1 shows an optical photomicrograph of a crystallization front in a glass. Constraints can be imposed on the glass composition to ensure that the liquidus temperature of the glass is below the nominal melt temperature by some safety margin. An alternative control strategy could be to ensure that the amount of crystallization that may occur in the melt is below a limit to ensure that the crystals can be drained from the melter without accumulation. With either of these process control strategies, a precise method to determine the glass liquidus temperature is needed.

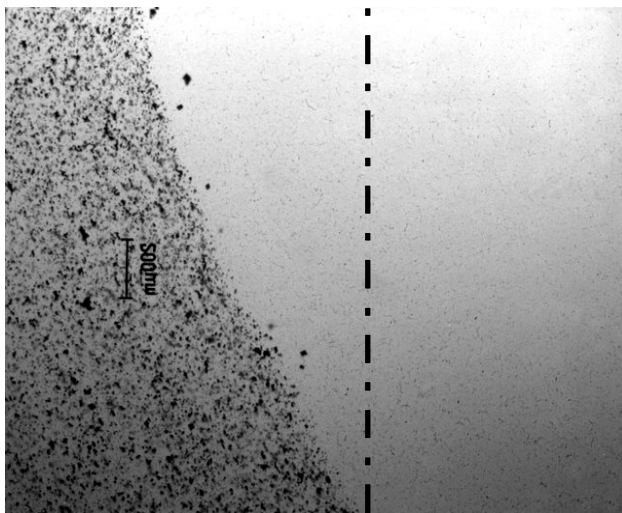


Figure 4.3.9. Optical micrograph of a crystalline front determined using a gradient furnace.

Liquidus temperature determination round-robin testing was identified as an interest to many TC05 members. An isothermal  $T_L$  determination technique, with two analyses variants, was developed by PNNL researchers that appeared to be repeatable and accurate. In one isothermal measurement variant, sequential isothermal treatments are used to bracket the temperature where crystals are and are not found and, thus, identifying the liquidus temperature. This method is referred to as the *Uniform Temperature Furnace Method (UT)*. X-ray diffraction (XRD), reflected light optical microscopy (RLM), or scanning electron microscopy (SEM) are used to identify the presence of or lack of crystals in a sample. A second isothermal testing variant is the *Crystal Fraction Extrapolation Method (CF)*. This method is a UT alternative method that uses XRD, RLM, or SEM to measure the crystal fraction of samples heat treated at temperatures below  $T_L$ . Using this method,  $T_L$  can be calculated by extrapolating crystal fraction as a function of temperature to zero crystals.

To date, five of the eight laboratories participating in the round-robin testing have transmitted data. An initial review of the data shows that the data is generally consistent with a potential low bias at one of the laboratories. An example of data obtained using the *Crystal Fraction Extrapolation Method* is shown in Figure 2.

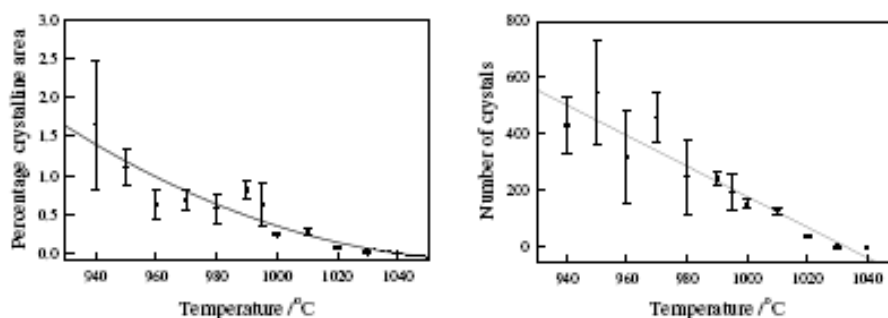


Figure 4.3.10. Percentage of crystalline area and number of crystals for Glass A. Extrapolation of the data to zero crystalline area or zero crystals gives  $T_L \approx 1035^\circ \text{C}$ .

It is anticipated that data from all eight laboratories will be received in early 2010. These data will be statistically analyzed to determine the precision and accuracy of the isothermal  $T_L$  measurement method. Based on the data analysis, a decision to proceed with formalizing the method as an ASTM procedure will be made. The results of the round-robin testing will be presented and published.

#### Technical Programming at PacRim/ICG Meeting

The symposium **Glasses and Ceramics for Nuclear and Hazardous Waste Treatment** was organized and conducted by TC05 at the PacRim/ICG meeting. A total of 17 papers were presented in the symposium. Six papers were presented in a session titled "Process Modeling and Waste Form Characterization and Analysis." The opening paper of the session "Thermodynamic Modeling of Comparative Melt Rates" provided an overview of experimental and thermodynamic modeling activities being conducted in nuclear waste glass compositions to understand compositional relationships to glass melting rates. The objective is to understand compositional relationships that could improve glass melting rates and, thus, waste vitrification throughput rates. This presentation was of interest to members of TC18 - Glass Melting and TC21 - Modeling of Glass Melting Processes and could be an area for future collaboration between TC05 and

these other TCs. Six papers were presented in a session titled “Glass, Glass-Ceramic and Cementitious Waste Forms.” The highlight of this session was an invited presentation by Professor Richard Brow on “Phosphate Glasses as Alternative Hosts for Radioactive Wastes.” This presentation provided an overview on the structure and properties of phosphate glasses and their potential application in the immobilization of nuclear wastes including several advantages of phosphate glasses compared to baseline borosilicate glasses currently used in waste vitrification. This session also included interesting papers on hazardous waste vitrification and potential re-use of the waste form products. Five posters from this symposium were included in the conference poster session. These papers were primarily related to waste form processing. The papers from the **Glasses and Ceramics for Nuclear and Hazardous Waste Treatment** symposium will be included in a **Ceramics Transactions** conference proceedings volume.

#### PLANS FOR 2010 AND DELIVERABLES

The primary objectives for 2010 will be to complete the liquidus temperature round-robin testing project and to continue technical programming efforts through sponsoring a symposium at the ICG meeting in Brazil. Based on the success of the technical programming sponsored by TC05 in 2007, 2008 and 2009, it is expected that this symposia will provide excellent opportunities for committee members to learn about vitrification activities being conducted in other countries and share technical information. Furthermore, since a focus for this symposium will be hazardous waste vitrification, it is hoped that interactions in this area will be increased.

Finally, the committee will actively work to identify longer-term activities such as joint publication of books and/or conducting workshops similar to the successful waste glass leach testing and performance modeling forum conducted in 2008.

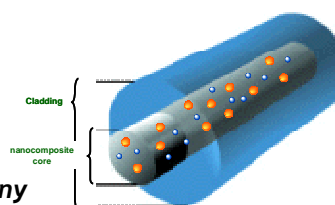
#### PUBLICATIONS AND OTHER CONTRIBUTIONS

The papers presented in the **Glasses and Ceramics for Nuclear and Hazardous Waste Treatment** symposium will be published by the American Ceramic Society in a Ceramic Transactions book volume.

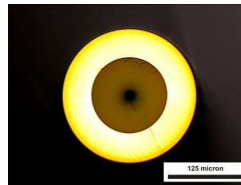
Members of TC05 had numerous publications in 2009. Of note is a book scheduled for release in 2010, **Crystalline Materials for Actinide Immobilisation** by Boris Burakov and TC05 members Michael Ojovan and William Lee.

#### 4.4.3 GLASS FOR OPTOELECTRONICS (TC20)

**Chairman:** *Setsuhisa Tanabe, Kyoto Univ., Japan*  
**Vice-Chairs:** *Giancarlo C. Righini, CNR, Italy*  
*Peter Kazansky, Southampton Univ., UK*  
**Chair Emeritus:** *Kazuyuki Hirao, Kyoto Univ., Japan*  
**Secretary:** *Jianrong Qiu, Zhejiang Univ, PRC*  
**Members:**  
*John Ballato, Clemson Univ., USA*  
*Matthew Dejneka, Corning Inc., USA*  
*Ulrich Fotheringham, Schott Glas, Germany*  
*Jong Heo, Pohang Univ., Korea*



Daniel Hewak, Southampton Univ., UK  
 Animesh Jha, Univ. of Leeds, UK  
 Shibin Jiang, AdValue Photonics Inc, USA  
 P Mazzoldi, Uni di Padova, Italy  
 Koichi Nishizawa, Japan (Past chair)  
 Yasutake Ohishi, Toyota Technological Institute, Japan  
 Guodong Qian, Zhejiang Univ, PRC  
 Kathleen Richardson, Clemson Univ., USA  
 Naoki Sugimoto, Asahi Glass Co., Japan  
 Hisayoshi Toratani, Hoya Corporation, Japan  
 V P Veiko, St Petersburg Inst of Prec Mech & Optics, Russia  
 X.Zhang, Univ. of Rennes, France



### SUMMARY

In 2009 we had a business meeting in May 31 at Vancouver, Canada, where the PacRim Ceramics and Glass Technology was held. As the 25<sup>th</sup> symposium of the ICG/GOMD meeting, “Optoelectronic glass symposium” was successfully organized attracting many audiences during the conference. Many of TC20 members contributed the organization of the symposium.



### PLANS AND DELIVERABLES FOR 2009

In 2009 we had a business meeting on May 31 at Hyatt Regency Vancouver, Canada, where the PacRim Ceramics and Glass Technology was held. Various topics such as the organization of the conferences in 2010 were discussed. As the 25<sup>th</sup> symposium of the ICG/GOMD meeting, “Optoelectronic glass symposium” was successfully organized during the conference. Many of TC20 members contributed the organization of the symposium.





## ACTIVITIES in 2009

### Meeting

In conjunction with PacRim Ceramics 2009, in Vancouver, Canada, TC20 had a business meeting on May 31, 2009. The main topics discussed in the meeting as well as the names of the Symposium organizers are shown below:

## Innovations in Glass Science and Technology (Jointly organized with GOMD and ICG)

### Symposium 25: Glasses for Optoelectronic and Optical Applications

Probably the most defining property of glasses is their optical transparency along wide ranges of wavelength which can be tuned with appropriate choices of composition. Indeed glasses have always played a central role in the development of optical technologies such as telecommunication networks. From simple lenses to fiber laser amplifiers or integrated optic circuitry, glasses are characteristically the materials which enable new optical technologies. Due to the wide variety of structural types available among amorphous materials, glasses constitute very flexible matrices for the design and development of optical devices both passive and active. This symposium will cover all topics related to glasses for photonic and optoelectronic applications. Development of glasses with new optical as well as combination of optical and electrical properties is of interest. This includes but is not limited to, luminescent materials for active device, photosensitivity and optical processing of glass, glass fibers and sensors and optoelectronic devices.

#### Proposed Session Topics

- Optically Active Glasses
- Glasses for Optoelectronics
- Photosensitivity in Glasses
- Optical Sensing
- Glass Fibers

#### Symposium Organizers

*Pierre Lucas*, University of Arizona, USA  
*Setsuhisa Tanabe*, Kyoto University, Japan  
*John Ballato*, Clemson University, USA

#### Symposium Organizers (Continued)

*Shibin Jiang*, Aduval Photonics, USA  
*Kathleen Richardson*, Clemson University, USA  
*Giancarlo C. Righini*, National Research Council (CNR), Italy  
*Norman Anheier*, Pacific Northwest National Laboratory, USA

#### Point of Contact

*Pierre Lucas*  
University of Arizona, USA  
Tel: 520-322-2311; Email: pierre@u.arizona.edu

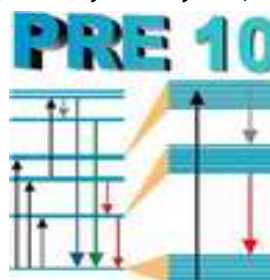
## PLANS FOR 2010 AND DELIVERABLE

We will meet on April 29 at Firenze, where the PRE2010 will be held. .

As the third organization of successful series since 2005 for every other years, we prepare the Workshop of PRE10 in Firenze on April 29 and 30. G.Righini, our vice chair, is heading the organization and many members are also cooperating as co-organizers.

Topics of interest include (and are not limited to):

- fundamental photoluminescence properties & spectroscopic measurements
- modeling, first-principles calculations, etc.
- rare-earth doped amorphous materials
- rare-earth doped glass-ceramic materials
- rare-earth-doped crystalline materials
- rare-earth optical amplifiers and lasers
- application-oriented materials investigations
- photonic and photovoltaic devices exploiting rare-earths' characteristics.



Many of TC20 members are involved either as chairs (G.Righini, S.Tanabe) or as committee (J.Ballato, Y.Ohishi, J.Heo, S.Jiang, A.Jha), as well as other TC members of ICG such as R.Almeida (Chair of TC16).

As research activities, TC20 focuses materials for “Green Photonics”.

In the next five years : The following research topics will be expected.

Glass Ceramic Phosphors for Solid-state Lighting

New glasses and fibers for fiber lasers and nonlinear optics,

New materials and process for infrared imaging and sensing.

Optical computing becoming more practical based on new materials.

Materials for solar cells show revolutionary increase in efficiency.

TC20 will focus also on New materials for Lighting and Solar Energy in addition to the present activities.

#### **PUBLICATIONS AND OTHER CONTRIBUTIONS**

A non exhaustive list of publications by TC20 members is given in **Annex 6**

### **4.5 R&D Activity Field “Information, Education and History”**

#### **4.5.1 INFORMATION AND COMMUNICATIONS (TC01)**

**Chairman:** *J M Parker, the University of Sheffield, UK*  
**Vice Chairman:** *A Makashima, Japanese Adv Inst of Sci & Technol, Japan*  
**Secretary:** *E Flygt, Glafo, Sweden*  
**Members:** *K Bange, Schott, Germany*  
*I Debaisieux, St Gobain, France*  
*H Schaeffer, Germany*  
*W Schaeffer, Germany*  
*J Vitkala, Tamglas, Finland*

#### **SUMMARY**

The EFONGA project was finally completed in June of 2009. As a final contribution to this event, TC01 with TC23 arranged a 2 day Workshop for New Research Students in Montpellier that attracted over 60 attendees. Within ICG TC01 continues to develop the web site, and several news items to promote ICG successes have been widely published. An editorial sub-committee immediately responsible to the Steering Committee has also been formed with the goal of expanding output and the visibility of ICG to the wider community.

#### **PLANS AND DELIVERABLES FOR 2009**

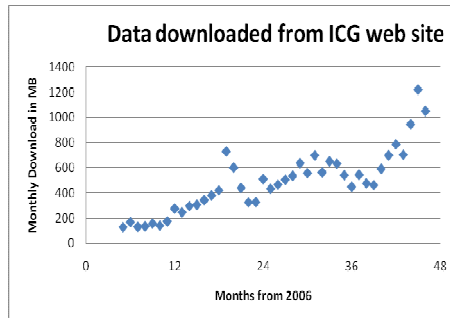
The main deliverables of TC01 in 2009 have been:

- Continuing revision and updating of the ICG and EFONGA Web sites
- Revision of the leaflet listing ICG officers
- Student workshop in Montpellier with TC23

- Minutes of CTC and EFONGA management board meetings
- The editing of News Briefs

## ACTIVITIES in 2009

The ICG web site continues to be a significant activity of TC01 and has been assisted by the preparation of informative news items by members of the CTC and Steering Committees. The contributions of Klaus Bange and his colleagues at Schott are particularly acknowledged. The quantity of data downloaded from the web site is shown in Figure 1 and has continued to expand rapidly this year; it now exceeds 1Gb per month.



We have had 17000 individual visits this year, from over 10000 unique visitors. 93000 pages have been viewed and we may surpass 100000 pages by the year end.

The web site host is able to provide very detailed web viewing statistics and these offer some useful insights. For example in just the first two weeks of December 2009, 32 people viewed the 2007 Annual Report and 27 viewed the 2008 report. Over a full year this extrapolates to more than 500 hits on each report, indicating how the web is expanding their availability; it also confirms the value of the effort put into increasing the quality of the Annual Reports over recent years. During the same 2 week period there were altogether 754 visits for an average time of 4 minutes each and with 5% of visits lasting more than 30 minutes. We can also identify the URLs for the most popular referring sites; for example we have a link from Wikipedia, via an article on self-cleaning glass. The above figures exclude visits by search engines.

A major change in the web site editing is that the software package used previously in the creation of the existing web pages is apparently no longer available and this is imposing a shift to alternative web authoring software.

The currency of the leaflet listing ICG officers has been maintained and copies are now available for download from the website.

Discussions have started on aspects of our corporate image such as the ICG logo, on efficient ways to maintain records of committee members by reconciling the various lists maintained by different officers, and on possible new publications based for example on the output from the EFONGA programme.

## PUBLICATIONS AND OTHER CONTRIBUTIONS

- ICG Web site
- ICG Officers leaflet
- Preparation of minutes for both the CTC and the EFONGA management committee
- Various news items relating to the workshops organised within EFONGA, annual conferences and other significant activities
- Teaching material from the Workshop in Montpellier ([www.efonga.eu](http://www.efonga.eu))

## KEY PLANS FOR 2010 AND DELIVERABLES

Specific goals for TC01 during the next year include:

- Maintain and improve ICG Web site information
- Adapt the web site structure to take account of the changes in TCs
- Encourage and support more TCs to produce their own web pages, e.g. by introducing standardised formats and data management systems
- Update the ICG history book in time for the ICG Congress in Brazil
- Generate further News Items on key ICG success stories

Continue to work with TC23 to produce a database of worldwide Universities offering courses in Glass Science and Technology.

### 4.5.2 GLASS FOR A SUSTAINABLE SOCIETY (TC12)

**Chairman:** *John Stockdale*  
**Vice-Chair:** *Michael Greenman*  
**Members:** *Lucien Belmonte, Abividro, Venezuela*  
*Manoj Choudhary, Owens Corning, USA*  
*Alastair Cormack, Alfred University, USA*  
*Alicia Duran, SECV-ICV, Spain*  
*Nicola Favaro, Stazione Sperimentale Vetro, Italy*  
*Wilfried Linz, Schott AG, Germany*  
*John Parker, University of Sheffield, UK*  
*Phil Ross, GICI, USA*  
*Guy Tackels, St Gobain, France*

#### SUMMARY

The mission in brief: to promote the use of environmental friendly glass products (initially those applicable in the climate change context) and generate better awareness by policy makers and the public about the benefits of glass.

There were 9 attendees at the Committee meeting in Lyon on 13<sup>th</sup> May where several members of TC13 were also able to contribute. The committee was also represented at the ICG Vancouver Conference in November by the Vice Chairman where the issue was raised with the steering group for resource support for development and maintenance of the website and participation and indeed initiation of external glass promotional events. The chairman and several others were available to attend the EFONGA meeting in Montpellier in June at which recent advances in glass technology and products applicable to sustainability were highlighted and contacts were made with academic bodies. Despite further attempts to encourage participation by these contacts in forthcoming conferences with sustainability themes there has been no response.

During the recession relevant members have continued to be extremely busy with environmental issues but mainly within their own organisations. There has subsequently been a lack of time or resource to devote to external communication. Indeed some company representatives questioned how it would be possible to justify the commitment of company resources given that it would likely be extremely difficult if not impossible

to identify any individual company financial benefit and that it would be some time before the situation changed. Inevitably whilst there was in theory support for the work of TC12 it was felt that it would be necessary to have access to funding to be able to make a significant advance. Furthermore resources had been allocated to promoting environmental credentials by one of the key sectors, flat glass, (and indeed the container sector) and there appeared little enthusiasm for duplication. Use has of course been made by committee members of any relevant materials where appropriate. No resources are currently available to pull together a concerted TC12 initiative.

#### **ACTIVITIES in 2009**

Members met at Lyon on 13<sup>th</sup> May in conjunction with the Glassman Exhibition. Modification and additions to the website were considered and members asked to forward further material. In particular with the help of Dr Kasper it was possible to include a section on environmental improvements related to glass in the automotive section. Members expressed the potential for glass promotion and the likely financial benefits in their respective areas and expressed concern about resources given the recession. No members had been able to submit generic presentation material for consideration. Attention was drawn to the fact that different countries might have very different priorities where “sustainability” was concerned and that the committee should be aware of this when developing generic material.

#### **PLANS AND DELIVERABLES FOR 2009**

Minor advances have taken place in 2009:

- Consolidation of the committee and objectives through a meeting in Lyon and on-line exchange of information
- Further development of the website.

Previously it had been suggested that it would be really useful if the TNO study on saving energy from using solar energy and E-glass could be made accessible for policy makers (amongst others) to calculate savings for their own regions. The chairman had approached TNO for an estimate of cost and the quote had been of the order of 80,000 Euros. Given the lack of funds any initiative to pursue was terminated.

#### **PLANS FOR 2010 AND DELIVERABLES**

- Continue to communicate on sustainability issues
- Continue to develop TC12 web pages
- Provide links to developing glass LCAs of which container and flat are under development
- Seek funding for promotional activity
- Encourage members and specialists to participate in relevant events where the environmental benefits of glass can be promoted

(Further specific information: There are initially, potentially two events identified in the US in 2010 year that could be appropriate venues for a TC12 presentation: the Glass and Optical Materials Division (of the American Ceramic Society) held in Corning, NY from 16 - 19 May (with a one-day GMIC workshop on glass strength on Thursday, May 20), and the Glass Problems Conference held in Columbus Ohio, October 18 - 20, again, with a one-day GMIC workshop on Thursday, October 21.) A proposal was approved in the last MB and SteCo meeting in Venice in October 27<sup>th</sup> to organise national one-day meetings with the

attendance of one ICG-champion. In the E glass, continuous fibre sector in the US activity is being fostered with the composites industry to develop LCI data and LCA cases to support sustainability activities within the composite industry.)

#### **PUBLICATIONS AND OTHER CONTRIBUTIONS**

Lobbying and information exchange at individual national level by members.

#### **4.5.3 EDUCATION & TRAINING (TC23)**

**Chairman:** *Reinhard Conradt, RWTH Aachen University, Germany*  
**Vice-Chair:** *Ales Helebrant, Inst. of Chemical Technology, Czech Republic*  
**Members:** *Carolina Brillante, GMAPI, the Philippines*  
*Petru Balta, Univ of Bucharest, Romania*  
*Charles Drummond III, The Ohio State University, USA*  
*Alicia Duran, Instituto de Ceramica y Vidrio, Spain*  
*Clara Goncalves, Instituto Superior Técnico, Portugal*  
*Hiroyuki Inoue, Institute of Industrial Materials, Japan*  
*Marek Liska, Trenčín University, Slovak Republic*  
*Angelo Montenero, Univ of Parma, Italy*  
*Morsi M. Morsi, National Research Center, Egypt*  
*Jean-Pierre Pagnac, Institut du Verre Prover, France*  
*John Parker, Univ of Sheffield, Great Britain*  
*Carlos Solier, INTEMIN/CIDEMAT, Argentina*  
*Alev Yaraman, Sisecam, Turkey*  
*Xiujian Zhao, Wuhan Univ of Technology, China*  
**Applicants:** *N. Papadopoulos, Greece; Candida, Brasil*

#### **SUMMARY**

The main focus of activities during the year 2009 was laid upon the organization and support of workshops, among which are the Montpellier Student Workshop 2009 (in cooperation with TC no. 01), the ICG Workshop on Thermodynamics & Chemical Technology in Glass Melting "Clear as Glass", Vancouver 2009, as well as several other student and training workshops. One TC member (A. Duran) successfully established an International Training Team of highly skilled individuals willing to serve in international training courses. Beyond this, a new scheme was developed to generate a new format of the ICG Book List, and a compilation of available courses on glass. TC no. 23 met in Vancouver on May 31 and had one Telcon for the core group.

#### **PLANS AND DELIVERABLES FOR 2009**

*The plans for 2009 were almost entirely focused on a successful organization and realization of different workshops and tutorials. The deliverables lasting beyond the immediate effect yielded during the events themselves consist in the lecture slides - and in some cases in full texts - of the individual courses and workshops. They are available for download under the addresses given below.*

## ACTIVITIES IN 2009

### Montpellier Student Workshop 2009

*The Montpellier Student Workshop was organized by TC01 in collaboration with TC23; locally, it was organized by Rene Vacher. The workshop was sponsored by EFONGA. Lectures were given by 11 individuals, 10 from EU, 1 from the US. The event attracted 55 young people from 13 different countries, mostly from EU, but also 3 from the US. Some undergraduates from Montpellier University spontaneously joined the event. The following topics were covered during a tough 2 days programme:*

- Glass forming ability; quench rates; glass compositions: commercial and experimental, oxide and non-oxide systems.
- Special techniques for glass making e.g. sol gel, rapid quenching, CVD; coating technologies.
- Chemical aspects of glass structure; relationship between composition and properties using thermodynamics.
- Structural characterization: diffraction techniques. X-ray, neutrons, EXAFS.
- Structural characterization: spectroscopic techniques: IR, Raman.
- Structural characterization: spectroscopic techniques : NMR, Mössbauer.
- UV, visible, near IR transmission & reflection spectroscopy; fluorescence.
- Glass properties: electrical, mixed alkali effect, semiconducting glasses, diffusion, chemical durability.
- Viscosity composition trends; relation to structure; definition & measurement of T<sub>g</sub>; other viscosity fixed points; fictive temperature & dimensional stability.
- Liquid-liquid phase separation; crystallization: liquidus, nucleation, crystal growth rates; induced nucleation, nanocrystallization.
- Glass transformation range behavior; relaxation processes, measurement, analysis & structural models.
- Glass ceramics; key properties. machineable glasses; bioceramics.
- Optical effects and crystallization; transparency, light scattering, size effects and quantum confinement; effects on fluorescence & excited state lifetimes.
- Bulk mechanical properties particularly elastic properties.
- Mechanical processes and glass surfaces: stress-corrosion mechanisms and AFM studies of glass surfaces.
- Making high quality glasses; ***melting/dissolution of sand grains, fining/removal of gases/gas bubbles from molten glass; evaporation, redox.***
- New applications and new requirements; road mapping.

*The feedback was unanimously positive. The written comment of one of the participants may serve as an example. He wrote:*

“I wanted to take this opportunity to thank those ... involved in organizing the 2009 EFONGA school. ... Not only did this event provide a fantastic networking opportunity (you may like to know a Facebook group has been started based on

the event!), it also helped me concrete my understanding of some of the basic concepts of glass forming, dynamics and properties. ... I think that given time constraints, the organization was great. Lectures were, on the most part, well delivered and pitched at the right level and the balance between discussion and lecture was good. I hope that similar workshops will continue in the future as I believe events like this are an important part of the research experience.”

*Yet, we probably tried to cover too much in a too short time. The topics of future workshops should be more focused, and more time should be allocated. Some students opted to arrange such workshops alongside with international conferences.*

### **ICG Tutorial “Clear as Glass” on Thermodynamics & Chemical Technology in Glass Melting, Vancouver 2009**

The scope of this tutorial responded to a need of many students engaged in glass courses. Students may gain a considerable background in materials science of glass, but often feel a lack of instruction in the theoretical background and the general concepts of industrial high-temperature processes. The tutorial aimed at closing this gap. The event was held as a part of the ICG annual meeting in conjunction with the GMOD PACRIM meeting of the American Ceramic Society. The lectures, delivered during ½ day by 3 individuals, covered the following topics:

- Thermochemistry of mineral raw materials, glass melts, and solid glass.
- The glass furnace - a thermochemical reactor.
- Thermochemistry of combustion.
- Transport mechanisms during glass melting.
- Mechanisms, thermochemistry, and kinetics of refining.

In total, 37 individuals participated in the tutorial, among which were 21 students (12 from the US and Canada, 11 from overseas) and 16 professionals from industry and academia. Again, the feedback of the participants was unanimously positive. Yet, the competition with interesting parallel sessions of the conference probably led to a comparatively small number of participating student.

### **Other courses**

Two further student workshops were held under the sponsorship of EFONGA:

- a Student Workshop in Cambridge, UK
- the 3. DGG Student Workshop “Glas?Klar!” in Amberg, Germany, as a part of the annual DGG-HVG conference.

### **PLANS FOR 2010 AND DELIVERABLES**

*In view of the encouraging feedback, the present TC23 members unanimously voted to continue similar events in the future with high priority. Thus, for the year 2010, the following events are planned:*



- a consecutive Montpellier Student Workshop, potentially as a summer school,
- a consecutive „Clear as Glass“ Workshop during the ESG conference in Magdeburg, Germany, (June 1; topic: Modification of the Glass Surface),
- a Student Tutorial during the ICG conference in Bahia, Brazil.

TC 23 will also contribute to the establishment of an Internet Course on Relaxation of Glasses presently prepared by several Universities, mostly from the US. The course is supposed to go on-line in late April 2010.

TC 23 will improve its website. A need is felt that the lecture slides and scripts are being made available immediately after the individual events and courses. The time lag during the present year certainly was too long and might jeopardize the long-term effect of the events.

Long-term plans:

*TC 23 will contribute to deal with an urgent problem frequently addressed by Oleg Mazurin and Adrian Wright, i.e., the problem of decreasing quality of experimental data for glasses and glass melts. It is obvious that the development of adequate educational measures must be part of the solution.*

## **PUBLICATIONS AND OTHER CONTRIBUTIONS**

*The following lecture slides and scripts are available as downloads:*

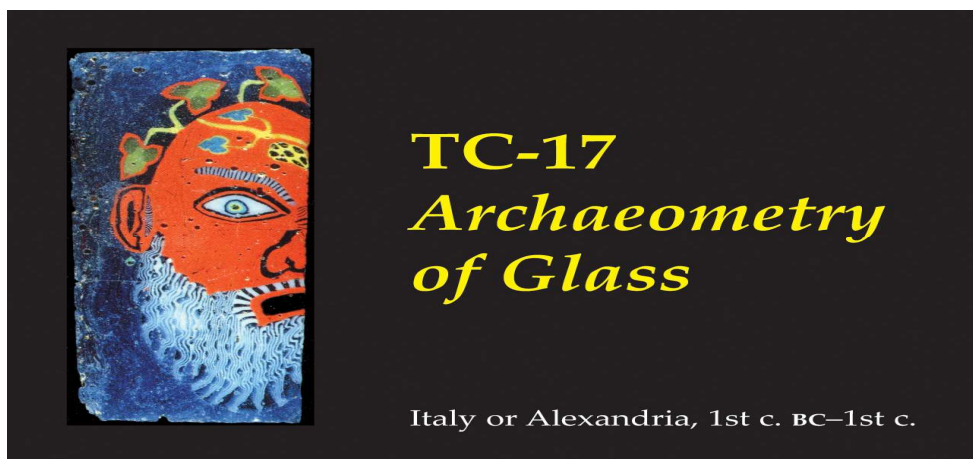
*Lecture slides of the Montpellier Student Workshop 2009 at  
www.icglass.com  
www.efonga.eu*

*Lecture slides and scripts of the ICG Tutorial “Clear as Glass” on Thermodynamics & Chemical Technology in Glass Melting, Vancouver 2009 at  
www.xxxxxxxx*

*Lecture slides of the Student Workshop at Cambridge 2009 at  
www.xxxxxxxx*

*Lecture slides of the DGG “Glas?Klar!” Course on Chemical Durability, Amber 2009, (in German) at  
www.hvg-dgg.de*

#### 4.5.4 THE ARCHAEOMETRY OF GLASS (TC17)



**Chairman:** Stephen P. Koob, Corning Museum of Glass, USA  
**Vice-Chair:** Robert H. Brill, Corning Museum of Glass, USA

**Regular Members:** Abdugani A. Abdurazakov, National Institute of Arts and Design, Uzbekistan  
H. C. Bhardwaj, Chandua Chittapur, India  
Catarina Carvalho, Museu do Vidro, Portugal  
Christopher R. DeCorse, Syracuse University, USA  
Gan Fuxi, Shanghai Institute of Optics and Fine Mechanics, China  
An Jiayao, Chinese Academy of Social Sciences, China  
Takayasu Koezuka, Nara National Cultural Properties Research Institute, Japan  
Alok Kumar Kanungo, Department of Archaeology, Deccan College, India  
M.O. Kozlova, State Hermitage, St. Petersburg  
David Martlew, c/o Society of Glass Technology, United Kingdom  
E. Edwards McKinnon, Pentlands Science Park, Scotland  
Patricia Pongracz, American Bible Society, USA  
Rainer Richter, Staatliche Kunstsammlungen, Germany  
Manfred Schreiner, Institut für Farbenchemie, Austria  
Colleen P. Stapleton, Mercer University, USA  
Norman Tennent, Glasgow, UK  
Marco Verità, Stazione Sperimentale Del Vetro, Italy  
Elzbieta Greiner-Wronowa, University of Mining & Metallurgy, Poland

**Consultative Members:**  
Jerzy Kunicki-Goldfinger, Institute of Nuclear Chemistry and Technology, Poland  
In-Sook Lee, Busan Museum, Korea  
Carlo G. Pantano, Materials Science & Engineering Dept., USA

**Members Emeriti:**  
Kazuo Yamasaki, Distinguished Scholar, Mizuko, Nagoya, Japan

***Shi Meiguang, Distinguished Scholar, China Building Materials Academy, China***

**SUMMARY**

The objectives and activities of TC17 differ somewhat from those of other TCs. The purpose of TC17, unchanged since its beginning in 1982, is to bring together glass scientists, archaeologists, museum curators, and conservators to present and discuss the results of research on early glass and glassmaking, and on the conservation of historical glass objects. Ordinarily, TC17 meets only at the International Congresses and centers its programs in an ad hoc manner on the research and glass problems of the regions where the Congresses are held.

Two very important aspects of TC17 are that it promotes collaboration among glass specialists in widely-separated countries and it serves as a stimulus and encouragement for glass scientists and historians in developing countries.

**ACTIVITIES in 2009**

**Publications**

Two books appeared in recent months that contain papers presented at two conferences sponsored by TC-17. TC-17 organized a conference on the "Archaeometry of Asian Glass", held in Kyoto in 2004. TC-17 also organized the "Ancient Glass Along the Silk Road" workshop held in Shanghai in 2005. Prof. Gan Fuxi, a long-time member of TC-17 arranged for the incorporation of the papers in two books, and the two books have just been published, one in English and one in Chinese. The TC-17 Kyoto and Shanghai papers are included in them, accompanied by papers from two conferences on related topics held in China.

These two books (as far as we know) are the first ever publications devoted to the study of glass found along the Silk Road. Therefore, they are something of landmarks in the field of Archaeometry of Glass.

The titles of the books are as follows:

Gan Fuxi, Robert H. Brill, and Tian Shouyun, editors, *Ancient Glass Research along the Silk Road*, World Scientific Publishing Co. Pte. Ltd., Singapore, 2009.

Gan Fuxi, Editor-in-chief, *Study on Ancient Glass along the Silk Road: Proceedings of 2004 Urumqi Symposium on Ancient Glass in Northern China and 2005 Shanghai International Workshop of Archaeology of Glass*, Fudan Press, 2007. (In Chinese.)

**Meetings**

None.

**Membership**

One new member was added in 2009. Dr. M.O. Kozlova of the State Hermitage, St. Petersburg was invited to become a regular member of TC17.

**PLANS AND DELIVERABLES FOR 2010**

At this point TC17 is not planning a special TC17 session or organized involvement with the XXII International Congress on Glass, to be held 20-25 September, 2010, in Bahia, Brazil.

**Annex 1**  
**Selected publications by TC03 members**

Herrmann, A.; Fibikar, S.; Ehrt, D.; Time-resolved fluorescence measurements on  $\text{Eu}^{3+}$ - and  $\text{Eu}^{2+}$ -doped glasses, *J. Non-Cryst. Solids* **355**, 2093 (2009).

Hojamberdiev, M.; Torrey, J. D.; Beltrao, M. S. D.; Wondraczek, L.; Cellular Anorthite Glass-Ceramics: Synthesis, Microstructure and Properties, *J. Am. Ceram. Soc.* **92**, 2598 (2009).

Mullenbach, T.; Franke, M.; Ramm, A.; Betzen, A. R.; Kapoor, S.; Lower, N.; Munhollon, T.; Berman, M.; Affatigato, M.; Feller, S. A.; Structural characterisation of alkaline earth borosilicate glasses through density modelling, *Phys. Chem. Glasses B* **50**, 89 (2009).

Machacek, J.; Gedeon, O.; Liska, M; Elastic properties of soda-lime silica glass from first principles, *Ceramics-Silikaty* **53**, 137 (2009).

Lumeau, J.; Sinitskii, A.; Glebova, L.; Glebov, L. B.; Zanotto, E. D.; Method to assess the homogeneity of partially crystallized glasses: Application to a photo-thermo-refractive glass, *J. Non-Cryst. Solids* **355**, 1760 (2009).

Hemono, N.; Pierre, G.; Munoz, F.; de Pablos-Martin, A.; Pascual, M. J.; Duran, A.; Processing of transparent glass-ceramics by nanocrystallisation of  $\text{LaF}_3$ , *J. Eur. Ceram. Soc.* **29**, 2915 (2009).

Takada, A.; New geometrical modelling of  $\text{B}_2\text{O}_3$  and  $\text{SiO}_2$  glass structures, *Phys. Chem. Glasses B* **50**, 219 (2009).

Moncke, D.; Dussauze, M.; Kamitsos, E. I.; Varsamis, C. P. E.; Ehrt, D.; Thermal poling induced structural changes in sodium borosilicate glasses, *Phys. Chem. Glasses B* **50**, 229 (2009).

Liu, Q. M.; Zhou, W.; Lu, X. M.; Hu, T.; Zhao, X. J.; Preparation and enhancement of second-order nonlinearity of hybrid PMMA/ $\text{SiO}_2$  glass with  $\text{Sb}_2\text{S}_3$  nanocrystals, *J. Mat. Res.* **24**, 2555 (2009).

Tilocca, A.; Cormack, A. N.; Modeling the Water-Bioglass Interface by Ab Initio Molecular Dynamics Simulations, *Appl. Mater. Interfaces* **1**, 1324 (2009).

**Annex 2**  
**Selected publications by TC27 members**

*Developments in Electronic Level Techniques:*

1. M. Micoulaut, R. Vuilleumier, and C. Massobrio, "Improved Modeling of Liquid GeSe<sub>2</sub>: Impact of the Exchange-Correlation Functional," *Physical Review B*, **79**, 214205 (2009).
2. C. Massobrio, M. Celino, P.S. Salmon, R.A. Martin, M. Micoulaut, and A. Pasquarello, "Atomic Structure of the Two Intermediate Phase Glasses SiSe<sub>4</sub> and GeSe<sub>4</sub>," *Physical Review B*, **79**, 174201 (2009).

*Statistical Mechanics of Glass:*

3. J.C. Mauro, R.J. Loucks, and P.K. Gupta, "Fictive Temperature and the Glassy State," *Journal of the American Ceramic Society*, **92** [1] 75-86 (2009).
4. J.C. Mauro, P.K. Gupta, R.J. Loucks, and A.K. Varshneya, "Non-Equilibrium Entropy of Glasses Formed by Continuous Cooling," *Journal of Non-Crystalline Solids*, **355**, 600-606 (2009).
5. J.C. Mauro and R.J. Loucks, "Forbidden Glasses and the Failure of Fictive Temperature," *Journal of Non-Crystalline Solids*, **355**, 676-680 (2009).

*Energy Landscapes and Applications:*

6. J.C. Mauro, S. Soyer Uzun, W. Bras, and S. Sen, "Nonmonotonic Evolution of Density Fluctuations during Glass Relaxation," *Physical Review Letters*, **102**, 155506 (2009).
7. J.C. Mauro, D.C. Allan, and M. Potuzak, "Nonequilibrium Viscosity of Glass," *Physical Review B*, **80**, 094204 (2009).

*Novel Topological Model Approaches:*

8. M. Micoulaut and M. Popescu, eds., *Rigidity Transitions and Boolchand Intermediate Phases in Nanomaterials*, INOE, Bucharest, Romania (2009).
9. P.K. Gupta and J.C. Mauro, "Composition dependence of glass transition temperature and fragility. I. A topological model incorporating temperature-dependent constraints," *Journal of Chemical Physics*, **130**, 094503 (2009).
10. J.C. Mauro, P.K. Gupta, and R.J. Loucks, "Composition dependence of glass transition temperature and fragility. II. A topological model of alkali borate liquids," *Journal of Chemical Physics*, **130**, 234503 (2009).
11. J.C. Mauro, Y. Yue, A.J. Ellison, P.K. Gupta, and D.C. Allan, "Viscosity of Glass-Forming Liquids" *Proceedings of the National Academy of Sciences of the United States of America*, in press (2009).

*Algorithm Development:*

12. A. Kushima, X. Lin, J. Li, J. Eapen, J.C. Mauro, X. Qian, P. Diep, and S. Yip, "Computing the Viscosity of Supercooled Liquids," *Journal of Chemical Physics*, **130**, 224504 (2009).
13. A. Kushima, X. Lin, J. Li, X. Qian, J. Eapen, J.C. Mauro, P. Diep, and S. Yip, "Computing the Viscosity of Supercooled Liquids. II. Silica and Strong-Fragile Crossover Behavior," *Journal of Chemical Physics*, in press (2009).

*Review Article (Result of EFONGA Workshop in Brig):*

14. L. Wondraczek and J.C. Mauro, "Advancing Glasses through Fundamental Research," *Journal of the European Ceramic Society*, **29**, 1227-1134 (2009).

**Annex 3**  
**TC7 Meeting, Vancouver, Canada**  
**June 2, 2009, 8:00 -11:20 am**

Attendees:

**Edgar Zanotto, Brazil (chairman)**  
**Wolfram Hoelland, Liechtenstein (vice-chair)**  
**Mark Davis, USA**  
**Joachim Deubener, Germany**  
**Ralf Mueller, Germany**  
**Maria J. Pascual, Spain**  
**Akihiko Sakamoto, Japan**

Guests:

**Alicia Duran (ICG treasurer)**  
**Lothar Wondraczek (TC8 chair)**  
**Adrian Wright (TC3 chair)**

Four members (Takayuki Komatsu; Robert Hill; Michael Budd and Miguel Prado) apologized for their absence. They have chosen to attend the TC7 meeting in Iguazu Falls, Brazil, next September. Other members (Joachim Deubener, Edgar Zanotto and Mark Davis) will participate in both meetings.

1. Brief introduction - **Edgar Zanotto - Fed. University São Carlos, Brazil**

The chairman welcomed the attendees and guests and went through the proposed agenda. He informed that Linda Pinckney of Corning, USA, asked to leave the TC7 for personal reasons. We are indebted to Linda for her excellent contributions and continuous support to the TC7 during many years and wish her good luck.

2. 10 minute technical presentations by the attendees.

**Mark Davis - SCHOTT North America, Inc.**

Mark has been working on electrically-conductive glass-ceramics. The idea is to combine the relative manufacturing ease of glass and glass-ceramics with high-temperature refractoriness and mechanical stability normally associated with ceramics. Work to date has focused on relatively simple systems, including lithium disilicate (L2S) doped with silver (the L2S base system has long been a focus of TC 7). Ceramization in a reducing environment, coupled with the addition of a suitable reducing agent in the glass batch, has led to a nearly  $10^4$  increase in total electrical conductivity as compared with the precursor glass or via other processing steps (Figure A3.1).

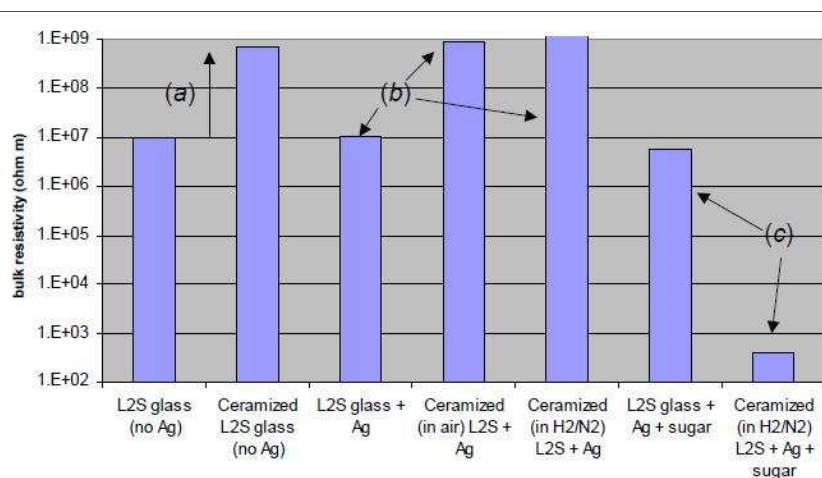


Fig. A3.1: (a) in this system (lithium disilicate), ceramization tends to increase resistance; (b) addition of silver alone has no measurable effect on resistance of either glass or glass-ceramic; and (c) addition of silver plus sugar tends to slightly decrease resistance of glass but greatly reduces resistance of glass-ceramic ( $\sim 10^4$  reduction)

#### Akihiko Sakamoto - Nippon Electric Glass, Japan

Akihiko reported about an “Anomaly in the CTE of a glass-ceramic”. A  $\text{LiO}_2\text{-Al}_2\text{O}_3\text{-SiO}_2$  glass-ceramic with a crystallinity less than 50 vol% showed anomalously low CTE:  $-7 \times 10^{-7}/\text{K}$ . This is estimated to be due to existence of interstices (cracks) between the crystalline and glassy phases. He will follow on focusing on a study the microstructure of phase boundary and its effect on the properties of this glass-ceramic.

#### Maria J.Pascual - ICV, Spain

Maria presented her results on “Nanocrystallisation in  $\text{LaF}_3$  containing glasses” with a summary of her recent findings about structural characterization of glass-ceramics containing nanocrystals using different experimental methods, and with special emphasis in the study of luminescence and up-conversion. Maria J.Pascual was also responsible for a poster presentation entitled “Glass-ceramics and hybrid seals for solid oxide fuel cells (SOFC)” in which three glass-ceramic compositions containing  $\text{SiO}_2$ ,  $\text{B}_2\text{O}_3$ ,  $\text{BaO}$ ,  $\text{SrO}$ ,  $\text{MgO}$ ,  $\text{ZnO}$  have been optimized for sealing SOFC (see micrograph below). The objective of her work was to obtain hybrid seals glass-ceramic/mica/glass-ceramic with stainless steel Crofer 22 (interconnect material) in order to improve the mechanical properties of the sealing system.

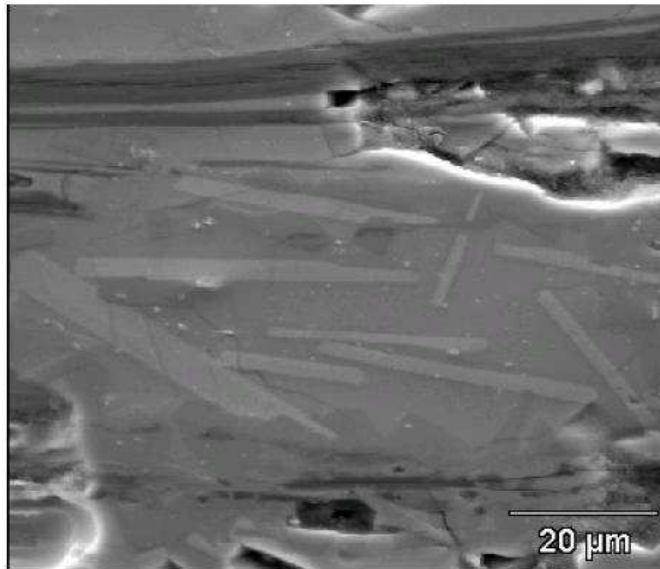


Fig. A3.2: Microstructure of one glass-ceramic used

**Joachim Deubener - TUC, Germany**

Joachim presented the results of his research work on the evaluation of “Fracture toughness of glass-ceramics by the COD method” and demonstrated that, among several indentation techniques, only the COD indentation method can give reliable values of toughness for glass-ceramics.

Compilation of glass-ceramic data:  
 - Sevim & Kuleki 2006  
 - Boccaccini et al. 2006  
 - Berthier da Cunha et al. 2007  
 - this work

Hardness does not correlate with Vickers indentation fracture toughness  $K_{VIF}$

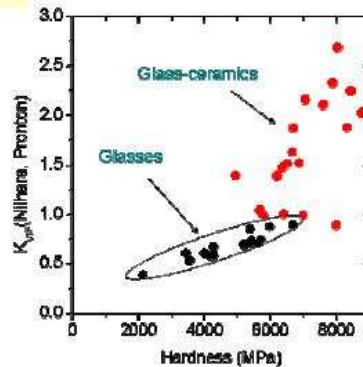


Fig. A3.3: Toughness versus hardness for several glasses and glass-ceramics.

**Ralf Muller- BAM**

Ralf reported about his recent studies concerning the sintering of glass matrix composites for LTCC as part of a current co-operation with Joachim. As one of the key factors, dissolution of alumina and its influence upon sintering and crystallization were



studied for calcium aluminoborosilicate glass / alumina composites (*Pacrim8-S24-P192-2009*). For the mean particle size, heating rate and alumina volume fraction under study ( $\approx 2 \mu\text{m}$ , 5 K/min, 25 vol %), typical for many LTCC, the composites fully densify not influenced by dissolution of alumina. Dissolution starts later when wollastonite - the primary crystal phase - has been fully precipitated and is accompanied by pronounced crystallization of anorthite. Accordingly, the effect of the alumina particles on sintering is mainly governed by their steric effects (*Pacrim8-S24-013-2009*). A simple kinetic model, based on the classical equations of Frenkel and Mackenzie, weighed super positions of differently sized particles and different types of glass-crystal clusters and which apply effective viscosity data measured from dense composites can explain this steric effect.

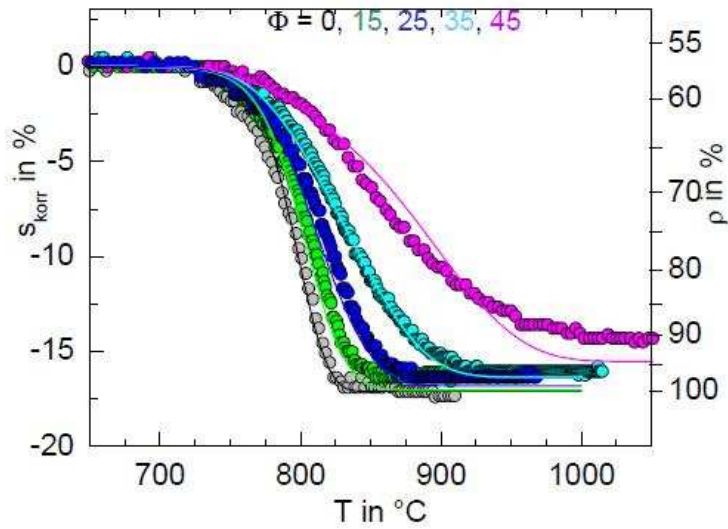


Fig. A3.4: Measured (spheres) and fitted linear shrinkage (curves) of aluminoborosilicate / alumina composites = volume fraction of alumina.

**Wolfram Höland**

presented a brief summary of the recent meeting in Trencin as well as the Efonta meetings in Brig and Montpellier. The main suggestions are summarized in figure A3.5.

**FUTURE MISSION MORE THAN A LEAST COMMON MULTIPLE**

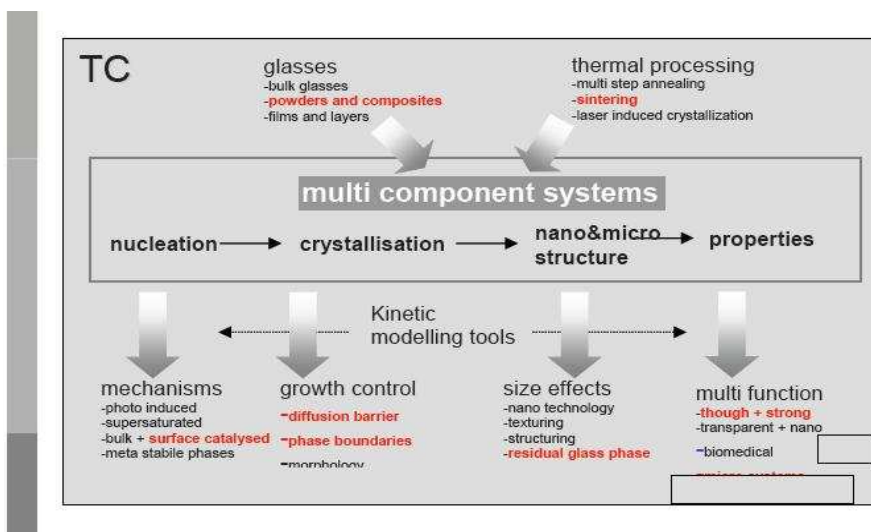


Fig. A3.5: Strategy and research topics of the TC7.

### Edgar Zanotto

presented a short report about the oral program and status of the "**Crystallization 2009**" to be held in Iguassu Falls, Brazil September 2009. The organization of the tri-annual *Crystallization* meetings is one of the most relevant deliverables of the TC7. Details can be seen at [www.pncs-crystallization.com.br](http://www.pncs-crystallization.com.br)

We started to discuss some of the questions recently posed by the ICG-CTC:

"First question: What will happen in your TC in the next 3 years?"

There has been a dynamic process in the development of the TC7 strategy in the last 5 years. We started to study the complex nano-crystallization process in photo-thermo refractive glass, a multicomponent oxy-fluoride glass; and we are now committed to focus on several types of *multicomponent glass-ceramics*.

The planned strategy is to combine fundamental and applied research. The following topics will be focused, and the TC7 members that are already working or intend to be actively working in the next three years on one or more of the topics are listed below

#### On going topics which started in the last -ten years:

- *Sintering and crystallization of glass powders* - Ralf, Edgar, Miguel, Maria, Joachim, Wolfram, Akihiko, Michael, Gilles have been actively working on this subject.
- *Nano crystal formation in GC* - Wolfram, Edgar, Fokin, Maria, Akihiko, Komatsu, Robert.

#### Relatively new topics:

- *Relationships between micro and nanostructure, strength and toughness of GC at low and high temperatures:* Wolfram, Joachim, Ralf and Gilles will be actively working on this subject.
- *Sealing different materials to GC* - Ralf, Wolfram, Michael, Joachim, Michael, Ian.
- *Interfaces between glass/crystal or GC/other materials* - Mark, Ralf, Wolfram, Akihiko
- *Rheological behavior of GC at high temperatures* - Ralf, Joachim, Gilles.

#### Research topics proposed for possible interaction with other committees

- with TC 8 (Relaxation) "Path dependent nucleation"

TC 7 members that are, in principle, interested: Mark, Edgar, Fokin, Joachim /TC 4 members: Lothar...

- with TC 3 (Basic Science) “*Structural aspects of glass crystallization*”

TC 7 members that are, in principle, interested: Edgar, Robert, Fokin.../ TC 3 members: Joe Zwanziger, Natalia Vedischeva, Adrian Wright, Alastair MacCormack...

(a thematic symposium has been proposed by A. Wright for the ICG 2010)

- with TC 4 (Biomaterials) / “*Microstructure, strength and toughness of bio GC*”

TC 7 members that are, in principle, interested: Wolfram, Joachim, Edgar / TC 5 members; Julian Jones, Aldo Boccaccini...

(a thematic symposium has been approved by the TC04 and is already being organized for the ICG 2010)

We resumed activities at 11:20am to attend Larry Hench’s award talk on bio glasses.

One of the main activities of the TC7 in 2009 was the organization of the *International Symposium on Glass Crystallization*. In this particular occasion that meeting took place back-to-back with the 12<sup>th</sup> *International Conference on the Physics of Non-crystalline Solids*. All the relevant information is available at [www.pncs-crystallization.com.br](http://www.pncs-crystallization.com.br); and a summary is shown below:

The **9th International Symposium on Crystallization in Glasses and Liquids** (Crystallization 2009) has a long and distinguished history. Symposia were held in the United States in 1961 (chaired by W.B. Hillig & G.E. Rindone), 1971 (L.L. Hench & S.W. Freiman), 1981 (J.H. Simmons, D.R. Uhlmann & G.H. Beall) and 1992 (M.C. Weinberg) with decade intervals. Recently, meetings have become more frequent due to growing interest in both the fundamental processes of nucleation and crystal growth in glasses and the development and properties of glass-ceramics. With the help of the **TC-7** (Nucleation, Crystallization and Glass-ceramics Committee of the ICG), symposia were held in Brazil in 1996 (chaired by E.D. Zanotto - **TC7 member**), in Liechtenstein in 2000 (W. Hoeland- **TC7 member**), in England in 2003 (P.F. James - **TC7 member**), and in the USA in 2006 (M.Davis - **TC7 member**).

Topics covered:

- Theoretical, simulational and experimental studies of nucleation, crystal growth and overall crystallization in glasses and liquids.
- Amorphous phase separation and its effect on crystallization.
- Glass-ceramic processing and the role of nucleating agents.
- Photo-induced crystallization.
- Microstructure/property relationships in glass-ceramics, including nano-crystallized materials.
- Thermal, mechanical, electrical, optical, and chemical properties of glass-ceramics.
- Applications of glass-ceramics, including medical and dental applications.
- Crystallization phenomena relevant to other types of materials, such as igneous rocks, minerals and synthetic crystals, metallic glasses, polymer glasses, sol-gel derived materials, etc.

#### INTERNATIONAL ADVISORY BOARD

- Akihiko Sakamoto - Otsu, Japan (**TC 7 member**)
- Angela Seddon - Nottingham, UK
- Bill Lee - London, UK
- Christian Ruessel- Jena, Germany

- Cristina Leonelli - Modena, Italy
- Falk Gabel, Mainz, Germany (TC 7)
- Iván A. Cornejo, Corning, USA
- Joachim Deubener - Clausthal, Germany (TC 7)
- Juern W. P. Schmelzer - Rostock, Germany
- Kenneth F. Kelton- St. Louis, USA
- Lindsay Greer - Cambridge, UK
- Reza Yavari - Grenoble, France
- Setsuhisa Tanabe - Kyoto, Japan
- Takayuki Komatsu - Nagaoka, Japan (TC 7)
- Vladimir Fokin - St. Petersburg, Russia (TC 7)
- Mark Davis\* - Duryea, USA (TC 7)
- Wolfram Hoeland\* - Schaan, Liechtenstein (TC 7)
- Edgar D. Zanotto\* (TC 7 chairman)
- Chairmen of previous Crystallization Symposia

#### INVITED SPEAKERS

- Christian Russel, *Germany* - Photo induced crystallization
- Erich Meyer, *Brazil* - Applicability of adiabatic nucleation theory to glass crystallization
- Juern Schmelzer, *Germany* - On the determination of the kinetic pre-factor in nucleation theory
- Julien Lumeau, *USA* - Complex crystallization pathways of a multicomponent PTR glass
- Ken Kelton , *USA* - Liquid and glass structures and their Influence on phase transitions
- Lian Yu, *USA* - Crystallization of organic glasses: how crystal growth transitions from diffusion-controlled to diffusionless and is enhanced by free surfaces
- Lindsay Greer, *UK* - Recent advances on crystallization of metallic glasses
- Mark Davis, *USA*, Crystal-Size Effects in Glass-Ceramics: a Review (TC 7)
- Olga Dymshits, *Russia* - Optical applications of glass-ceramics
- Pavel Hrma *USA* - Crystallization in multicomponent glasses
- Vitaly Schneidman, *USA* - Mathematical theory of the two-step annealing experiment

In that occasion, for the first time the organizers decided to give a good break and only charged 160 Euros for the registration fees of all TC7 members, i.e.the same fee as for students.

About 250 attendees from 25 countries flew to marvelous Iguazu Falls and spent about a week there, from September 6 to 10. Some statistics about the number of presented papers are shown below:

	PNCS XII	Crystallization	Total
Invited talks (30 min)	30	11	41
Oral presentations (10 min + 5 minute questions)	86	34	120
Posters (short 1 min. + 2 hours)	160	91	251

**Annex 4**  
**TC7 Business Meeting, Iguazu Falls**  
**Sept. 2009**

The TC 7β had a second business meeting in Iguazu Falls, Sept 2009, with the following attendees:

**E.D Zanotto, Brazil**  
**M. Davis, USA**  
**G. Voelksch, Germany**  
**J. Deubener, Germany**  
**M.O. Prado, Argentina**  
**M. Budd, Norway**  
**R. Hill, UK**  
**T. Komatsu, Japan**  
T. Johansson, Germany representing F. Gabel  
S. Reinsch, Germany representing R. Muller  
A. Duran, Spain representing M. J. Pascual  
J. Zwanziger, Canada - guest (chairman of the TC 3)

Ian Donald informed on his retirement. On behalf of the TC 7 members we take this opportunity for tanking Ian for all his valuable services to the TC 7 and wish him the very best for the future.

We summarize below some talks presented in the Iguazu Falls meeting.

**T. KOMATSU, JAPAN**

Komatsu's group their research mainly on the development of nanocrystallized glasses and laser patterning of crystals on glass substrates. For instance, the following topics are being studied.

1. Development of transparent crystallized glasses consisting of ferroelectric  $Sr_xBa_{1-x}Nb_2O_6$  nanocrystals: We confirmed the electro-optic effect in our crystallized glasses. "Synthesis, Ferroelectric and Electrooptic Properties of Transparent Crystallized Glasses with  $Sr_xBa_{1-x}Nb_2O_6$  Nanocrystals"  
**T. Yamazawa, T. Honma, H. Suematsu, and T. Komatsu**  
Journal of the American Ceramic Society, 92[12], 2924-2930 (2009).
2. Patterning of crystals by laser irradiation and the mechanism of laser-induced crystallization: They are trying to pattern various functional crystals by laser-induced crystallization techniques. The understanding of the mechanism is also important in the science and technology of glass crystallization. The figure shown below is the cover picture of their recent paper on the laser patterning of ferroelastic  $\beta'$ -(Sm,Gd) $_2$ (MoO $_4$ ) $_3$  crystals lines. A very unique periodic domain structure (generation of the periodic high and low refractive index regions) is observed, and we think that ferroelastic  $\beta'$ -(Sm,Gd) $_2$ (MoO $_4$ ) $_3$  crystals are examples for understanding of the mechanism of laser-induced crystallization in glasses.

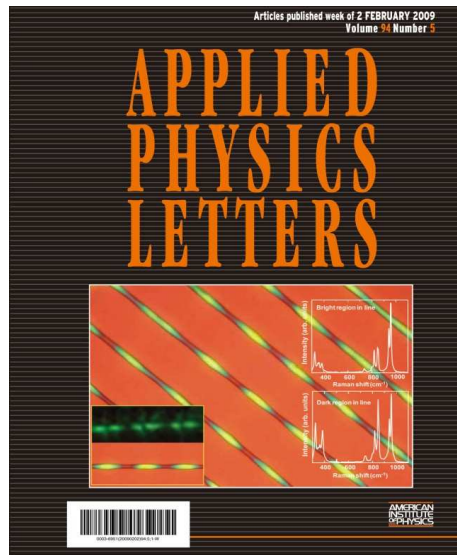


Fig.A4.1: Self-organized periodic domain structure for second harmonic generation in ferroelastic beta'-(Sm,Gd)<sub>2</sub>(MoO<sub>4</sub>)<sub>3</sub> crystal lines on glass surfaces- Y. Tsukada, T. Honma, and T. Komatsu, Applied Physics Letters, 94, 059901 /1-3 (2009).

### Michael Budd

Michael Budd presented some results from fundamental studies on the crystallization kinetics of powder route glass-ceramic sealants in the CaO-MgO-SiO<sub>2</sub> system with small additions of Y<sub>2</sub>O<sub>3</sub>. Sintering was complete prior to the initiation of crystallization on all of the materials studied, so the differences in sealing performance (flow and bonding) were determined by the kinetics of crystallization after full densification. Measurements of surface crystal growth rates on bulk materials were combined with studies of microstructural development on powder route materials and glass viscosity measurements. The results suggest that Y<sub>2</sub>O<sub>3</sub> additions improve sealing behaviour by increasing the induction period for development of stable surface nucleation sites and by decreasing the rate of crystal growth; allowing the materials to be heated to higher temperatures (and lower viscosities) before crystallization finally inhibits flow.

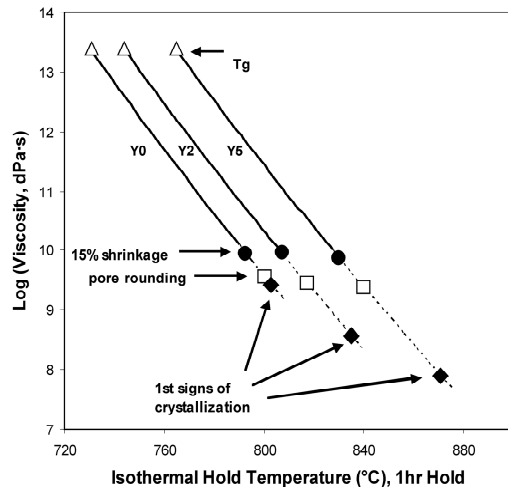


Fig. A4.2: Relation between progress of microstructural development and viscosity for CaO-MgO-SiO<sub>2</sub> based, powder-processed glass-ceramics containing 0, 2 and 5 mol% Y<sub>2</sub>O<sub>3</sub> subjected to 1 hour isothermal hold at various temperatures.

### Günter Völksch, Germany

Fresnoite (Ba<sub>2</sub>TiSi<sub>2</sub>O<sub>8</sub>) glass-ceramics prepared by electrolytic induced crystallization of a melt have been investigated by cathodoluminescence (CL) and electron backscatter diffraction (EBSD) in the SEM. Oriented crystallization was found over long distances starting close to the anode of the electrolytic cell (Figure A4.3). Luminescence at 502 nm was observed after irradiation with 20 keV electrons. The intensity depends on the distance from the anode (Figure A4.4).

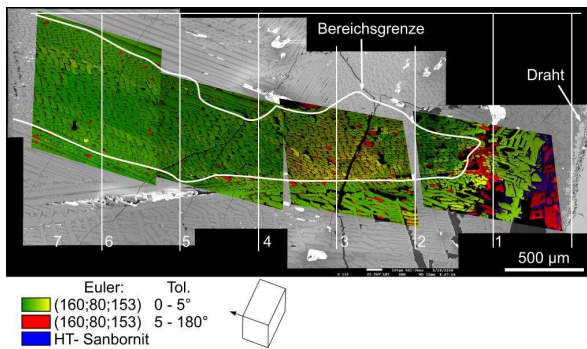


Fig. A4.3: Distribution of the Euler angles (green to yellow) of the tetragonal fresnoite crystals from the anode (Pt wire on the right side) to the edge of the sample

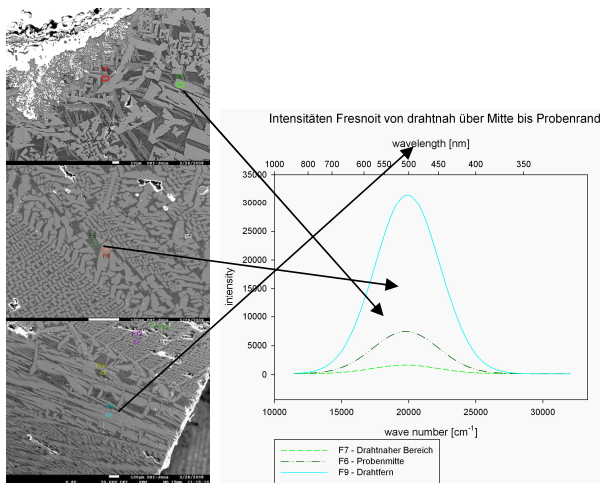


Fig. A4.4: Cathodoluminescence of fresnoite crystals depending on the distance from the anode (from F7- close to the wire to F9-far from the wire)

**S. Reinsch, R. Müller, J. Deubener, Germany**

Glass matrix composites of calcium-alumo-borosilicate glass and dispersed  $\alpha$ - $\text{Al}_2\text{O}_3$  are progressively used for Low Temperature Co-fired Ceramics (LTCC) in ceramic packaging of microelectronic components. Sintering kinetics and evolution of microstructure of  $38\text{CaO}-4.7\text{Al}_2\text{O}_3-7.3\text{B}_2\text{O}_3-50\text{SiO}_2$  glass (CABS) / alumina composites (10 vol%) during constant heating at 5 K/min were investigated by heating microscopy, DTA, and SEM. It was shown that the primary crystal phase (wollastonite) crystallizes by surface nucleation mechanism against what the second crystal phase (anorthite) crystallizes in all probability by homogeneous nucleation near the surface of corundum particles. The latter is controlled by dissolution of the alumina particles and diffusion of Al into the glass. Therefore, the diffusion coefficients of Al in CABS between 875 and 936 °C were determined using diffusion pair experiments. The resulting coefficients of  $2 - 6 \cdot 10^{-12} \text{ cm}^2/\text{s}$  are comparable to literature data (see figure).

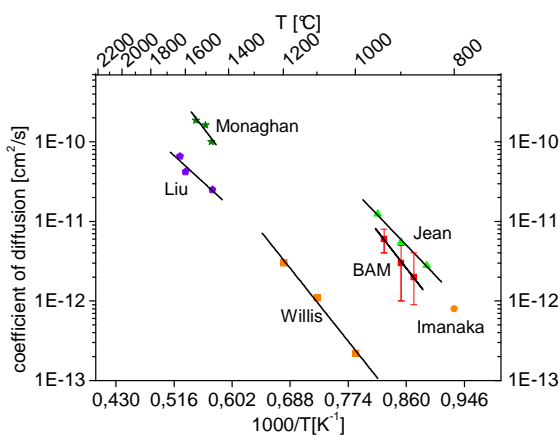


Figure A4.5: Diffusion coefficients of Al in alumo-borosilicate glasses.



Author	Composition (wt %)	
Willis	50 SiO <sub>2</sub> 20 Al <sub>2</sub> O <sub>3</sub> 10 CaO 10 B <sub>2</sub> O <sub>3</sub> 10 Na <sub>2</sub> O	<i>J.Am.Ceram.Soc. 63 (1980)</i>
Monaghan	48.3 SiO <sub>2</sub> 23.7 Al <sub>2</sub> O <sub>3</sub> 28.0 CaO	<i>J.Non-Cryst. Sol. 347 (2004)</i>
Liu	46.2 SiO <sub>2</sub> 24.1 Al <sub>2</sub> O <sub>3</sub> 29.7 CaO	<i>J.Am.Ceram.Soc. 90 (2007)</i>
Imanaka	80.5 SiO <sub>2</sub> 2.2 Al <sub>2</sub> O <sub>3</sub> 0.2 CaO 12.9 B <sub>2</sub> O <sub>3</sub> 3.8 Na <sub>2</sub> O 0.4 K <sub>2</sub> O	<i>J.Am.Ceram.Soc. 78 (1995)</i>
Jean	70-75 SiO <sub>2</sub> 25-30 B <sub>2</sub> O <sub>3</sub> 1-2 alkaline oxids	<i>J.Mater.Res. 7 (1992)</i>
BAM	49.07 SiO <sub>2</sub> 7.83 Al <sub>2</sub> O <sub>3</sub> 34.81 CaO 8.30 B <sub>2</sub> O <sub>3</sub>	<i>this work</i>

**Th. Johansson, F. Gabel, Germany**

A new dilatometry method to determine the kinetic parameters of glass transition and ceramization will be proposed.

Standard pushrod-dilatometers are not applicable to measure the elongation of glasses above transformation temperature T<sub>g</sub>, because the softening of the glass or glass ceramic samples leads to incorrect measurements induced by contact forces of the fixing system. This new contact-free dilatometer type based on light shadowing overcomes these limitations. It opens the way to measure directly expansion phenomena above softening point like elongation above glass transition, ceramization shrinkage or effects of additives at temperatures up to 200 K above T<sub>g</sub>.

Structural relaxation parameters of glasses are mostly determined by the analysis of Differential Scanning Calometry (DSC) measurements. This method assumes that length and enthalpy relaxation follow identical kinetics in glasses. Analyzing the glass transition by a contact-free dilatometer enables the direct determination of the structural relaxation parameters. In addition the thermal expansion coefficient of a melt in the relaxed liquid state was obtained by this method. Using the same type of measurements also the ceramization kinetics was determined.

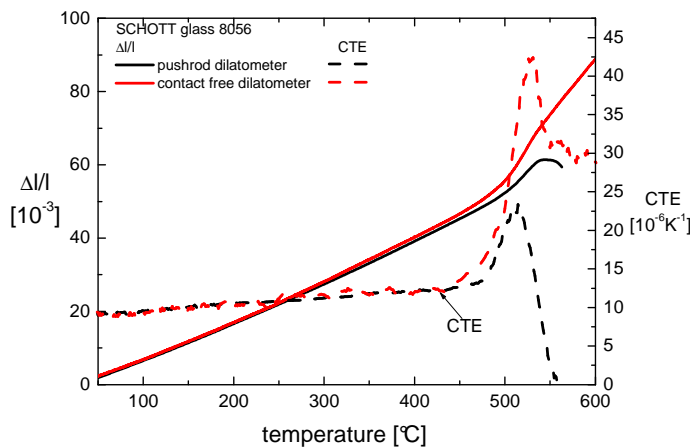


Fig. A4.6: The thermal expansion  $\Delta l/l$  of a SCHOTT glass 8056 sample and the derived CTE, measured both by standard and by optical dilatometry

**Annex 5**  
**Crystallization related publications of TC7 members in 2009**

Title: *Effect of chemical etching on the surface morphology of laser-patterned lines with Er<sup>3+</sup>-doped CaF<sub>2</sub> nanocrystals in oxyfluoride glass*

Author(s): Kanno M, Honma T, Komatsu T

Source: MATERIALS RESEARCH BULLETIN

Volume: 44 Issue: 11 Pages: 2143-2146 Published: NOV 2009

Title: *Laser patterning and magnetic properties of perovskite-type La<sub>0.7</sub>Sr<sub>0.3</sub>MnO<sub>3</sub> crystals on the glass surface*

Author(s): Kioka K, Honma T, Ishibashi T, et al.

Source: SOLID STATE COMMUNICATIONS

Volume: 149 Issue: 41-42 Pages: 1795-1798 Published: NOV 2009

Title: *Influence of Sm<sub>2</sub>O<sub>3</sub> doping on formation and structure of SrBi<sub>2</sub>Nb<sub>2</sub>O<sub>9</sub> nanocrystals in lithium borate glasses*

Author(s): Venkataraman BH, Fujiwara T, Varma KBR, et al.

Source: MATERIALS CHEMISTRY AND PHYSICS

Volume: 117 Issue: 1 Pages: 244-249 Published: SEP 15 2009

Title: *Self-powdering and nonlinear optical domain structures in ferroelastic beta'-Gd<sub>2</sub>(MoO<sub>4</sub>)<sub>3</sub> crystals formed in glass*

Author(s): Tsukada Y, Honma T, Komatsu T

Source: JOURNAL OF SOLID STATE CHEMISTRY

Volume: 182 Issue: 8 Pages: 2269-2273 Published: AUG 2009

Title: *Dissolution of Alumina, Sintering, and Crystallization in Glass Ceramic Composites for LTCC*

Author(s): Muller R, Meszaros R, Peplinski B, et al.

Source: JOURNAL OF THE AMERICAN CERAMIC SOCIETY

Volume: 92 Issue: 8 Pages: 1703-1708 Published: AUG 2009

Title: *Sintering of glass matrix composites with small rigid inclusions*

Author(s): Eberstein M, Reinsch S, Muller R, et al.

Source: JOURNAL OF THE EUROPEAN CERAMIC SOCIETY

Volume: 29 Issue: 12 Pages: 2469-2479 Published: SEP 2009

Title: *Synthesis and characterization of rare-earth doped SrBi<sub>2</sub>Nb<sub>2</sub>O<sub>9</sub> phase in lithium borate based nanocrystallized glasses*

Author(s): Venkataraman BH, Fujiwara T, Komatsu T

Source: JOURNAL OF SOLID STATE CHEMISTRY

Volume: 182 Issue: 6 Pages: 1538-1544 Published: JUN 2009

Title: *Correlation between the temperature of molten state and the SH intensity of 30BaO center dot 15TiO<sub>2</sub> center dot 55GeO<sub>2</sub> crystallized glass*

Author(s): Masai H, Suzuki Y, Takahashi Y, Komatsu T et al.

Source: JOURNAL OF THE CERAMIC SOCIETY OF JAPAN

Volume: 117 Issue: 1365 Pages: 671-674 Published: MAY 2009

Title: *Two-Dimensional Mapping of Er<sup>3+</sup> Photoluminescence in CaF<sub>2</sub> Crystal Lines Patterned by Lasers in Oxyfluoride Glass*

Author(s): Kanno M, Honma T, Komatsu T  
Source: JOURNAL OF THE AMERICAN CERAMIC SOCIETY  
Volume: 92 Issue: 4 Pages: 825-829 Published: APR 2009

Title: *Optical characteristics of nanocrystallized glass fiber with second-order optical nonlinearity*

Author(s): Iwafuchi N, Fujiwara T, Benino Y, Komatsu T et al.  
Source: JOURNAL OF THE CERAMIC SOCIETY OF JAPAN  
Volume: 117 Issue: 1362 Pages: 143-146 Published: FEB 2009

Title: *Temperature dependence of refractive index and electronic polarizability of KNbGeO5 glass and its nanocrystallized glasses*

Author(s): Honma T, Ito N, Dimitrov V, Komatsu T et al.  
Source: JOURNAL OF APPLIED PHYSICS  
Volume: 105 Issue: 5 Article Number: 053105 Published: MAR 2009

Title: *Viscosity, relaxation and elastic properties of photo-thermo-refractive glass*

Author(s): Deubener J, Bornhoft H, Reinsch S, et al.  
Source: JOURNAL OF NON-CRYSTALLINE SOLIDS  
Volume: 355 Issue: 2 Pages: 126-131 Published: JAN 15 2009

Title: *Self-organized periodic domain structure for second harmonic generation in ferroelastic beta'-(Sm,Gd)(2)(MoO4)(3) crystal lines on glass surfaces (vol 94, art no 041915, 2009)*

Author(s): Tsukada Y, Honma T, Komatsu T  
Source: APPLIED PHYSICS LETTERS  
Volume: 94 Issue: 5 Article Number: 059901 Published: FEB 2 2009

Title: *Enhanced quantum yield of yellow photoluminescence of Dy3+ ions in nonlinear optical Ba2TiSi2O8 nanocrystals formed in glass*

Author(s): Maruyama N, Honma T, Komatsu T  
Source: JOURNAL OF SOLID STATE CHEMISTRY  
Volume: 182 Issue: 2 Pages: 246-252 Published: FEB 2009

Title: *Synthesis of LaF3 nanocrystals by laser-induced Nd3+ atom heat processing in oxyfluoride glasses*

Author(s): Honma T, Kusatsugu M, Komatsu T  
Source: MATERIALS CHEMISTRY AND PHYSICS  
Volume: 113 Issue: 1 Pages: 124-129 Published: JAN 2009

Title: [Analytical Model for Heterogeneous Crystallization Kinetics of Spherical Glass Particles](#)

Author(s): Ferreira EB, Lopez-Richard V, Zanotto ED, et al.  
Source: JOURNAL OF THE AMERICAN CERAMIC SOCIETY  
Volume: 92 Issue: 11 Pages: 2616-2618 Published: NOV 2009

Title: *Nano-crystallization in LaF3-Na2O-Al2O3-SiO2 glass*

Author(s): Bhattacharyya S, Hoche T, Hemono N, et al.  
Source: JOURNAL OF CRYSTAL GROWTH  
Volume: 311 Issue: 18 Pages: 4350-4355 Published: SEP 2009

Title: *Method to assess the homogeneity of partially crystallized glasses: Application to a photo-thermo-refractive glass*

Author(s): Lumeau J, Sinitskii A, Glebova L, Zanotto, E.D. et al

Source: **JOURNAL OF NON-CRYSTALLINE SOLIDS**

Volume: 355 Issue: 34-36 Pages: 1760-1768 Published: SEP 2009

Title: *Processing of transparent glass-ceramics by nanocrystallisation of LaF<sub>3</sub>*

Author(s): Hemono N, Pierre G, Munoz F, et al

Source: **JOURNAL OF THE EUROPEAN CERAMIC SOCIETY**

Volume: 29 Issue: 14 Pages: 2915-2920 Published: NOV 2009

Title: *Correlation between Alkaline Earth Diffusion and Fragility of Silicate Glasses*

Author(s): Smedskjaer MM, Yue YZ, Deubener J, et al

Source: **JOURNAL OF PHYSICAL CHEMISTRY B**

Volume: 113 Issue: 32 Pages: 11194-11200 Published: AUG 2009

Title: *Sintering of glass matrix composites with small rigid inclusions*

Author(s): Eberstein M, Reinsch S, Muller R, et al

Source: **JOURNAL OF THE EUROPEAN CERAMIC SOCIETY**

Volume: 29 Issue: 12 Pages: 2469-2479 Published: SEP 2009

Title: *Pressureless Sintering of Apatite/Wollastonite-Phlogopite Glass-Ceramics*

Author(s): Faeghi-Nia A, Marghussian VK, Taheri-Nassaj E, et al.

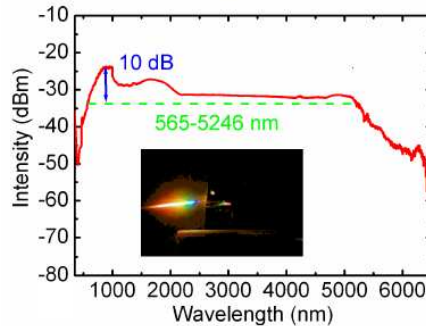
Source: **JOURNAL OF THE AMERICAN CERAMIC SOCIETY**

Volume: 92 Issue: 7 Pages: 1514-1518 Published: JUL 2009

**Annex 6**  
**Publications of TC20 members in 2009**

1. "Ultrabroadband supercontinuum generation from ultraviolet to 6.28  $\mu\text{m}$  in a fluoride fiber", G. Qin, X. Yan, C. Kito, M. Liao, C. Chaudhari, T. Suzuki, and Y. Ohishi, *Appl. Phys. Lett.* vol.95, pp.161103 (1-3), (2009).

**RCAPT in TTI succeeded in the world record ultra-broadband supercontinuum generation over four octave using fluoride fiber.**



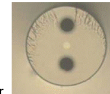
2. J Geng, Q Wang, J Smith, T Luo, F. Amzajerjian, Shibin Jiang, et al, "All-fiber Q-switched single-frequency Tm-doped laser near 2 $\mu\text{m}$ ", *Opt. Lett.*, 34[23], 3713-3715 (2009).

3. Q. Wang, J. Geng, T. Luo, and S. Jiang, "2 micron mode-locked laser with highly thulium-doped silicate fiber," *Opt. Lett.*, 34[23], 3616-3618 (2009).



**2 Micron Fiber Laser**

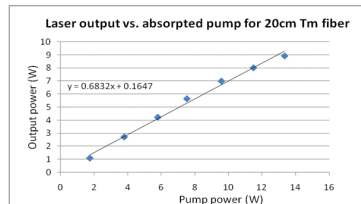
- > Developed new Tm-doped glasses and fibers
- > Demonstrated slope efficiency >68%
- > Demonstrated mode-locked 2 $\mu\text{m}$  fiber laser
- > Demonstrated 2 $\mu\text{m}$  single frequency fiber laser
- > Demonstrated Q-switched 2 $\mu\text{m}$  single frequency fiber laser



4. J Geng, Q. Wang, T. Luo, S. Jiang, F Amzajerjian, "Single-frequency narrow-linewidth Tm-doped fiber laser using silicate glass fiber", *Opt. Lett.*, 34[22], 3493-3496 (2009).

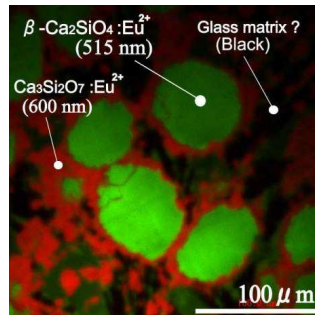
5. L. Sun, S. Jiang, J. D. Zuegel, and J. R. Marcianite, "Effective Verdet constant in a terbium-doped-core phosphate fiber," *Opt. Lett.* 34, 1699-1701 (2009)

6. Y. W. Lee, M. J. F. Digonnet, S. Sinha, K.E. Urbanek, R. L. Byer, S. Jiang, "High-power Yb<sup>3+</sup>-doped phosphate fiber amplifier," *IEEE J of Selected Topics in Quantum Electronics*, Vol. 15, no. 1, pp. 93-102, (2009).

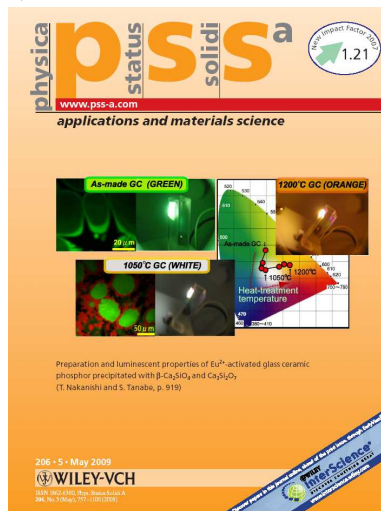


7. M. Leigh, W. Shi, J. Zong, Z. Yao, S. Jiang, and N. Peyghambarian, "Narrowband pulsed THz Source using eyesafe region fiber lasers and nonlinear crystal," *IEEE Photon. Technol. Lett.*, 21[1], pp. 27-29, (2009).

8. J. Ueda and S. Tanabe, "Visible to near infrared conversion in  $Ce^{3+}$ - $Yb^{3+}$  Co-doped YAG ceramics", *J. Appl. Phys.* 106[4], (2009) 043101(5p).  
 T. Nakanishi, S. Tanabe, "Preparation and luminescent properties of  $Eu^{2+}$ -activated glass ceramic phosphor precipitated with  $\beta$ - $Ca_2SiO_4$  and  $Ca_3Si_2O_7$ ", *Phys. Status Solidi A* 206[5], (2009) 919-922.
10. J. Ueda, S. Tanabe and A. Ishida, "Surface Plasmon Excited Infrared-to-Visible Upconversion in  $Er^{3+}$ -Doped Transparent Glass Ceramics", *J. Non-Cryst. Solids* 355, (2009) 1312-1315.
11. S. Nishiura, S. Tanabe, "Preparation and luminescence properties of glass ceramics precipitated with  $M_2MgSi_2O_7: Eu^{2+}$  (M= Sr, Ca) phosphor for white light source" *J. Select. Top. Quant. Electron.* 15[4], (2009) 1177-1180.
12. T. Nakanishi, S. Tanabe, "Novel  $Eu^{2+}$ -activated glass ceramics precipitated with green and red phosphors for high power white LED", *J. Select. Top. Quant. Electron.* 15[4], (2009) 1171-1176.
13. J. Ballato, T. Hawkins, P. Foy, B. Kokuoz, R. Stolen, C. McMillen, M. Daw, Z. Su, T. Tritt, M. Dubinskii, J. Zhang, T. Sanamyan, and M. J. Matthewson, "On the Fabrication of All-Glass Optical Fibers from Crystals," *J. Appl. Phys.* 105, Article 053110 (2009).

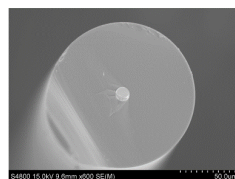


9.

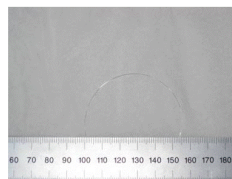


Glass Clad Fiber with Ge Core

14. K. Serivalsatit, B. Yazgan Kokuoz, B. Kokuoz, and J. Ballato, "Nano-Grained Highly Transparent Yttria Ceramics," *Optics Letters* 34, 1033 - 1035 (2009).
15. J. Ballato, T. Hawkins, P. Foy, B. Yazgan-Kokuoz, R. Stolen, C. McMillen, N. K. Hon, B. Jalali, and R. Rice, "Glass-Clad Single-Crystal Germanium Optical Fiber," *Optics Express* 17, 8029 - 8035 (2009).
16. C. Kucera, B. Kokuoz, D. Edmondson, D. Griese, M. Miller, A. James, W. Baker, and J. Ballato, "Designer Emission Spectra through Tailored Energy Transfer in Nanoparticle Doped Silica Preforms," *Optics Letters* 34, 2339 - 2341 (2009).



SEM micrograph of cross section of borosilicate clad, Ge core fiber; redrawn from cane.



< 5 cm bend radius of resultant fiber. Not bad for a borosilicate cladding glass that is not fire polished.

J. Ballato, et al., *Optics Express* 17, 8029 - 8035 (2009).



17. S. Aref, O. Frazão, P. Caldas, L. Ferreira, F. Araújo, J. Santos, H. Latifi, P. Foy, T. Hawkins, J. Ballato, T. Her, and F. Farahi, "Modal Interferometer Based on ARROW Fiber for Strain and Temperature Measurement," *IEEE Photon. Technol. Lett.* 21, 1636 - 1638 (2009).

18. "Ultrabroad emission from a bismuth doped chalcogenide glass", Hughes MA, Akada T, Suzuki T, et al.: *Opt. Exp.* 17[22], 19345-19355 (2009).

19. "Spectral broadening in femtosecond laser written waveguides in chalcogenide glass": Hughes MA, Yang WJ, Hewak DW : *J. Opt. Soc. Am. B* 26[7], 1370-1378 (2009).

21. S. Ohara and Y. Kuroiwa, "Highly ytterbium-doped bismuth-oxide-based fiber," *Optics Express*, vol. 17, no. 16, pp. 14104-14108 (2009).

22. N. Nakamura, N. Fukumoto, F. Sinapi, N. Wada, Y. Aoki, K. Maeda, "Glass Substrates for OLED Lighting with High Out-coupling Efficiency," *SID 2009 Digest of Technical Papers (Society for Information Display, 2009)*



Only the square area is lighting

Light can be also extracted not only from the square area but also from the scattering layer.

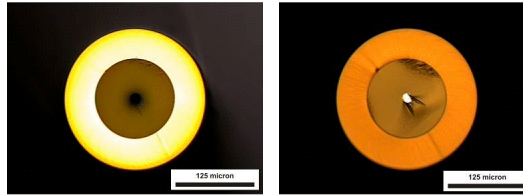
23 S. Zhou, N. Jiang, B. W u, J. Hao, J. Qiu, "Ligand-Driven Wavelength-Tunable and Ultra-Broadband



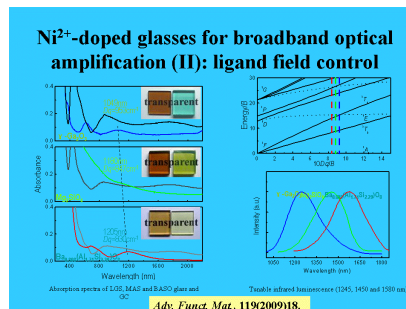
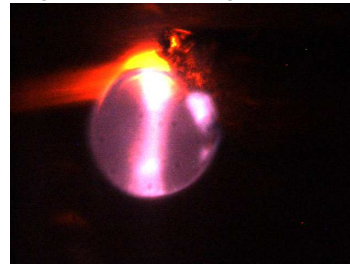
Crystal Core Optical Fiber

Long lengths of flexible glass-clad single crystal Ge core fiber

100 meters of 125 μm fiber with 15 μm Ge core



J. Ballato, et al., *Optics Express* 17, 8029 – 8035 (2009).



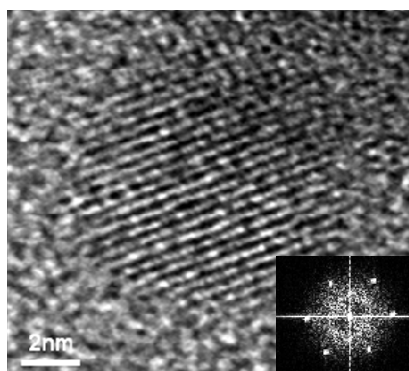
Infrared Luminescence in Single-Ion-Doped Transparent Hybrid Materials”, *Adv. Funct. Mater.*, 19(2009)2081.

24. S. Zhou, W. Lei, N. Jiang, J. Hao, E. Wu, H. Zeng, J. Qiu, “Space-selective control of luminescence inside the Bi-doped mesoporous silica glass by a femtosecond laser”, *J. Mat. Chem.* 19, (2009) 4603.

25. C. Liu, Y-K. Kwon, Jong Heo “Optical modulation of near-infrared photoluminescence from lead sulfide quantum dots in glasses”, *Appl. Phys. Lett.* 94 (2009) 021103

26. J. Chang, C. Liu, Jong Heo “Optical properties of PbSe quantum dots doped in brosilicate glass” *J. Non-Cryst. Solids*, 355 (2009) 1897-1899

27. C. Liu, Y-K. Kwon, Jong Heo “Novel nano-structured glasses containing semiconductor quantum dots: controlling the photoluminescence with phonons and photons” *J. Mater. Sci.: Mater. Electron.* 20 (2009) S282-S285



28. Y. Liu, M. Shimizu, X. Wang, B. Zhu, M. Sakakura, Y. Shimotsuma, J. Qiu, K. Miura, K. Hirao, “Confocal raman imaging of femtosecond laser induced microstructures in germanate glasses”, *Chem. Phys. Lett.* 477, (2009) pp.122-125.

29. Y. Liu, M. Shimizu, B. Zhu, Y. Dai, B. Qian, J. Qiu, Y. Shimotsuma, K. Miura, K. Hirao, “Micromodification of element distribution in glass using femtosecond laser irradiation”, *Opt. Lett.* 34[2], (2009) pp. 136-138.

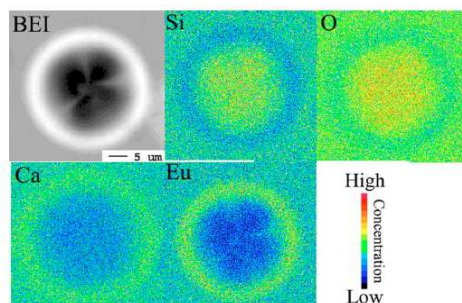


Fig. 1. (Color online) Backscattering electron image and EPMA mapping showing relative concentration change of the different ions in the glass around the focal point after the femtosecond laser irradiation.



Annex 7  
Press releases produced by ICG in 2008-2009



## INTERNATIONAL COMMISSION ON GLASS

A SOCIETY OF SCIENTIFIC AND TECHNICAL ORGANISATIONS

<http://www.icglass.org>

### Press release

May 2008

<p><b>Contact and more information:</b></p> <p>Dr. Klaus Bange Phone: +49-6131-66-7420 fax: +49-6131-66-7355 email: <a href="mailto:Klaus.bange@schott.com">Klaus.bange@schott.com</a></p>	<p><b>Contact and more information:</b></p> <p>Prof. René Vacher Phone: +33-4 67-143449 fax: +33-4 67-143299 email: <a href="mailto:rene.vacher@univ-montp2.fr">rene.vacher@univ-montp2.fr</a></p>
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## Technology Roadmap on Innovative Glass Melting and Advanced Materials

The International Commission on Glass (ICG) invited international experts to take a look into the future of glass.

BRIG (Switzerland) - *In March 2008, the International Commission on Glass (ICG) organized a Top-level expert meeting on the "Future of Advanced Materials and Glass-Melting Technologies for the year 2020" in Brig (Switzerland). It was financed by the European Union within the framework of the EFONGA project. Two expert workshops were held in parallel and covered the topics "Advances in materials: glasses, glass-ceramics, ceramics" as well as "Innovation in glass melting technology: revolution or evolution".*

The objective of the two workshops was to bring together international experts in the field of glass melting and material science to discuss future developments in the field of glass melting and new glasses, glass-ceramics, and ceramic materials. About 30 experts presented papers

addressing either the current status of glass/ glass ceramic/ceramic materials and new functionalities, or developments in and future concepts for new melting technologies, The outcome was an extensive evaluation of the requirements that new technologies must meet and the research needed to develop new materials and processes.

The workshop “**Advanced Materials**” was hosted by Prof. Wolfram Höland (Ivoclar Vivadent AG). The presentations focused on glasses for technical applications and environmental protection, glass-ceramics with new properties, trends in functional ceramics, biomaterials for dental restoration, and medical applications.

The first session focused particularly on innovative applications using glass or glass-ceramics. After populating a roadmap with content, the workshop participants ranked the different items according to their level of impact and concern. Several topics were identified as being highly relevant:

1. **Education:** The participants demanded that stronger efforts be made to attract young people not only to the field of glass and glass-ceramics, but also to materials science.
2. **Tough/Strong:** the participants agreed that achieving both toughness and strength simultaneously is difficult. They also addressed the question of the high m-modulus after aging. There identified a need to utilise different approaches and develop models for characterization of glass failure in terms of quality aspects. Also discussed were aspects of “Fracture Theory” and measurement of toughness and strength.

Because of time pressure during the workshop these further topics will be addressed in future discussions: Solar glass, Photonics/OE, Add-on functionality, Modelling and Solar Photocatalysis / Chemical Reactions.

In the second session the topics “Functional Ceramics and Biomaterials” were combined to “Materials for Biomedical Applications”. Several topics were identified as highly relevant:

1. **Nanostructured materials:** Problems regarding upscaling aspects of nano-scaled monolithic ceramic products versus fast processing of nanoscaled ceramic coatings were reviewed. Other topics discussed included safety issues, control of agglomeration, loss of functionality by agglomeration, material handling, and understanding of materials properties from modelling.
2. **Bioactive materials for tissue regeneration:** Discussion focused on types of tissues, different aspects of materials properties, understanding of biological and materials mechanisms, and understanding of interrelations with living cells.

3. **Dental materials:** Problems regarding metal-free restorations (tough and strong with special optical properties) and minimally invasive techniques.
4. **Tests for bioactive materials:** The discussions related to conclusions about the adoption of experiences from a new ISO test of treating the materials in simulated body fluid. The participants agreed that there is also a need for a cell-based test with standard cell-type, cell-seeding, concentration, flow-rate, etc. A standardised test for aging of mechanical properties would be helpful.

Further topics from the ranking not be discussed in detail were: Role of surface properties, Modelling, and Self Healing Medicine.

Both sessions focused primarily on glass and glass-ceramics for. “solar systems” and “biomedical applications”. The specific challenges for the future were summarized as:

1. sustainable energy supply.
2. access to clean water.
3. affordable health care.

The participants therefore saw a growing demand for new glasses, glass-ceramics, and the technical solutions needed to apply these innovative materials to the year 2020 and beyond.

The workshop “**Glass Melting Technology**”, hosted by Prof. Ruud Berkens (TNO Glass Group/NL) and Prof. Helmut Schaeffer, included the following topics: analysis of today’s glass melting processes, new glass melting concepts, intensive-heating technologies for glass melts, process intensification, rapid glass melting, batch technology, tailored raw material batches, process control and sensors for glass melting processes, energy savings by reduction of heat losses and waste heat recovery, energy efficient glass melting, and glass melting with extremely low emissions.

Besides the presentations the workshops included discussions on potential improvements for glass melting with respect to energy efficiency, environmental impact, glass quality and production cost reduction, and prioritising the most important directions for future research, as well as defining paths for future activities (projects, workshops, training).

Nine clusters of important technologies have been identified as being very important and needing further development. The four top themes were elaborated in more detail:

1. **New melting technologies:** development of a glass melting process with tailored process steps in series where each process step can be optimised and controlled separately. For

each process step, new technologies can be applied in order to improve glass quality, flexibility, and energy and cost efficiency.

2. **Tailored batch technology:** with the goal of improving melting kinetics and batch homogeneity or reducing batch costs by replacing an expensive raw material such as soda ash by other raw materials.
3. **Energy efficiency (waste heat recovery):** recover the heat of waste energy streams, especially flue gases and re-use this energy directly in glass melting processes.
4. **Sensors and advanced control:** improve the operation of or modify existing sensors for glass melt properties and combustion processes in order to control glass melt quality with respect to fining and glass colour, and to control the combustion process with respect to energy efficiency and low NO<sub>x</sub> emissions.

A team has been appointed for each theme to prepare by mid June a plan for further activities (nutshell proposals).

Other subjects for future activities in the field of glass melting, should be:

Measuring methods and definition of 'glass quality'; application of chemical engineering and thermodynamic principles in developing new glass melting processes; primary measures within glass production to reduce emissions to the environment; and advanced refractory material development for glass furnaces enabling more insulation without decreasing furnace lifetime or glass quality.

The participants of both workshops agreed that a "road-mapping project" should be initiated, and worked on in the future. The aim of such a project would be to foster effective, focused communication leading to closer multi-disciplinary interaction and collaboration.

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### 1. *About the International Commission on Glass (ICG)*

ICG is a non-profit international GLASS SOCIETY consisting of 28 national organisations in glass science and technology. The aim of ICG is to promote cooperation between glass experts. ICG organises [Technical Committee](#) work (laboratory round robins, publication of scientific and technical papers). ICG organises every three years the [International Congress on Glass](#): [www.icglass.org](http://www.icglass.org)

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### 2. *About the European Forum on New Glass Applications (EFONGA)*

EFONGA is a Coordination Action in the field of glass science and technology, which aims at co-ordinating all European groups working in fundamental and applied pre-competitive research. The success of this project could be the basis for the establishment of a Network of Excellence on Glass. The EFONGA project works in the following fields: basic knowledge of glassy materials, relation structure-properties, setting-up of new methods for the characterisation of glassy materials, preparation of reference materials, information exchange on efficient production technology. The three activities of this Coordinated Action are: round robin tests, organisation of workshops, diffusion and dissemination of information and coordination of training and education on a European level. (for more information: [www.efonga.group.shef.ac.uk](http://www.efonga.group.shef.ac.uk))

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### 3. *About the Roadmap*

The overarching goal of the roadmapping activity as a method for carrying out technology foresight is to identify interesting aspects and trends including their dependencies across the different levels. The

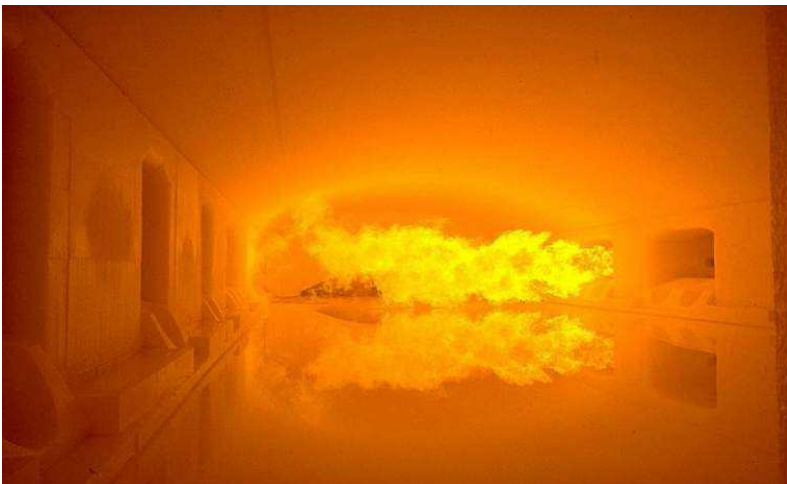
roadmaps can be used for different purposes. Associations and research organizations orient their R&D activities on roadmaps and companies can use the roadmaps for uncovering future trends and lead markets.

Research organizations can identify technology avenues they want to follow or try something in different directions. Clearly, research funding organizations can use the roadmap to uncover and monitor interesting trends.

The gathered information is supposed to be used to enhance the competitiveness of materials research in Europe and also outside the EU. The future discussion about the roadmap help to obtain a cleaner picture on future developments and currently neglected opportunities in the landscape of material and material processing science.



Metal-free dental restoration: glass-ceramic dental bridge on a mirror



Flame in Glass Furnace

## Press release

April 2009

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### Commission on Glass (ICG) ICG celebrates 75th Anniversary

Last year, the International Commission on Glass (ICG) celebrated its 75<sup>th</sup> Anniversary. Presentations were held to commemorate this occasion during the opening ceremony of the ICG Annual Meeting held in Trencin, Slovakia, in June of 2008. The program was divided into four elements to give a picture of the origins, continuing progress and the future of the Commission. The presenters were Prof. Helmut A. Schaeffer, Prof. Henk de Waal, Mrs. Alev Yaraman and Dr. Klaus Bange.

In his speech, Prof. Schaeffer, a former President of the ICG, focused on the historical context that led to the formation of the ICG in 1933. With the outbreak of World War I, the UK was cut off from the supply of optical glasses and was forced to develop its own supply. This prompted initiatives to improve glass melting by applying scientific methods and led to the founding of the Society of Glass Technology (SGT) in the UK in 1916. Similarly in the post-war era, Germany suffered from a severe shortage of coal, which stimulated initiatives in glass melting to improve the efficiency of coal usage, as well as the optimization of combustion and heat transfer in heat recovery systems.. This eventually led to the formation of the Deutsche Glastechnische Gesellschaft (DGG) in 1922. Arising from the ensuing collaboration of these two societies came the formation of the ICG. Prof Schaeffer concluded his presentation on the origins of the ICG by observing that, "Standing on the shoulders of our forefathers, we appreciate their dedication and vision – thus giving us encouragement to proceed and acquire new forms and fields of collaboration."

Next, Prof. de Waal expanded on this theme by asking “How ICG had become what it is today?” He started with an impressive array of statistical information showing the strength and breadth of the ICG. This is referenced in greater detail in his book published by the ICG entitled “ICG2000: History and Vision”. To date, the ICG has had 22 presidents with a wide international distribution (5 from Germany, 5 from the U.S.A., 3 from both France and the UK, and one each from Belgium, Italy, Japan, the Netherlands, Czechoslovakia, Turkey), and 4200 papers were presented at the first 18 International Congresses, held across Europe, Asia and America.

Prof. de Waal then continued where Prof. Schaeffer had left off, examining the re-emergence of the ICG after WW II. In 1948, 14 invited scientists from 8 countries met in Buxton, UK, and appointed a provisional Commission (12 members from 11 countries). Further meetings took place in 1949 (Brussels) and 1950 (London), at which a new Constitution was defined. This defined new criteria for ICG membership, which was restricted to national and multi-national bodies and no longer based on personal invitation. In 1950, 12 countries became members of the ICG at the first (annual) conference in Bern. The objectives of the ICG, as defined by the Constitution were “*To promote and stimulate understanding and cooperation between different countries for the exchange of information on the art, history, science and technology of glass*” by such means as:

- Serving as an international center for the exchange of information,
- Assisting in the universal development of interest in glass,
- Arranging periodically to hold international congresses and technical sessions on glass,
- Preparing and issuing reports and surveys with an international character.

Prof. de Waal concluded his talk by describing the evolution of the organization and of the Technical Committees of the Commission.

The next speaker, Mrs. Alev Yaman, who served as President from 2003 until 2006, remains the first and only woman to ever hold this office. In her lecture entitled “ICG-A Global Cooperation in the Challenging World of Glass”, she commented that, “*having learned about the history of ICG, we are all proud of being a part of this long and excellent tradition of global cooperation. Under the umbrella of ICG, coming together on different platforms to strengthen the ties between us and share the accomplishments of scientific and technological developments with future aspirations, resulting in more usage of glass in our lives and environment, is our continuing challenge.*”

She examined the objectives of the ICG more closely, specifically the promotion and stimulation of understanding and cooperation between all individuals with a view towards exchanging information on the art, history and science and technology of glass by all appropriate means, as listed in the above extract from the constitution. She pointed to the successful 2005 ICG meeting in Shanghai, where glass technologists were able to meet with each other to exchange ideas, underlining the advancements achieved when technologists join in international cooperation, sharing their experiences at the pre-competitive stage for the continuous development of this excellent material, while enhancing the spirit of friendship in which the ICG works.

Mrs. Yaman considers the ICG to be not only a society of scientists, technologists, artists, or businessmen of glass, but also a school that teaches how to excel, as best described in the words of Prof. W.E.S. Turner, written in 1951, that are still valid today: “*Competition develops the powers of hard thinking, ingenuity and resourcefulness, and can thus be salutary. But there are many ways in life which we*

*can carry on competition and yet be helpful to one another. There can, I feel sure, be many occasions, even in business, where mutual giving and mutual taking help both parties to the exchange. The International Commission is a body in which its distinguished members can talk with one another and be mutually helpful.* After listing the Technical Committees of the Commission she illustrated the three key awards sponsored by ICG and namely: V. Gottardi Prize (annual), Turner Award (annual), President's Award (triennial). Mrs. Yaraman called glass an indispensable and brilliant material for a better life and demonstrated the enormous role it plays in a modern society, spanning from the past to the future and covering technology from commodities to high-tech products. She concluded by pointing out that the international collaboration between glass technologists and scientists performed within the ICG's TCs will contribute to the achievement of increased glass usage over many different areas.

Finally, Dr. Klaus Bange, Chair of the Coordinating Technical Committee, spoke on "Glass -The Challenge for the 21st Century". Before analyzing the future R&D activities of the TCs, he described the situation today. The TCs described by earlier speakers are now organized into 5 Clusters led by CTC committee members. The titles of these groups are: 1) *Basics & Properties*, 2) *Glass Melting & Production*, 3) *Surfaces & Interface* 4) *New Application Fields* and 5) *Information, Communication, Education, History*.

Dr. Bange commented on the difficulty of looking into the future and deciding what the most attractive applications of glass will be in 2020. As he put it, "There are no instruments to do this except, possibly, one made from glass in the shape of a ball." Future studies (foresight, futurology) reflect how today's changes will become tomorrow's reality. Here, various methodologies have been developed including the Delphi interview; Role playing; Road mapping; Relevance tree; Perspective factory; Cross-impact analysis; Computer simulation, to name only a few.

As yet another approach to analyzing the future, a road-mapping exercise was recently undertaken at an ICG workshop. This highlighted a number of attractive fields for study and development. Various possibilities were identified for glass, especially in the field of energy and the environment. For example, according to Dr. Bange, glass can play an important role in combating the effects of climate change, an aspect that needs to be recognized by governments. Examples include glasses for photovoltaics, glass mirrors and tubes for solar power plants, as well as low-E glazing. Finally, he proposed an action list that included a wide variety of activities.

Dr. Bange concluded his talk by confirming that, as Mrs. Yaraman had said earlier, the tradition of the ICG will continue. Furthermore, he made the point that "the future of glass starts today".





**4.6 The speakers and moderators of the event**

**4.7 (from the left: Helmut Schaeffer, Fabiano Nicoletti, Dusan Galusek, Alev Yaraman, Klaus Bange)**



## INTERNATIONAL COMMISSION ON GLASS

A SOCIETY OF SCIENTIFIC AND TECHNICAL ORGANISATIONS

<http://www.icglass.org>

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### Press release

August 2008

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#### Glass - the challenge for the 21<sup>st</sup> century

The *9th ESG Conference* with the Annual Meeting of the International Commission on Glass (ICG) hosted by the Slovak Glass Society was held in *June 2008 in Trenčín, Slovakia*. The conference was intended to deal not only with the state of the art in the areas glass science and technology today, but also to address the questions of future developments, applications and challenges in glass science and technology. Special attention was paid to the future role of ICG.

*Increasing energy costs, limited availability of several raw materials in the future, REACH obligations, needs for alternative raw materials and new glass compositions, as well as strict(er) legislations on emissions during the glass production, are seen as the main threats for glass and glass producers in the future.*

*On the other hand, a variety of new opportunities are seen for glass: new energy-saving applications, glass in sustainable energy supply, glass as a construction material or lightweight glass products, but also improving the image and awareness of “Glass” and its indispensable contributions in the society, adding value to base glass products as well as more efficient and focused R&D in the glass industry for breakthrough developments in energy savings and sustainable energy generation. The main threats and opportunities for glass and the glass industry especially in Europe were discussed in the ICG’s plenary session with a panel of invited experts, who first presented a short introduction (papers can be obtained by [www.icglass.org](http://www.icglass.org)) to the topics:*

- *Availability of non-energy materials for the glass industry within the EU (Dr. Thomas Hünlich, Schott AG, Mainz, Germany)*
- *Glass and environment: informing the future (John Stockdale, British Glass, Sheffield, UK)*
- *Energy and climate change (Dr. Guy Tackels, Saint Gobain)*
- *Glass technologists and researchers: who is inspiring whom? (Prof. Lubomír Němec, Laboratory of Inorganic Materials, VŠChT, Prag, Czech Republic)*

*According to the experts’ recommendations the main efforts for the glass industry in the 21<sup>st</sup> century should be:*

- *improve communication with the policy makers and society in general and demonstrate the positive role that glass products have always played and will continue to play in meeting future needs;*
- *be alert to changes in the world that may jeopardize the future supply of raw materials and fossil fuels necessary to make all types of indispensable glass products;*
- *improve the efficiency of research, not only by new innovative ideas, but also by communication between R&D centers and industry, and by the formation of consortia including academia, the glass industry and suppliers;*
- *find new methods to reduce energy consumption in glass production and minimize CO<sub>2</sub> emissions: e.g. increased recycling, more energy-efficient glass furnaces, stronger glass (light-weighting) and higher production yields.*

*The second part of the plenary session was a discussion based on questions from the audience. The following issues were raised during the discussions and the four experts have treated questions on these topics:*

*The use of Life Cycle Assessment (LCA) for glass products*

*The reliability of LCA information seems to be questionable: different institutes or industries have produced LCAs for flat glass or container glass products (comparing it with other packaging materials), including energy consumption and CO<sub>2</sub> analysis. However, a realistic comparison of the results often fails. The CO<sub>2</sub> emissions during glass production would be relatively easy to determine, but the CO<sub>2</sub> emission reduction realized during the application of a glass product in a country would be more difficult to assess and would require further consideration in LCAs.*

*Show the potential of energy savings*

*Unfortunately the EU only considers caps on energy consumption and CO<sub>2</sub> emissions for production facilities and does not take into account savings made during the use of the product. The glass industry should bring a clear message to society and politicians that most glass products will give, during their lifetime, a strong net contribution to CO<sub>2</sub> emission reductions and energy savings, outweighing by far the energy used for this glass production. Reliable data would be absolutely important to show the very important role that the glass industry plays in reaching the CO<sub>2</sub> emission reduction targets set by the EU.*

*Alternative energy sources, more efficient use of energy in glass melting processes*

*It was mentioned that electric melting of glass, using electricity that is not generated from gas, oil, brown coal, or coal might become of increasing interest. The glass industry should also search for alternative processes supported by mechanical devices or other methods that require less energy than thermal processes only. In addition, new routes for batch preparation or use of pre-reactions at lower batch temperatures might be exploited to convert most batch materials at much lower temperatures than applied today into a silicate material. New types of glass melting systems equipped with flue-gas waste-heat recovery need to be developed. The glass industry should also become aware of energy efficiency improvements made in other industrial sectors working with high temperatures and melting processes, such as the steel industry, in order to learn from them..*

*Organization of research activities in glass industry*

*It was pointed out that R&D in the community needs to be better organized and priority should be given to the most essential developments. The International Commission on Glass (ICG) should increase its role in defining and organizing research activities on energy efficient and environmentally sound glass production or development of new glass products. Two ICG-expert meetings in Brig, Switzerland, in March 2008 could have been the first steps to define and organize large-scale projects in the glass society with the aim of developing breakthrough technologies in glass products and glass production. Since R&D budgets for the glass sector available from governments in countries such as Germany are rather small, it would be important to gain access to financial support from other states or from the EU. It was proposed that the glass society should improve communication with governments and the EU commission to help develop realistic funding schemes or to look for financial institutions that might support innovation in the glass industry, especially for projects aimed at energy efficiency improvement and major breakthroughs in CO<sub>2</sub> emission reduction.*

## Role of ICG

It was stated that ICG now enters a new era. ICG-internal processes had been optimized, resulting in a new constitution. In addition ICG will strengthen their external activities and has an important role to play in initiating and stimulating R&D and promotion activities for glass and glass products. It should improve the “image” of glass in society, showing its unique role in saving energy, generating energy, and achieving the CO<sub>2</sub> emission reduction targets.

Stimulating worldwide cooperation has always been a major focus of ICG. Many issues in Europe, such as the future position of the glass industry in society, energy efficiency, alternative energy sources, and CO<sub>2</sub> emission reduction targets are similar to those in the USA. Therefore it would be important for European glass players to communicate with the US glass industry (represented by GMIC) and to organize joint workshops, a role that ICG is well placed to play.

Main conclusions of the plenary sessions were:

- The glass industry and ICG need to improve their external communication with other parties: governments, politicians, funding organizations, the public, but especially the policy makers. Only communication will enable them to get across the message that glass products play a key role in making solar energy competitive and in meeting the Kyoto and post-Kyoto targets on greenhouse gas emission reduction. It should be made clear that glass definitely is part of the solution rather than of the problem.
- ICG should take a leading role in defining, initialising and organizing consortia for major research activities, addressing innovative glass products and energy efficient glass production.

The introduction papers can be obtained by [www.icglass.org](http://www.icglass.org)

### **1.4. About the International Commission on Glass (ICG)**

ICG is a non-profit international GLASS SOCIETY consisting of 28 national organisations in glass science and technology. The aim of ICG is to promote cooperation between glass experts. ICG organises work (laboratory round robins, publication of scientific and technical papers). ICG organises every three years the International Congress on Glass: [www.icglass.org](http://www.icglass.org)

Mise en forme : Pucés et numéros

### **2-5. About the ESG Conference**

The European Society of Glass (ESG) Conference, one of the most important meetings in the field of glass science and technology, is held every two years in a different country, promoting the exchange of scientific information, and bringing together experts working in such diverse areas of glass science and technology as technical and industrial glasses, their applications, glass manufacturing, glass archaeology, art, environmental issues, etc.

Mise en forme : Pucés et numéros



Participants of the round table discussion:  
 John Stockdale, Dr. Guy Tackels, Prof. Ruud Beerkens (Moderator), Prof. Reinhard Conradt (Moderator), Prof. Lubomir Němec, Dr. Thomas Hünlich (from the left)



One contribution to the discussion



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### ICG Press release

November 2008

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*At the ICG Annual Meeting on June 24, 2008, in Trencin, Slovakia, the Council of the International Commission on Glass (ICG) approved the **New Constitution** and the admission of three **National Participating Organizations**, which increases the number to 32 countries.*

#### **New Constitution of the International Commission on Glass (ICG)**

The International Commission on Glass (ICG) is a non-profit international association of national scientific and technical organizations with particular interests in glass science and technology. It was founded in 1933 and has grown to become the recognized world-wide organization bringing together the world's most respected universities, institutions and companies operating in the field of glass in 32 countries.

The main objects of the Commission are from the beginning *“to draw the various countries into cooperative effort and to provide their representation”, “to be a clearing house of international technical and scientific work, especially with reference to furthering preparations for future congresses” and “to render assistance to those countries in which no society exists for the open cultivation of the technology and science of glass”.*

The original Constitution from 1950 which detailed and extended the above mentioned objects has been successively modified four times in 1964, 1974, 1978 and 1999, mostly to render it compatible with regulations.

In Trencin, Slovakia, on June 24, 2008, a new Constitution was approved by the Council that, without changing the main objects and contents, with a clearer and modern structure allows to be more interactive, more productive and more multi-disciplined. The most relevant additions are :

- Individual glass companies can now directly take an active part in participating in ICG activities as “Associated Member Companies”, especially in stimulating R & D and promoting activities for glass and glass products.
- Highly respected glass scientists working in a country where no national glass organization exists may now be admitted as “Individual Members” and participate to ICG activities.
- A more operative “Management Board”, instead of the old “Bureau”, and a more powerful and on a global scale representative “Steering Committee”, will allow better and faster management of the daily business and public affairs, together with careful guidance and control of the scientific and technical activities.
- The introduction and definition of the duties and responsibilities of the Coordinating Technical Committee (CTC) and its precise guidelines for the organization of the Technical Committees (TC) ensure now the optimum development of the activities of the 24 present TCs which are the backbone of the ICG.

The optimization of all internal processes will make it easier for ICG to strengthen its external relations and activities and to play the important global role of initiating and stimulating R & D and promotion activities for glass and glass products.

### **Three new countries associated to the International Commission on Glass (ICG)**

The manifold technical and scientific activities in the ICG - R&D fields “Basics and Properties of Glass”, “Glass Melting and Production”, “Surfaces”, “Thin Films and Interfaces” and “New Fields of Application” attract more and more members to the Technical Committees and cause more national organizations to join the ICG.

On June 24, 2008, in Trencin, Slovakia, the Council of the International Commission on Glass unanimously approved the admission of:

- Republic of Serbia, through its National Participating Organization “Faculty of Technical Sciences of the University of Novi Sad” and the two representatives Prof. Dr. Ana Kozmidis-Petrovic and Prof. Dr. Agnes Kapor.
- Canada, through its National Participating Organization “Institute for Research in Materials of Dalhousie University” and the two representatives Prof. Josef W. Zwanziger and Prof. Scott Kroeker.
- Australia, through its National Participating Organization “Australian Ceramic Society” and its representative Dr. Dan Perera.

The number of National Participating Organizations associated to the ICG thus rises to 32.







## INTERNATIONAL COMMISSION ON GLASS

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<http://www.icglass.org>

### Press Release

January 2008

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### Chinese Ceramic Society (CCS) meets with International Commission on Glass (ICG)

On November 12, 2008, the Management Board of the International Commission on Glass (ICG MB) met with several representatives of the Chinese Ceramic Society (CCS) in Shanghai at the China Triumph International Engineering Co., Ltd. (CTIEC). The aim of the meeting was to further intensify the cooperation between the two organizations. Mr. Shou Peng opened the meeting by briefly introducing the CTIEC. CTIEC operates as a core enterprise on the science and technology platform of the China National Building Material Group Corporation. Next, Mr. Zhanping Jin presented the CCS, an academic, non-profit corporate and social organization for professionals engaged in the science and technology of inorganic and non-metallic materials. Founded in 1945, CCS has 19,906 individual members in total and employs a staff of 23.

In his presentation, Mr. Juanrong Ma from China Building Materials Academy noted that the Glass Sub-Committee actually conducts both academic and technological activities and organizes various seminars at different levels. There are currently three types of members (48 enterprises altogether) - research units, engineering design and service and plants, including international companies, like Tamglass.

According to Mrs. Lili Hu from Shanghai Institute of Optics and Fine Mechanics, the objective of the Special Glass Sub-Committee is to provide a platform for academic exchange for glass scientists and engineers in the field of optical glass, specialized glass

fiber, micro-nano structure fiber and glass, functional coatings for glass, glass for medical applications, novel electron-photon glass materials, and interaction between lasers and glasses. The Sub-Committee has more than 20 members at universities, research institutes and glass companies in China. It has already organized four successful symposiums on specialized glasses since 1999.

Mr. Hongyan Li from BOE Technology Group Co Ltd. then informed the audience of the activities of the Electronic Glass Sub-Committee. This Sub-Committee, founded in 1979, now has 40 members and organizes technological exchange seminars each year. Its activities focus mainly on monitor glass, sealing glass and solar battery glass.

Mr. Hui Yang from Zhejiang University followed by introducing the Sol Gel Sub-Committee. With more than 100 organizations as members, this Sub-Committee actively studies, performs research and develops applications in this field. A total of five seminars have been organized since 1990. At the most recent event, an International Symposium held in 2008 and attended by 150 people, 200 reports were presented.

Mr. Hervè Arribart went on to introduce the International Commission on Glass as a non-profit international association of national scientific and technical organizations, whose aim is to promote and stimulate understanding and cooperation between all parties. Here, the focus is on exchanging information on glass science and technology, but also on the art and history of glass, and serve as an international center for exchanging information, providing assistance on developing interest in glass, encouraging the holding of international congresses and colloquia on glass, as well as preparing and publishing reports and surveys.

Mr. Klaus Bange followed by presenting the structure and hierarchy of the ICG, as well as the work of the technical committees in the R&D activity fields “Basics and Properties”, “Glass Melting”, “Surfaces and Interfaces”, “New Applications” and “Information, Communication, Education and History”. The action list for 2008/2009 and the potential for changes in R&D activities for the future were also discussed.

Last, but not least, Mr. René Vacher gave a brief overview of the European project “European Forum On New Glass Applications (EFONGA)”, which started in June of 2005, as well as the projects “Glass for a Sustainable Society (GlaSS)” and “Innovative Glass Melting”, which are to be initiated in the near future.

During the “wrap up” session held at the end of the meeting, it was decided that the exchange between the two societies will be intensified and the connection between ICG TCs and CCS Sub-Committees strengthened. Furthermore, the ICG TCs chairs and the corresponding CCS Sub-Committee chairs will cooperate more closely in the future. CCS will also propose candidates for ICG TCs membership and confirm its official candidature to organize the ICG International Congress 2016, once it has been approved by the Standing Board of Directors. Finally, the announcement was made that the ICG Annual Meeting 2011 will be held in Shenzhen, Guangdong Province.

The peerless hospitality during the whole stay was emphasized by a dinner where Prof. Fuxi Gan was present as Guest of Honor.

#### **About CCS**

CCS is an academic, non-profit corporate and social organization for professionals engaged in the science and technology of inorganic and non-metallic materials. Founded in 1945, CCS has 19,906 individual and 49 group members, 19 sub-committees, 3 working committees and 124 local societies. There are five

departments under the CCSs headquarters with a total staff of 23. The professional Sub-Committees are as follows:

- Cement
- Building Materials
- Concrete and Cement
- Ceramics
- Sol-gel
- Special Ceramics
- Refractory
- Glass Fiber Reinforced Plastics and Composite Materials
- Crystal Growth and Materials
- Non-metallic Minerals
- Glass
- Electronic Glass
- Special Glass
- Glass Fiber
- Industrial Petrology
- Automation
- Environment Protection
- Fast Ionic Conductor
- Enamel

CCS regularly organizes China International Glass Industrial Technical Exhibition, which is the only international glass exhibition supported and sponsored by all governmental departments responsible for the glass industry and nationwide glass-related associations in China. The latest creative achievements in research, production and design for ceramics, glass, cementing materials, refractory, artificial crystals, and other non-metallic materials are published each month in the Journal of the Chinese Ceramic Society. For more information, please see: [www.ceramsoc.org](http://www.ceramsoc.org)

#### ***About the International Commission on Glass (ICG)***

ICG is a non-profit international glass society that consists of 32 national organizations in glass science and technology. The aim of the ICG is to promote cooperation between glass experts. ICG organizes Technical Committee work (laboratory round robins, publication of scientific and technical papers). Every three years, the ICG organizes the International Congress on Glass. For more information, please see: [www.icglass.org](http://www.icglass.org)

#### ***About CTIEC***

CTIEC is a core enterprise on the science-and-technology platform of China National Building Material Group Corporation and also a core business unit of China National Building Material Holding Company Ltd. (A listed company on the Hong Kong Stock Exchange). It is a comprehensive science and technology enterprise in engineering consultation, design, general engineering project contracting, science and technology development, technical services, product manufacturing and domestic and foreign trade. The scope of business is in glass, cement, building ceramics and sanitary wares, new building materials, refractory, non-metallic ore-mining and ore-dressing and environment protection engineering. It was set up in 1953 and has staff with 1,100 employees. CTIEC holds 80% of the high-level glass engineering design market and 90% of the glass general contracting market in China. CTIEC Research Institute consists of six major centers, Glass Engineering Technology Research Center, New Function Materials Technology Research Center, Electro-mechanic Equipment Research Center, Powder Material Research Center, Environment Protection and Energy Saving Research Center, and Cement Engineering Technology Research Center.

## Press release

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### International Commission on Glass (ICG)

#### Experts Meeting on Conditioning of Glass Melts and Forming of Glass Products

*From November 13 - 14, 2008, the European Forum on New Glass Applications (EFONGA) held a technical workshop in Eindhoven, The Netherlands.*

In their keynote speech entitled “The Technical Committee on Modelling of Glass Forming Processes (TC25) of the International Commission on Glass (ICG) - a platform for benchmarking software capabilities for glass forming”, Christoph Berndhäuser from SCHOTT AG in Mainz, Germany, and Dries Hegen from TNO in Eindhoven, The Netherlands, discussed that sharing and exchanging current practices of mathematical modeling of glass forming processes is the aim of TC25. They explained that TC25 is currently working on three areas of glass forming and shaping: 3D-TV panel pressing, gob forming and continuous fiber drawing. Their presentation focused more specifically on the results of the 3D-TV panel pressing that were obtained during round robin tests (RRT). Here, the challenge is to treat/model large deformations during the forming process, despite the contact problem that arises between the molten glass and the mold / plunger.

In the next presentation, Menno Eisenga from Glass Service in Maastricht, The Netherlands, illustrated how modern model-based predictive control can help to keep temperatures closer to the optimal set-points during stable, as well as unstable conditions, for instance starting up new manufacturing. Adriaan Lankhorst, Andries Habraken and Dries Hegen from the TNO Glass Group in Eindhoven then discussed how the TNO Glass Group’s state-of-the-art multi-physics CFD tool GTM-X is being used as tool for studying glass melting, combustion and especially flow and temperatures of the melt in forehearth/feeder processes.

In his presentation entitled “Does size matter - an investigation into one aspect of forehearth design”, Richard Sims from Nikolaus Sorg GmbH & Co KG, elaborated on the fact that it is generally accepted today that it may be necessary to utilize both heating and cooling systems simultaneously, with the cooling system being used to reduce the temperature of the main body of the glass bath flowing in the channel center, while the heating system is used to keep the glass at the sides of the channel warm. He discussed few design issues, such as: downward protruding refractory parts (noses) for partial division of the superstructure (roof construction) of feeders into different areas for cooling and heating

Erik Muijsenberg & Jiri Brada of Glass Service Inc. from the Czech Republic held a presentation on mathematical simulation studies of stirring in forehearth of glass melting furnaces. Main objective was to show the capabilities and possible applications of the mathematical model of stirring used in their CFD package Glass Furnace Model (GFM). They introduced a matrix to evaluate mixing efficiency taking into account minimum and average residence time, standard deviation of temperature and a new defined dilution index that describes the dissolution of a cord of given initial diameter due to velocity gradients.

Gesine Bergmann and Hayo Müller-Simon from the Research Association of the German Glass Industry (HVG) in Offenbach, Germany, discussed two projects in which the glass gob temperature was measured underneath the surface immediately after the shear cut and the thermal changes of the glass gobs caused by the delivery system were tracked by measurement and with the help of FEM Calculations. The objective of these two projects was to thermally characterize a gob after cutting and manipulate its temperature distribution, either with existing or new hardware so that a desired temperature and viscosity profile was achieved.

In their presentation entitled “Coupled Simulation of Stirring, Feeding and Forming”, Alfons Möller and Jörg Kuhnert from Nograd GmbH in Mainz, Germany, demonstrated the capability of their CFD software to be beneficially applied in cases where grid-based methods face limitations. Examples include fluid dynamical problems with free surfaces, moving parts, multiphase flows, fluid-structure (mold or plunger) interactions with a strong change of the computing domain or mechanical problems with substantial structure changes.

Next, Matt Hyre from Emhart Glass Research in the United States addressed the topic of radiation modeling in glass container forming simulations. He explained that in glass container manufacturing, optimization of the forming process using numerical modeling requires an accurate representation of heat transfer from the glass during all steps of the forming process. He noted that it is particularly important to take an approach that includes the effects of glass/mold heat transfer and to address the thermal changes in the glass during steps where the glass is not in contact with a mold.

Dominique Lochegnies and P. Moreau from LAMIH in Valenciennes, France, explained to the audience how the research team “Glass Forming and Tempering” of the Laboratory of Industrial and Human Automation, Mechanics and Computer Sciences LAMIH has been working in the field of glass forming and modeling since the 1990s. One recent LAMIH project focused on thermal replication to produce progressive glass molds for use in the optic industry.

In his presentation entitled “Effective Cooling by Utilizing Blow Air in Glass Container Production”, Adnan Karadag from Şişecam in Istanbul, Turkey, discussed the results of his study on whether the cooling potential of blow air can be used to aid the cooling of a glass jar during the final blow on an IS machine so that higher production rates can be achieved.

A significant share of rejects in the float glass process can be caused by surface defects such as “top specks” or “bottom open seeds”, according to U. Lange and C. Roos of SCHOTT AG in Mainz, Germany. To better understand the evolution and origin of such defects they combined a numerical model of the float glass ribbon with detailed models for the evolution of the shape of these surface defects as they travel with the glass ribbon through the float bath.

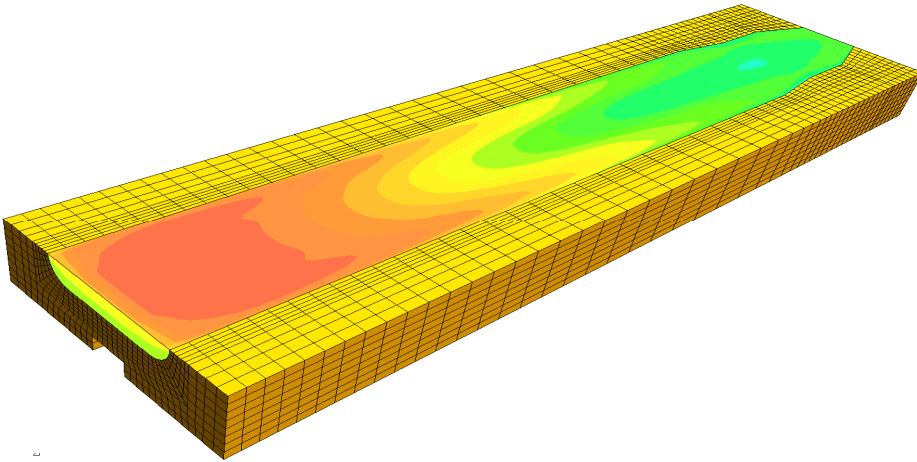
The last speaker, Paul Laimböck from Read Ox & Consultancy B.V. in Valenswaard, The Netherlands, discussed how special probes have been developed to detect changes in oxidation state by continuous monitoring of the oxygen content of the molten tin and to respond on that to prevent oxygen levels from becoming too high in the tin bath and of the atmosphere in the float bath. It has been shown that high oxygen levels that result from inadequate bath sealing or bath emergencies, such as a leaking cooler, can be detected at a much earlier stage than can be detected by the regular optical detection of defects on the glass sheet surface.

#### About the European Forum on New Glass Applications (EFONGA)

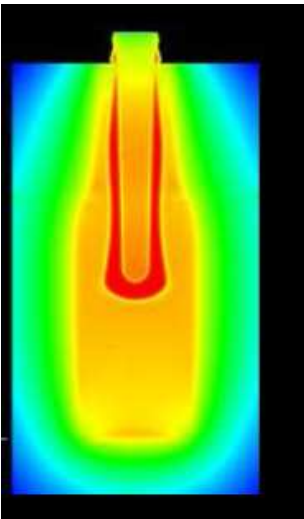
EFONGA is a Coordination Action in the field of glass science and technology, which aims at co-ordinating all European groups working in fundamental and applied pre-competitive research. The success of this project could be the basis for the establishment of a Network of Excellence on Glass. The EFONGA project works in the following fields: basic knowledge of glassy materials, relation structure-properties, setting-up of new methods for the characterization of glassy materials, preparation of reference materials, information exchange on efficient production technology and glass melting. The three activities of this Coordinated Action are: round robin tests, organization of workshops, diffusion and dissemination of information and coordination of training and education on a European level. (for more information: [www.efonga.group.shef.ac.uk](http://www.efonga.group.shef.ac.uk))

#### About the International Commission on Glass (ICG)

ICG is a non-profit international GLASS SOCIETY consisting of 28 national organizations in glass science and technology. The aim of ICG is to promote cooperation between glass experts. ICG organizes [Technical Committee](#) (TC) work (laboratory round robins, publication of scientific and technical papers). ICG organizes every three years the International Congress on Glass. (for more information: [www.icglass.org](http://www.icglass.org))



*Modeling of glass melt in feeder channel (Adriaan Lankhorst, TNO GTM-X Feeder model)*



*Modeling of glass container forming in mould, Matt Hyre, Emhart, Glass Research*



## Press release

June 2009

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### International Workshop Series on “Glass & Entropy”

The first of a new series of international workshops on glass and entropy was held in Trencin in the Slovak Republic from June 25 - 26, 2008. The objective was to exchange opinions on the entropy of the glassy state. After all, many issues still need to be resolved and more and more researchers in fields like glass and polymer sciences, statistical mechanics and computational simulation, agree today that there is a need to attend workshops on this topic that are held on a regular basis.

Corning’s European Technology Center in Avon, France, agreed to sponsor the first workshop on this subject and Professors Lothar Wondraczek and Reinhard Conradt, both from Germany, agreed to organize and chair it. The first workshop was endorsed by the newly founded Technical Committee 08 of the International Commission on Glass “Relaxation Phenomena in Glasses” and supported locally by the Slovak Glass Society. It attracted contributions from 38 outstanding scientists, most of which were published in a special issue of the Journal of Non-Crystalline Solids in April of this year.

The essence of the present controversy evolves around questions like “does a glass possess a finite residual entropy at absolute zero?”, “how does the entropy of a glass forming system abruptly change at the glass transition?”

Based on the computation of energy landscapes and the concept of broken ergodicity, the glassy state is described in terms of a liquid confined to a single metabasin of the configurational phase space with an entropy loss - but no latent heat - accompanying the glass transition. In this frame of description, a glass does not appear to have any residual entropy at absolute zero. The opposite answer is derived by means of classical thermodynamics and the thermodynamics of irreversible processes. This controversy clearly shows that the statement made in 1995 by the 1997 Nobel laureate (physics) P.W. Anderson still holds today: The “deepest and most interesting unsolved problem in solid state theory is probably the theory of the nature of glass and the glass transition.”

The second International Workshop on Glass and Entropy was held from April 22 - 24, 2009, in Aberystwyth, United Kingdom, when the special issue of the Journal of Non-

Crystalline Solids was published. This round of discussions was organized by G. Neville Greaves, Martin Wilding and Lothar Wondraczek and endorsed by ICG and its TC08.

Sponsored by the EU-FP6-initiative EFONGA (European Forum on New Glass Applications), 28 papers were presented by scientists from all over the world at this second workshop. Whereas the first meeting concluded on the note that there is still a need to specify a common nomenclature (e.g. characteristic temperatures, definition of entropy, etc.) and to design experiments that will be accepted as decisive by the broad community, the participants in the second workshop agreed to jointly pursue three types of experiments in particular: dissolution calorimetry (having identified model glasses); measurements of the electromotoric force in glass-crystal galvanic cells and vapor-pressure measurements. "Glasses under extreme conditions" was identified as a key new area of specific interest, with a special emphasis on the role of high pressures on the structure and dynamics of glass-forming systems.

In the meantime, plans to hold a third workshop in Nuremberg, Germany, in 2011 are already underway. Here, all parties have expressed their hope that it will be possible to maintain momentum, and build on it as the basis for a new, more complete understanding of the glassy state.

#### About the European Forum on New Glass Applications (EFONGA)

EFONGA is a Coordination Action in the field of glass science and technology, which aims at co-ordinating all European groups working in fundamental and applied pre-competitive research. The success of this project could be the basis for the establishment of a Network of Excellence on Glass. The EFONGA project works in the following fields: basic knowledge of glassy materials, relation structure-properties, setting-up of new methods for the characterization of glassy materials, preparation of reference materials, information exchange on efficient production technology and glass melting. The three activities of this Coordinated Action are: round robin tests, organization of workshops, diffusion and dissemination of information and coordination of training and education on a European level. (for more information: [www.efonga.group.shef.ac.uk](http://www.efonga.group.shef.ac.uk))

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*Fig. 1: Attendees of the 1st International Workshop on Glass and Entropy*

## Press release

July 2009

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### **Scientific expert workshop “Glass surfaces and stress corrosion mechanisms at the nanoscale” held in Montpellier**

As part of an EU-funded project (EFONGA), the International Commission on Glass (ICG) organized a scientific workshop on “glass surfaces and stress corrosion mechanisms at the nanoscale” in Montpellier, France, from February 22 - 25, 2009. Fifteen international experts on specialized topics pertaining to surface or strength items in the field of glass were invited to attend. The objective of the meeting was to review the scientific state of the art, identify the deficits and thus create a roadmap for future work. According to Dr. Volker Rupertus, one of the Chairmen of the appropriate Technical Committees of the ICG, “It is extremely important to have a clear understanding of the mechanism behind stress corrosion in the nm-range. Unlike metals, semiconductors and other materials, glass behaves completely differently with respect to strength and corrosion.”

His colleague and Co-Chairman, Dr. Matteo Ciccotti adds, “Glass is also a very challenging material that offers many fantastic properties, including transparency, high inertness against chemical attack, stiffness and many others. The brittleness of glass is also legendary.” Nevertheless, despite significant developments that have been made in locally measuring physical properties over the last ten years, obtaining useful information at the nanometric scale in disordered material remains a challenge.

Especially for subsequent processes, like surface conditioning or coating aimed at optimizing the properties of the material, the reaction mechanisms on the glass surface become more and more important in overcoming the critical points. The mechanisms of crack propagation and driving forces in the nm-scale in particular are still under discussion.

Carlo G. Pantano from the Department of Materials Science and Engineering Materials Research Institute at Penn State University in the United States emphasized to the audience that surface adsorption reactions, in-depth hydration and corrosion reactions are truly of great interest.

Russell J. Hand and Damir R. Tadjiev from the University of Sheffield, agreed that what seems to be clear is that, ultimately, strength controlling defects must bear some relationship to the underlying structure of the glass, as well as be affected by interactions with mobile atmospheric species, such as water. Furthermore, because bulk production of silicate glasses is based around a narrow range of soda-lime-silica compositions, any variation in mechanical properties with composition is normally considered to be of little interest and has thus not been studied to a significant degree. One might also note that while mechanical contact during manufacturing is the dominant factor in determining defect formation, it seems reasonable to suggest that defects are still formed preferentially at specific sites within the glass surface.

Tanguy Rouxel from France discussed how the Vickers indentation test allows for a simple comparison of the apparent hardness of glasses and is a good introduction to the more complicated problem of scratching. Expectations are high when it comes to improving the hardness or the scratch resistance of glass by playing on the composition to favor one deformation mechanism over the other. When shear flow is favored, as for metallic glasses, or when densification contributes to a large extent, as for silica-rich glasses, then the glass can accommodate the sharp contact load by relaxing the stresses through the displacement of matter (energy dissipative process). Hence, for Rouxel, it seems that it is possible to tune hardness, damage resistance and possibly fracture toughness by playing on the composition.

Etienne Barthel and René Gy, also from France, discussed how interesting results have emerged that limit the possible extent of plastic deformation at the crack tip. They explained the relevance of high strength fiber experiments to understanding amorphous silicate rupture and reviewed some of the parameters affecting fiber strength, such as temperature, ageing and water (at the surface or in depth) and attempted to bring them in relation with silica rearrangement processes. Furthermore, they also raised the question of the development of advanced micro-mechanical experiments and modeling, which could help in this area. Finally, they emphasized the connection between the local picture of fracture, corrosion, rearrangement mechanisms in silicates and other macroscopic processes of practical interest, such as strength degradation of silicate glass from surface contact damage, mechanics and strengthening of sol-gel coatings, chemo-mechanical polishing and other interesting phenomena in areas, such as geochemical compaction or lubrication of silicates in water.

According to Dr. Uwe Rothhaar from SCHOTT AG in Mainz, Germany, the interaction between a glass surface and a surrounding “wet” environment is known to be a critical factor in many applications. In most cases, durable borosilicate glasses were used to overcome the gravest corrosion problems in the fields of pharmaceutical packages or with containers and piping systems in the chemical and food industry. Nevertheless, progress is required, especially in reducing the glass dissolution or the leaching of single elements and in understanding the adsorption of organic molecules / bio-film formation. Although these are important issues for a number of products, the recent developments are strongly driven by the special needs of the pharmaceutical industry.

Joachim Deubener and G. Hensch from the Institute of Non-Metallic Materials at the Clausthal University of Technology in Germany noted that sol-gel techniques have long been used for wet chemical processing of glasses, ceramics and organic-inorganic compounds. Ready preparation of thin films and coatings, nano-crystalline powders and hybrid materials, as well as the availability of good optical qualities, are advantageous

for the development of novel functional materials by sol-gel processing. On glass substrates, the most widespread commercial uses are in architecture, construction and solar power of reflective, colored and AR coatings, partially with water repellent or hydrophilic surfaces. In looking to the future, concepts on mechanical protection and strength enhancement of glasses could include active coatings, i.e. self-healing of cracks through local release of organic molecules and controlling pH in the stress corrosion regime from sol-gel derived hybrid coatings

By using a roadmap process, the key breakthroughs, tasks and possible applications were worked out, clustered and prioritized in a time scale from now until 2025. These roadmaps are part of the EFONGA project and will be published in an international journal quite soon.

EFONGA is a Coordination Action in the field of glass science and technology, which aims at co-ordinating all European groups working in fundamental and applied pre-competitive research. The success of this project could be the basis for the establishment of a Network of Excellence on Glass. The EFONGA project works in the following fields: basic knowledge of glassy materials, relation structure-properties, setting-up of new methods for the characterization of glassy materials, preparation of reference materials, information exchange on efficient production technology and glass melting. The three activities of this Coordinated Action are: round robin tests, organization of workshops, diffusion and dissemination of information and coordination of training and education on a European level. (for more information: [www.efonga.group.shef.ac.uk](http://www.efonga.group.shef.ac.uk))

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*Fig. 1: Participants to the Workshop*

## Press release

July 2009

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### **Student workshop on “Glass structure-property relationships” held by EFONGA in Montpellier**

Passing on knowledge, and stimulating and encouraging the next generation to think creatively in key technical areas that underpin our society are key objectives for the EFONGA (European Forum on New Glass Applications) project. At the same time, a project that is run with European framework 6 funding has an obligation to share the results that have been achieved over the course of the project. Both objectives were met during a workshop that was held from May 4 - 5, 2009, in Montpellier, France. 55 young research workers from 12 different European countries and the United States gathered to listen to nine selected academics and two industry representatives who talked about subjects that excited them.

The workshop was held at the CNRS laboratory in Montpellier and was entitled “Glass structure-property relationships”. The attendees, mainly research students but with two from industry, were taught by 11 staff members who presented 16 lectures. The presenters also came from several European countries, as well as one lecturer from the U.S. The opening sessions on day one focused on the spectroscopic and diffraction techniques that allow glass structures to be characterized on various scales from the atomic upwards. Later, the speakers moved on to address the subject of properties in relation to composition and properties, including: thermodynamics; crystallization; phase separation; viscosity; transformation range behaviour; optical properties; mechanical behaviour and the effect of surfaces in particular; and electrical and transport properties such as chemical durability. Two final presentations covered the production of high quality glasses for research and the wide range of road-mapping techniques available to identify technology gaps and corresponding future research directions. The PowerPoint slides of all these presentations are available as downloadable PDF files from the EFONGA web site at [www.efonga.eu](http://www.efonga.eu).

The workshop also successfully stimulated discussion. Lecturers and students were encouraged to intermingle and discuss their research issues during breaks and over dinner. Group problem-solving exercises, where glasses had to be designed to match

particular scenarios, were held on the first evening. This truly captured the imaginations of many participants, although one student who suggested that plastics offered the perfect solution was almost ejected from the event! On the second evening, the students carried out a brief road-mapping exercise on their own, quickly identifying the importance of environmental issues, energy conservation and creation, and the importance of novel materials in medicine. Hot topics included the role of glass in solar cells, but also subjects such as desalination to provide drinking water, were raised.

In designing the program, social interaction between the different groups and lecturers was viewed to be of key importance. One measure of how successful the organizers were in achieving these goals is that the students have set up a facebook account to develop the links initiated during the workshop and display the photographs taken during the last night of the event.

Following this successful event, the ICG plans to develop appropriate teaching activities and hopes to offer students an annual summer school (starting 2010), as well as lectures on specific topics, in addition to glass conferences. In addition, the ICG offers TC23 on Glass Education and Training in Glass Science and Engineering as a forum for glass educators. More information can be found on the ICG website at [www.icglass.org](http://www.icglass.org).

EFONGA is a coordinated activity in the field of glass science and technology that aims at coordinating all European groups working in fundamental and applied pre-competitive research. The success of this project could well form the basis for the establishment of a Network of Excellence on Glass. The EFONGA project works in the following fields: basic knowledge of glassy materials, relation structure-properties, setting-up of new methods for the characterization of glassy materials, preparation of reference materials, information exchange on efficient production technology and glass melting. The three activities of this coordinated activity are round robin tests, organization of workshops, diffusion and dissemination of information and coordination of training and education at the European level. (for more information: [www.efonga.eu](http://www.efonga.eu).)

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## Press release

October 2009

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### The International Commission on Glass (ICG) convenes in Vancouver

The International Commission on Glass (ICG), a non-profit international society of national scientific and technical organizations that have a special interest in glass science and technology, convened only recently in conjunction with the 8<sup>th</sup> PACRIM conference in Vancouver to discuss a number of important issues with respect to its national membership structure and strategic focus for the future. Founded in 1933, the ICG has grown to become a highly respected global organization in the field of glass and currently has 34 member organizations that bring together the world's most respected universities, scientific institutions, companies in the glass industry and allied organizations.

At the Vancouver convention, the Council unanimously voted to admit both Bulgaria and Denmark as new members of the ICG. These countries are both represented by their respective national organizations, "The Bulgarian Commission on Glass" and "The Danish Ceramic Society". Both organizations were represented at the convention by Isak Avramov and Vesselin Dimitrov from Bulgaria and Karsten Nielsen and Yuanzheng Yue on behalf of Denmark.

A number of key changes were made including the election of both a new President and Vice President by the Steering Committee and Council but also to the membership of the Coordinating Technical Committee (CTC) and the Technical Committee (TC) chairs. Fabiano Nicoletti from the Stevanato Group in Italy was appointed the new President of the ICG and Shou Peng from China Triumph International Engineering Co. Ltd. in China was named Vice President. Roland Langfeld from Schott AG in Germany, Lucien Belmonte of Abividro in Brazil and Vladimir Shevchenko, who works for the Institute of Silicate Chemistry in Russia, were welcomed as new members of the Steering Committee.

The CTC meeting was split into two parts for the first time. It consisted of a technical (TECH) part followed by a business part on the next day. In the TECH meeting, the

cluster leaders gave extended presentations and many details on the status of the work of the TCs; only a short summary was presented during the business meeting. In any case, the participants greatly appreciated this excellent opportunity to engage in in-depth discussions of technology and discuss what they feel needs to be done over the next five to ten years to support the roadmap process. As a result of the extremely positive feedback that was received on this event, the decision was made to organize a CTC TECH meeting each year that will be open to TC chairs, as well as active TC members.

All cluster leaders briefly described the current situation of the TCs and then focused on future aspects of the five different fields. This, in turn, yielded a very clear picture of the future needs with respect to R&D. At the end of their presentations, the cluster leaders attempted to answer the relevant questions, the answers to which could well form a guideline for the future roadmap process in the different R&D fields.

The progress that has been made with respect to the ICG's technology road map was also the subject of discussion during the CTC business meeting. Here, an initial workshop was held during the ICG congress in Strasbourg, France, in 2007 and major progress was made later at the meeting held in Brig, Switzerland, in 2008. ICG roadmaps have now been developed on key topics like advanced melting, glass as a material with a focus on bioglass, surface defects and stress corrosion, and a preliminary one the fundamentals of the material. Work is still in progress on the existing roadmaps, as well as new roadmaps that will cover other specialized topics of importance.

In addition, the proposal was made to form a number of new Technical Committees, including Atomistic Modeling and Simulation, with J. Mauro as the Chair, Structure and Vibrations (B. Helen as Chair), Structure-Property Relations (G. Calas as Chair). All of the proposed new TC members were also admitted as expected. The new CTC chair is René Vacher, CNRS, France, and a CTC new member is Volker Rupertus, Schott AG, Germany. Gulcin Albayrak, Sisecam, Turkey, began her second term as a CTC member.

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## Press release

January 2010

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### **International Commission on Glass (ICG) Prepares for the New Decade** *New President Fabiano Nicoletti inaugurated at conference in Vancouver*

At its annual conference held in Vancouver in June of 2009, the International Commission on Glass adopted a number of important fresh initiatives under its new President, Fabiano Nicoletti. Key objectives for the future include greater globalization of activities and opening up the organization to more major glass companies.

Recent years have seen: the effective re-organization of Technical Committee activities and the Coordinating Technical Committee by Klaus Bange; the successful conclusion of the important European project EFONGA by René Vacher; the creation of important Road Maps for future glass technology development, by Ruud Beerkens and Wolfram Hoeland in particular; and a new modern ICG Constitution that opens up the organization to individuals and to international glass companies.

A number of important steps still need to be taken. First of all, it is agreed that all future ICG activities must be global. And to achieve this goal, greater involvement of the BRIC countries: China, Brazil, Russia and India is perceived to be vital. The first three of these have already pledged to contribute to the success of this new age and will thus be assuming greater responsibility, and taking on more duties, within the framework of the ICG. The President Fabiano Nicoletti indicated that India will most likely follow suit. He noted that Europe, the United States, Japan, China, Russia, Brazil and India need to interact in order to identify common objectives for the promotion of glass and the advancement of glass science and technology.

Greater involvement of the higher echelons of glass companies is also being encouraged by allowing them to participate directly in ICG decisions as a way of achieving continuous and effective interaction.

Furthermore, the effectiveness of the National Participating Organizations (NPOs) in representing their constituencies still needs to be verified. Their knowledge of and

interaction with the national industrial glass community merits improvement. The NPOs should contribute toward the initiatives of the ICG and support them in an operational manner, for instance by providing training teams, encouraging national glass production, identifying new and/or local financing sources and proposing new activities. Fabiano Nicoletti underlined that they should be the first vehicle for providing and disseminating information in their respective countries.

He requested that the Steering Committee Members become more active in all areas; for example a teleconference for the Steering Committee would be organized every two months.

It was also agreed that the research activities of the ICG's Technical Committees need to be more oriented towards a modern Sustainable Low-Carbon Society (SLCS), in which high-tech glasses will be required to support energy saving and environmental protection initiatives. One key to the growth of glass applications will be a better understanding of glass surfaces and the development of more and more products that utilize thin-film technology. Furthermore, function-oriented glasses in combination with non-glass products need to be considered and examined. As Fabiano Nicoletti put it, "We should focus our attention on the areas with increasing demand, for instance glass fibers, heat-resistant glass, glass for electronic devices, medical, biotech, generating energy savings and storage, and on the fundamental research necessary to prepare the next generation of glass products."

He also made it clear that, according to the constitution of the ICG, the art and history of glass should receive appropriate attention. An effort will now be made to verify and identify the existing international bodies in these fields that might be associated with the ICG.

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### *The Coordinating Technical Committee and Steering Committee meet in Venice*

The Coordinating Technical Committee (CTC) and Steering Committee of the International Commission on Glass (ICG) met on Thursday 29<sup>th</sup> October, for the third time in 2009. The venue was the peaceful and architecturally beautiful Sala Barbantini, often used for international events and situated on the small Isola di San Giorgio Maggiore in Venice, Italy.

This CTC meeting was the first since René Vacher took on the mantle of the Chairmanship from Klaus Bange and he immediately focused on developing the ideas that arose out of the analysis of cluster activities at the previous CTC meeting in Vancouver (June 2009). In particular he proposed to use this opportunity: 1) as a platform for initiating discussions on managing the output of the Technical Committees (TCs); 2) to identify gaps in coverage within the overall cluster activities; and 3) to uncover the potential for new synergies.

Within the Basic Science Cluster for which he is responsible, René Vacher highlighted the need for studies on 'Structure and vibrations' and 'Atomistic simulation' to complement and supplement the output of TC03 on Basic Science, which has an emphasis on diffraction studies. Two new committees (TC26 and TC27) have been commissioned to develop these areas. New committees on Nanomechanics (TC09) and the Glass Transition (TC08) are developing their work programmes and their linkages to other committees (e.g. TC09 with TC19), and TC08 has opportunities to move into areas such as relaxation in highly viscous liquids. TC07 (Nucleation, crystallization and glass-ceramics) with TC10 (Optical properties of glass) both work at the boundary between fundamental science and applications, to their advantage but also needing careful control. Similarly René Vacher questioned whether TC02 (Chemical durability), although working very well, might benefit from input from other committees such as TC19; he sees such synergies as a key factor to unlock new output.

The Glass Production Cluster, under the leadership of Ruud Beerkens, has a particular reputation for hard work and effective output. With Gülçin Albayrak, Ruud has requested EU funding, under the COST programme, for four workshops based on subjects

identified by road-mapping. TC13 has initiated a programme concerned with the chemicals leached from glass within the framework of exemption of glass products from the requirements of REACH registration; this potential links to TC02 activities. On the other hand, the work programme of TC25 (Modelling of Glass Forming Processes) is currently limited by the existence currently of just 2 appropriate software packages.

The Surfaces and Interfaces cluster is working actively on “Nanostructured Glasses” (TC16) using sol gel techniques while TC24, “Coating on Glasses”, has focused on self cleaning glasses. TC19, “Glass Surface Diagnostics”, concentrates predominantly on analytical techniques. These committees adopt very different approaches, making interactions difficult, but there is enormous potential in combining diagnostics with areas such as medical and nano applications, and with committees involved in chemical durability such as TC02 and TC05. René Vacher stressed the need to think out of the box, as he put it, “New horizons need to be identified.”

The ‘Applications’ cluster, under the Chairmanship of Richard Brow, covers: “Glasses for Medicine and Biotechnology” (TC04), concerned particularly with the glass-media interface in medical applications and characterization methods; “Nuclear and Hazardous Waste Vitrification” (TC05); and “Glasses for Optoelectronics” (TC20). Applications are key to the importance of Glass in Society and Richard Brow has identified many gaps in coverage within the current list. These committees also should link strongly to other, more basic committees e.g. TC05 with TC02 on “Chemical Durability and Analysis” and TC18 on “Properties of Glass Forming Melts. A future CTC focus will be the status of such links and their development.

The ‘Communications’ cluster is responsible for presenting the ICG and its activities to the broader community. Exciting possibilities arise for Committee TC12 (Glass, Society and Environment) in areas such as a blog to discuss the advantages of glass, and life cycle analysis. A round table discussion at the next Congress in Brazil is also on the cards. TC01 (Communications) and TC23 (Education and Training) are running successful workshops for students.

In summarizing the discussions, René Vacher proposed splitting the cluster entitled ‘Basics and Properties’, dropping ‘Surfaces and Interfaces’ as a separate Cluster and grouping Technical Committees under the new headings: Basics; Properties; Characterization; Applications; Production and Information. Some lively discussions with the Committee Chairs are expected to follow.

In reporting new developments already in place, René Vacher mentioned that new TCs on Atomistic Modelling and Simulation (TC26 Chair: John Mauro); Structure and Vibrations (TC27 Chair: Bernard Hehlen) and Structure-Property Relationships (TC22 Chair: Georges Calas) were approved at the last Council meeting. The Steering Committee has also set up an Editing Sub-committee consisting of John Parker (Chair), René Vacher, Alicia Duran and Cluster Coordinators, as required. In addition to defining policy for publicity and encouraging the Committees to publish their work, it has taken on the specific task of generating an update to the summary of ICG activities last produced by Henk de Waal for the 2000 Conference in Amsterdam.

Following the very successful Summer School for new research students held in Montpellier in May 2009, the CTC considered how best to organize more such events. The feedback from the students and lecturers indicated that a longer, more focused meeting of up to 5 days was needed, offering extended opportunities for tutorial activities and student input. To maintain continuity a single center should be designated for these events and Montpellier was accepted as a suitable venue.

Additionally the CTC agreed to support single topic teaching activities organized alongside ICG conferences and congresses.

The Steering Committee Meeting, chaired by the new ICG president, Fabiano Nicoletti, approved a proposal by Alicia Duran to co-finance of a Bio-Glasses book, edited by Alix Clare and Julian Jones. A specific program for financing an editorial plan and expert meetings in 2010 is to be presented at the next Steering Committee meeting. Goals include: the publishing of an ICG history book; an EFONGA final report; more press releases; and a booklet on ICG technology roadmapping.

The organising of the ICG triennial congress is recognised as an honour for the host nation and is a much sought after privilege among ICG national members. Arrangements are already in hand for the 2010 and 2013 events, but the 2016 meeting currently has 3 candidate organisers. New guidelines for selecting hosts have been drawn up to assist the Steering Committee in making its recommendations to Council. The document, entitled "The criteria for selecting locations for the ICG Annual Meetings and International Congresses" and edited by Roland Langfeld, was ratified.

The ICG Congress 2010 is to be held from September 20 - 25 at Pestana Hotel in Rio Vermelho, Salvador, Brazil. The Steering Committee will invite representatives of all three candidates for the 2016 ICG Congress, the People's Republic of China, the United Kingdom and the United States, to make oral presentations explaining the reasons for their candidacy at the Steering Committee and Council meetings in Brazil in September 2010.

The next Coordinating Technical Committee and Steering Committee meetings will be held in Mainz, Germany, on March 11, 2010.

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