Research group Thermoanalysis and Laboratory for Thermal Analysis of ITC -

Thermoanalysis as an Efficient Tool in Material Research for Technical Processes

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Thermoanalysis – Research

Material cycles' research in technical processes requires exchange of information between numerous scientific disciplines and data from different environments, ranging from all steps of technical processes to the environment, from input to output resp. partitioning in technical installations. However, in addition to these efforts, basic research is needed to understand the scientific principles and mechanisms behind the observed facts. This knowledge allows the optimisation of the ecological and economic conditions of technical processes for a sustainable use of resources and protection of the environment.

The research group Thermoanalysis bridges the gap between basic research and technical processes. Simultanously to the development of a new technical process, we investigate and apply peculiar scientific and analytical tools and thus, contribute directly to the optimisation of technical processes by basic investigations of material properties and reactions on molecular range.

Our research projects are financed by Helmholtz-Association (HGF) and are carried out and validated in the HGF-program "Energy Efficiency, Materials and Resources". Emphasis lies in Topic 5 "Resource Technologies". This topic focuses on the development and implementation of innovative technologies to improve the energy and resource efficiency with which mineral raw materials are produced and recycled.

Our specific research projects aim to describe material cycles and structural features of novel materials in these processes. New thermoanalytical and MIR-spectroscopic tools are developed, applied and validated in cooperation with Deutsche Gesellschaft für Thermische Analyse (GEFTA).

Current research projects include:

1. Development and validation of novel analytical tools, specializing on hyphenated techniques and the quantification by coupled thermochemistry and spectroscopy.
2. Structural features of nano-scaled novel cementitious materials and complex inorganic materials
   [Preparation of a Novel Cementitious Material from Hydrothermally Synthesized C–S–H Phases, K. Garbev, G. Beuchle, U. Schweike, D. Merz, O. Dregert and P. Stemmermann, Journal of the American Ceramic Society Volume 97, Issue 7, p 2298–2307, July 2014]
3. Investigations of surficial and structural changes of cementitious materials due to water vapor treatment and CO_2-treatment.

Key Method: Coupled Thermoanalysis

The coupling of Thermogravimetry (TG) and Fourier Transform Infrared Spectroscopy (FTIR) represents an efficient tool for studies on material cycles in thermochemical processes. Use is made of the fact that thermogravimetry allows parameters to be varied within wide ranges and that the respective constants stay rather reproducible. By detecting functional groups, FTIR allows to draw conclusions about the chemistry even of complex gaseous mixtures. When it comes to quantitative TA-FTIR, we have to face various challenges: Since quantification via FTIR-spectroscopy is based on Lambert-Beer's law, the concentration range has to be selected accordingly. In practice, however, molecular interaction effects and other known phenomena result in a non-linear behavior in higher concentration ranges. This is investigated for each analyte. On-line qualitative and quantitative data for released volatile and reactive substances are gained, which are strongly correlated to distinct thermal treatment conditions.

Thermoanalysis - Teaching

1. Teaching of PhD- and Master-students (personal training) in analytical chemistry and data validation, workshops in thermochemistry.
2. Member of Steering Committee of Karlsruhe House of Young Scientists (KHYS).

Thermoanalysis - Innovation

1. Development of online analytical tools for the Celitement process.
2. Characterisation of materials from the Celitement process.