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Asian Dyer

Editor & Publisher
Chandradeep S Kwatra
BChemEngg, MBA

Manager
Thomson George

Corporate Office
201/Bldg 2, New Sonal Link Indl Estate
Link Road, Malad (W), Mumbai 400064, India.
Tel : +91 28812709
E-mail : asiandyer@gmail.com, info@asiandyer.com

Advertising
C S Kwatra
Cell : + 91 9820606050

Media Representatives

Europe
Sabine Dussey
Tel : +49 2129 348 390
Mobile: +49 171 547 3990
E-mail : sabine.dussey@dussey.de

US, UK & Rest
C S Kwatra
Cell : +91 9820606050

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WickView grading system turns moisture management on its head

UK based textile testing solutions provider James Heal has announced a revolutionary new grading system for moisture management testing that literally turns the assessment of wicking behaviour within a fabric on its head.

In 2019, James Heal launched their innovative WickView moisture management test instrument, enabling the wicking properties of a textile to be tested both vertically and horizontally, to better reflect real-life wear conditions. Many other instruments and test methods available test only horizontally.

The WickView instrument technology has advanced more quickly than the industry test standards; these use basic distance and time as a measure to assess the spread of moisture, rather than the exact movement in multiple directions. To address this, James Heal has created a test method and system of grading to ensure systematic, accurate product testing in laboratories, and a software system that also enables the sharing of data and real-time video footage recorded of the actual test, electronically with colleagues or partners based in other locations.

WickView in its vertical testing position alongside laptop showing example wicking test data.

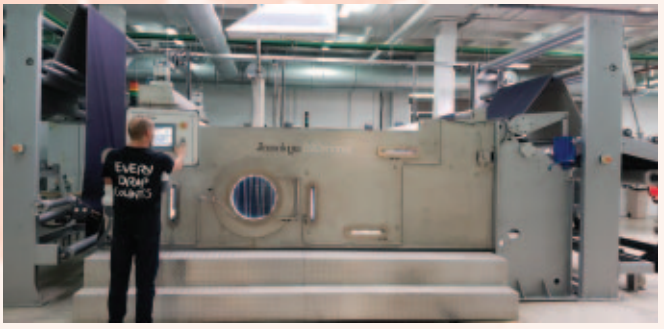
Integrated cameras are mounted either side of the test specimen within the WickView, that combined with intuitive TestWise software, uniquely track, record and measure the multidirectional movement of moisture through a fabric on both skin and face sides. Numerous parameters can be measured for comparison, and features in the software allow users to identify and discount aspects that may skew the results such as the effects of gravitational pull and run-off, giving the most precise results.

Now with the James Heal test method and grading system, users can be confident that they are testing correctly to achieve the most realistic, accurate results. A wealth of data is available within the WickView software, from watching recordings of the live test on each side of the specimen through to the resulting graphs and tables showing the grades of performance across a range of parameters. Results can be read individually or in different combinations to suit the scope of the testing, enabling users to understand and interpret their meaning in the context of the textile being tested, and where needed shared via email or online with their customers such as retailers or brand owners.

James Heal head of Technical, Guy Smithurst comments, 'The WickView has pushed the boundaries of moisture management testing, and together with TestWise software offers a totally fresh approach. Having designed the instrument, written the test method and developed the grading system, the entire James Heal team including innovation, software developers and technical specialists working in collaboration have created a new concept in this area of performance testing, providing manufacturers with a system to identify moisture movement and behavioural pattern, giving a 'true wicking value' of a fabric.'

Jeanologia demonstrates the way for detoxed fabrics

Jeanologia, a leading Spanish company in the development of eco-efficient technologies, demonstrated how to achieve detoxed and sustainable fabric for the textile industry at the DTG exhibition recently.



For Jeanologia, sustainable textile production must start with the fabric, reducing its environmental impact in the manufacturing process and carrying out a precise selection to achieve more efficient processes from the fabric. To this end, the company successfully introduced G2 Dynamic ozone technology to the market, as well as Anubis technology, which enables the production of sustainable fabrics and achieves a perfect combination of fabric and finish.

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Monforts marks 40 years of advanced manufacturing in Austria

Montex Maschinenfabrik - the key site for the manufacturing of Monforts finishing machines in Austria celebrated its 40th anniversary in 2022. Located in St Stefan, in the centre of Austria's Lavant Valley in Carinthia, the advanced manufacturing hub was founded by Monforts in 1982.

'From the outset, we have specialised in all aspects of machine production, including high-precision sheet metal working, laser cutting and welding, and the pre-assembly of machines and components, along with a well-organised quality management and spare parts service,' says Montex plant manager, Gert Hanzl.

Montex specialises in all aspects of machine production, including high-precision sheet metal working, laser cutting and welding

'We work very closely with the Monforts research and development team in Mönchengladbach, Germany, to take the latest new ideas through testing and prototyping, in readiness for future series production,' Hanzl says. 'We are fully exploiting the many new possibilities in the continuous development of design and manufacturing methods. The respective electrical switch cabinets for the machines are delivered just-in-time from Monforts in Germany according to our production schedules.'

While there is standardisation in series-produced Monforts machines, Montex is also increasingly called upon to construct bespoke machines with unique designs, according to the special needs of customers in technical textile or special textiles, he adds. 'We aim for the best combination of already-proven components and carefully tested special constructions and are equipped to handle large projects.'

The core Monforts machine range, including the industry standard Montex stenters, along with relaxation dryers, Thermex dyeing ranges, Monfortex compressive shrinking ranges and MontexCoat coating units is built at the Austrian site.

'We have employees who have worked at this site long time, some even since the foundation of Montex Austria, but its very important that we train apprentices at the same time, in order to pass on our know-how and ensure the high standard that customers expect from Monforts systems is maintained going forward,' Hanzl says. 'One of the key advantages of being here in the heart of Europe is the Dual Training System - one of the best training systems in the world. It combines theoretical instruction in a vocational school with practical training both, within the company and in training workshops.

'Colleagues from Mönchengladbach heartily congratulate the Montex team on its 40th company anniversary,' adds Monforts Managing Director Stefan Flöth. 'We would like to thank the company for the decades of good and successful cooperation we have had and wish the operaton continued success in working with us for the next 40 years.'

In the opinion of Jean-Pierre Inchauspe, business director of Jeanologia's G2 Dynamic, ozone has become an essential element to guarantee a more sustainable and competitive textile industry and, to that end, it is essential to start the process with the fabric in order to prepare it for later processes that are more environmentally respectful.

Jeanologia's Anubis technology is based on thermal shock. Using no water and, in a reduced time frame, it provides maximum shrinkage control and permits fabric relaxation. In combination with the subsequent ozone treatment with G2 Dynamic, the cleaning effect is maximized, thus becoming the only treatment needed for continuous finishing of fabrics, while avoiding the use and spillage of water. On the same note, G2 Dynamic is an ecofriendly alternative to some of the most polluting and water-consuming fabric finishing processes.

This ozone technology for continuous treatment of fabrics achieves authentic results more quickly, saving resources both, during fabric production and subsequent stages of garment production.

Successfully implanted in over 40 industrial weavers around the world, its high-performance cleaning prevents build-up, improves crocking and colour fastness, as well as acting as a laser enhancer. In addition, it reduces water consumption by upto 95%, chemical consumption by 100%, energy by 80% and carbon footprint by upto 40% as compared to conventional finishing methods.

The Anubis and G2 Dynamic technologies are key pieces in Jeanologia's MissionZero to eliminate 100% of the waste generated in the manufacturing and finishing of jeans, from the fabric to the final garment. A mission in which Bangladesh, as a major denim-producing powerhouse, plays an essential role. The company works closely with the country's leading jeans manufacturers through its commercial office in Bangladesh at facilities which serve as a base for over 20 employees, and from which

Jeanologia provides advisory services and disruptive technology, as well as comprehensive technical service, support and training.

Data controlled production - the answer to challenges in textile coating

Extreme rise in energy prices and a growing uncertainty in almost every industrial sector - many manufacturing textile companies face immense challenges these days. To compete in the market, they must increase the flexibility and efficiency of their production, and minimize manufacturing costs by reducing the input of resources. Online quality control in textile production processes is suddenly more important than ever before. The German machine builder, Mahlo, shows how data-controlled production can solve these problems.

Web gauging with Qualiscan QMS

'The key points are the correct collection, analysis and treatment of the right data as well as the seamless transition of data flows between machines, company divisions and to other companies such as customers or suppliers', says Matthias Wulbeck, product manager for Quality Control Systems (QCS) at Mahlo. He also notes that leading industrial companies are thinking ahead as well, producing in a sustainable way before they are forced to, and introduce automated processes and high-tech networked devices to perform live data analysis.

I4.0-compliant Mahlo quality control systems installed throughout a modern textile coating line show the variety of options to control a production. 'To adapt to the different needs, Mahlo has a broad portfolio of intelligent scanners and sensors in the Qualiscan QMS system. They record product and process parameters online such as basis weight, add-on weight, thickness, moisture content, web temperature, residual moisture, exhaust air humidity, air permeability etc at different stages of the production.'

The measured values are processed directly in real-time processors of the sensors. The finished measurement data is visualized internally in an intuitive control display or transmitted via interfaces to an external network. The implemented automatic control algorithms interact directly with the suitable actuators of the textile coating line and reduce deviation from the target and thus results in a more uniform end product. This allows optimised target value specifications and, in addition to better product quality, leads to significant savings in raw materials and energy costs. Furthermore, process reliability and production throughput increase. 'And, you can react fast and flexible on the changing market demands', Wulbeck adds.

Fermentation route for the royal dye

Conagen, based in Bedford, Massachusetts, US, has successfully scaled up the production of its sustainable, cost-effective Tyrian purple - a historically coveted and expensive dye found in rare and limited sources in the marine nature.

Conagen is the world's first and only biotechnology company commercialising a sustainable Tyrian purple by fermentation. As with any biologically-sourced textile dye, this colour-fast compound reduces pollution and carbon footprint when used as an alternative to petrochemically synthesized dyes commonly used in the textiles industry these days.

Also known as Phoenician purple, royal purple, imperial purple or imperial dye, Tyrian dates back several millennia to the bronze age when the Phoenicians from Tyre on the Levantine coast produced it for the ancient

DyStar announces leadership changes

DyStar, a leading speciality chemical company with a heritage of more than a century in product development and innovation, has announced its key leadership changes to Global Management with immediate effect.

Yalin Xu (left) and Eric Hopmann

Yalin Xu has been appointed Managing Director and President of DyStar Group by the Board of Directors. He will be directly responsible for the management and operations of DyStar Group. Mr Xu first joined DyStar in 2010 and has since been the Executive Board Director.

Eric Hopmann has been redesignated as CCO (Chief Commercial Officer), with a focus on Sales and Marketing of DyStar Group. He will continue to report to Yalin Xu. Mr Hopmann was with DyStar when the company started in 1995 and has been leading various leadership positions at DyStar Group, including the most recent CEO role, to which he was appointed in 2014.

DyStar's leadership change is in response to the rapid global market changes, and more importantly, to enable the group to accelerate growth and drive productivity. The change will enable DyStar Group to streamline its operations and better utilise its resources efficiently across its network.

DyStar remains committed to delivering sustainable products and solutions to its customers and supply chains.

Greeks, Persians, Byzantines and Romans to clad emperors and kings with luxury textiles. Tyrian purple was once worth more than its weight in gold for its prized deep rich purple. During the Roman Empire, one pound of Tyrian purple dye was priced at approximately three Troy pounds of gold - roughly US$ 66,000 in today's currency.

Current producers extract and harvest Tyrian purple from the murex shellfish in much the same way as the ancient Phoenicians. Approximately 10,000 of these predatory sea snails (54 kg) are required to make a single gram of the dye, making it impracticable, expensive and environmentally unfriendly. Ancient dye producers all but drove the murex species to extinction along the coasts of Phoenicia - evident in the vast deposits of the shells excavated on the outskirts of Sidon, Tyre, and across the Mediterranean.

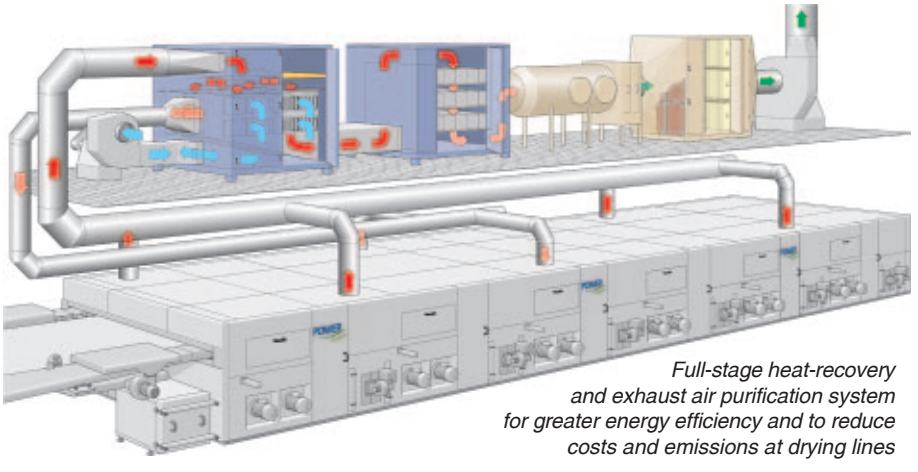
'Conagen is democratising the exclusive use of a colour once reserved for royalty and now obtainable on a global scale,' said Casey Lippmeier, senior vice president, Innovation, Conagen. 'Our fermentation and bioconversion technologies enable us to offer true-to-nature products. By leveraging our bioengineering and commercial manufacturing capabilities, we are unlocking Tyrian purple's great potential as an accessible and sustainable dye.'

Reducing energy consumption and purifying exhaust air on textile finishing machines

Due to rapidly rising energy costs or even supply bottlenecks, energy consumption is more in focus today than ever before. Finishing gives textiles dimensional stability and functions, but this requires a relatively high proportion of primary energy compared to the overall manufacturing process. Due to legal requirements, e.g. German TA-Luft regulations, it is necessary to clean the exhaust air of the drying lines.

In order to increase the energy efficiency of lines, heat recovery systems have to be used in addition. These use the exhaust air heat of the production lines for heating fresh air or water. For this purpose, BRÜCKNER has proven and highly efficient ECO-HEAT lines in its program.

The first line stage is usually an ECO-HEAT heat-recovery system air/air. Here, by means of plate or tube heat exchangers, the exhaust air heat is indirectly transferred to the cold fresh air which is then fed back into the drying process. This increases the drying capacity and reduces energy consumption. Of course, ambient air can also be heated with this system,



Full-stage heat-recovery and exhaust air purification system for greater energy efficiency and to reduce costs and emissions at drying lines

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ECO-HEAT air/air


ECO-HEAT air/water

especially in colder countries, thus relieving the building heating system.

An ECO-HEAT heat-recovery system air/water is often used as a second stage. The exhaust air heat is transferred to water through heat exchangers. The heated water is then used in other textile processes or to heat buildings, thus reducing energy requirements elsewhere. Through heat-recovery, the exhaust air from a drying line, which is contaminated with spinning oils, kerosenes, avivages or chemicals, is already cooled down considerably, causing the pollutant particles to condense on the heat exchangers and be separated out. Over time, however, deposits form on the heat exchangers. Integrated steam cleaning, while not 100% clean, keeps the heat exchangers operational for an extended period of time.

Every few weeks, the handy heat exchanger modules can simply be removed for cleaning and replaced with clean replacement modules. The dirty modules can be cleaned easily and efficiently in an ultrasonic cleaning bath. Afterwards, the cleaned heat exchanger modules can be used again immediately.

If in addition to the heat-recovery an exhaust air purification is of interest, BRÜCKNER offers with its ECO-AIR products a modular system for the compliance with existing exhaust air regulations. Here, the second or third system stage after the ECO-HEAT heat-recovery can be an ECO-AIR exhaust air scrubber which


ECO-AIR test unit for exhaust air purification

cools down the exhaust air further and binds oil-containing pollutants in its closed water circuit. Due to the sophisticated design of the exhaust air scrubber, very little wastewater is produced. The oily substances separated from the exhaust air are separated from the water by an oil skimmer and disposed of separately. After this, an ECO-AIR electrostatic precipitator can ensure that even the finest aerosols are separated from the exhaust air after the exhaust air scrubber. This also causes the visible smoke above the outside chimney to disappear and the exhaust air odour to be reduced to a minimum.

If this is still not sufficient for some special processes, an additional bio-filter can be installed downstream. This is a simple and cost-effective method of cleaning exhaust air containing odorous substances and VOCs. Microorganisms on carrier material in special biofilter containers convert organic contaminants into carbon dioxide with the aid of oxygen. In addition, organic molecule chains can be broken down in a UV light reactor by intensive UV light irradiation of the exhaust air, and oxygen can be converted into active ozone. In this way, as in the bio-filter, odours and VOC concentration in the exhaust air can be minimized.

With this methodology, it is possible to test in advance how the exhaust air behaves with regard to possible separation effects and whether the prescribed exhaust air limits can also be complied with. With such a modern, multi-stage heat recovery and exhaust air purification system, a very high energy efficiency is achieved, since a large part of the exhaust air heat or exhaust air energy can be recovered. Moreover, thanks to BRÜCKNER's ECO-AIR exhaust air cleaning system, the exhaust air is effectively cleaned. These systems can also be retrofitted to third-party lines and contribute to a more sustainable and resource-saving production.

Heimtextil 2023 sets the course for sustainable transformation

Heimtextil 2023 ended with concentrated intercontinental strength and set the course for a successful

trade fair year. 44,000 buyers took advantage of the opportunity to participate in the global market for home and contract textiles and to gain a bundled overview of global textile innovations - from fibres, yarns, upholstery and decorative fabrics, functional textiles, outdoor fabrics, artificial leather and wallpapers to bed and bathroom textiles, mattresses, sleep systems, curtains and decorative cushions. The top ten exhibiting countries were China, India, Turkey, Pakistan, Italy, Germany, Spain, Portugal, France and Great Britain. The top visitor countries included Germany, Italy, Turkey, US, Great Britain, France, the Netherlands, Spain, Pakistan, India and Greece.

'Heimtextil made a powerful return to January 2023 and set all the signs for success as a barometer for the trade fair business year - with an outstanding degree of internationalization of 129 participating nations,' said Detlef Braun, member of the Executive Board of Messe Frankfurt. Compared to 2020, the leading trade fair for home and contract textiles achieved an increase in the degree of internationalisation - in terms of exhibitors to 94% and in terms of visitors to 82%. There was growth on the exhibitor side as compared to the pre-pandemic edition from Turkey and Pakistan. In 2023, there were also more buyers from Italy, Turkey, Spain and especially Greece.

Finally, a return to new global contacts, networking and ordering: personal encounters were at the heart of Heimtextil 2023 and celebrated in full exhibition halls. This was also reflected in the active ordering of the visitors.

According to representative surveys, 80% of exhibitors had already achieved their trade show goals by the third day. Satisfaction with visitor quality was also very high: 72% of visitors were top decision-makers. In addition to the diverse range of high-quality volume business from Asian exhibitor nations, the focus was also on European design and retail volumes - a mix that resulted in particularly high visitor satisfaction: 92% of buyers achieved their trade show goals.

Heimtextil Trend Space

Innovative material developments from natural raw materials such as mushrooms, plant fibres or recycled waste products provide impulses for the future of home textiles. This was clearly demonstrated by the 'Future Materials Library' at Heimtextil. But also to the present applies: the majority of the global textile industry has long since set out on the path to sustainably redesigning manufacturing processes and forming strong partnerships and measures for transparent supply chains. To this end, Heimtextil exhibitors offered products, solutions or suggestions at many booths.

The opportunity for personal exchange, inspiration and more know-how was offered by an extensive and multifaceted supporting program. This included guided tours at the trade show, high-profile lectures, events and special themed areas.

With trade fair visitors' significantly increased demand for sustainable products and solutions, the need for more transparency is also growing. This was evident, for example, in the Green Village, where interested visitors met label providers, certifiers and companies that have made an integral commitment to sustainability.

In the Green Lectures on the stage of the Green Village, certifiers, industry experts and NGOs spoke about solutions, best practices and challenges around sustainability in the contract business. The Green Tours led interested trade visitors to selected exhibitors and their sustainable product solutions.

In the new area for fibres and yarns, Heimtextil met the growing demand for textile materials for preliminary stages. For the first time, visitors found a global range of fibres and yarns for decorative and upholstery fabrics compactly arranged. This was supplemented by exhibitors with outdoor fabrics as well as imitation leather.

New method can break down 95% of toxic 'forever chemicals' in water

Scientists have discovered a new way to break apart 'forever chemicals', the notoriously stubborn pollutants that contaminate the waterways and threaten public health, contributing to a growing list of potential methods of dealing with the long-lived compounds.

News of a simple, low-energy way to degrade some, but not all, forever chemicals came in August 2022 from researchers at Northwestern University who described how these tightly bonded, long-chain synthetic

Oerlikon expands service offering for customers

The American subsidiary of the Swiss Oerlikon Group, Oerlikon Textile Inc, is expanding and moving into new, modern premises tailored to future needs just a few km away from its previous location in Charlotte, North Carolina, US. A new service centre for the polymer processing industry will be created latest by the middle of this year.

At the new address, synergy effects and resources can be used to a noticeably greater extent for the benefit of all Oerlikon customers in approximately 4500 m² of office and commercial space.

'We are the preferred technology partner in the field of man-made fibre production in the US and not only want to remain so, but also to further expand our services for our customers. However, the previous premises no longer offered any opportunities for expansion,' explains Chip Hartzog, President of Oerlikon Textile Inc.

All processes were analyzed in advance and will now be optimized in the new buildings. Incoming goods, warehouse and dispatch will be merged; inventory control will be strengthened. On top, the range of services in the repair area will be expanded. 'In addition to our services in the area of filament and carpet yarn systems, we will also be able to offer our customers repair services for staple fibre components such as crimpers or nonwoven systems in the future,' says Chip Hartzog. This will further strengthen the market position for the Oerlikon Barmag, Oerlikon Neumag and Oerlikon Nonwoven brands.

Still in full swing: the relocation of the commercial departments of Oerlikon Textile Inc has already been completed, so that the customer support can already be provided at the new location in Charlotte, North Carolina. The mechanical repair workshop and the electronic repair workshop will follow in the coming months.

Oerlikon Textile Inc has been active in the manmade fibres business in the US for over 55 years. In addition to the sale of staple fibre, BCF, IDY, POY, FDY and texturing plants, the product portfolio also includes upgrades and modernization of old plants, service and training offers as well as repair services and spare parts supplies.

chemicals, once thought impossible to degrade without a great deal of energy, 'fell apart' under unexpectedly mild conditions.

Now, a team of scientists at University of California (UC), Riverside, US, have reported an alternative method for supercharging the destruction of PFAS chemicals in water. It uses UV light and hydrogen gas to break down these harmful substances found in drinking supplies.

'The advantage of this technology is that it is very sustainable,' says Haizhou Liu, a chemical and environmental engineer at UC Riverside, and senior researcher on the team who developed the new patent-pending process which does not generate any undesirable byproducts.

The new process works by bubbling hydrogen gas through contaminated water to ionize the water molecules. This generates reactive species including hydrated electrons that then attack the strong bonds holding PFAS chemicals together. Blasting the water with high-energy, short-wavelength UV light also helps speed up these chemical reactions that have otherwise been too slow to be useful in industrial settings.

So far, the researchers have only tested their method on small volumes (500 ml or 17 fluid ounces) of tap water spiked with PFOA and PFOS, two types of forever chemicals. But they have achieved fast and near-complete degradation of the pollutants in these test batches using less electrical energy than the earlier attempts.

The double-whammy of hydrogen gas and UV light degraded 95% of PFOA and PFOS chemicals within 45 min of water treatment, and upto 97% overall. But the method still needs some optimizing because, even at barely detectable levels, PFAS chemicals are dangerous.

'We are optimizing it by trying to make this technology versatile for a wide range of PFAS-contaminated source waters,' Liu says. 'The technology has shown very promising results in the destruction of PFAS in both, drinking water and different types of industrial wastewater.'

ITMA 2023 exhibition space fully booked

The stage is set for ITMA 2023 to host a highly anticipated showcase of trendsetting textile and garment technologies when it opens in Milan on 8 June 2023. Exhibition space grossing 220,000 m² of the Fiera Milano Rho exhibition centre is fully booked.

Mr Charles Beauduin, Chairman of ITMA Services, said: 'Since the last ITMA exhibition in Barcelona in 2019, the world has changed drastically due to the coronavirus pandemic and geopolitical situation. Despite various disruptions, we are glad that space in ITMA 2023 is

fully booked. Companies are buoyant about the outlook of the market with most borders now fully open.'

The upcoming exhibition will feature over 1,600 exhibitors from 44 countries and a list of 100 companies are still waiting to be allocated space in their preferred sectors. There is a total of 20 product sectors covering

the entire textile and garment manufacturing value chain, including textile composites.

Mr Ernesto Maurer, President of CEMATEX, said: 'Sustainability is no longer just a buzzword; the industry has to move faster to adopt the sustainability agenda to secure the future of their business. During the pandemic, many of our members channelled their resources into R&D activities. ITMA 2023 is perfectly timed to offer our exhibitors an opportunity to showcase these new products and cutting-edge technology. If and when R&D is paired with sustainability efforts, this will be the formula for success.'

'Our visitors can look forward to ITMA 2023 to preview the latest innovation. We hope that textile and garment manufacturers, brands and retailers will take this opportunity to meet at ITMA to source and collaborate with leading members of the textile industry. In addition, they can also gain insights into industry trends and developments at various complementary events.'

ITMA 2023 will be accompanied by several activities spotlighting industry innovation. Among the highlights is the Innovator Xchange which offers participants unique opportunities to gain insights from the winners and finalists of the ITMA Award, as well as exhibitors and industry experts.

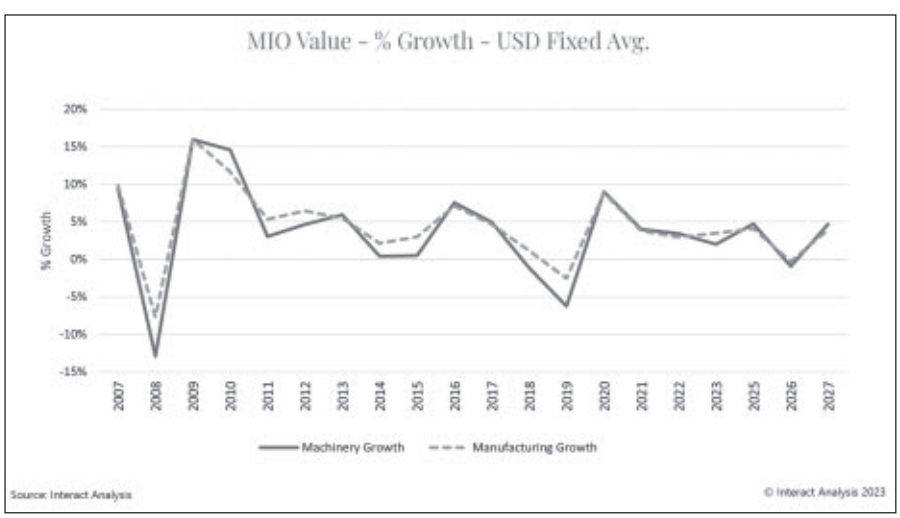
The Innovator Xchange will be held from 9 to 13 June 2023. Other highlights held alongside ITMA 2023, are the ITMA Sustainable Innovation Award, Innovation Video Showcase, ITMA forums and partner events. Online ITMA 2023 visitor registration is open. Visitors can enjoy early bird badge rates until 7 May 2023 when they register online. With the badge, they will be able to access the ITMAconnect platform from 8 March 2023 to plan their exhibition visit. Visitors can explore exhibitors' digital spaces, chat and make appointments for stand visits.

Global manufacturing industry growth reaches 3.8%

Updated research by Interact Analysis shows that the Asia Pacific (APAC), Europe and US have performed very differently in terms of manufacturing output growth during 2022. Growth in Europe has been slow throughout the year, while it has been strong in the US, and steady in APAC. Machinery sectors have performed better than the manufacturing sector overall and, despite current challenges, the next global downturn for manufacturing is not expected until late 2025 or early 2026.

Regionally, the US manufacturing industry has performed strongly; the US growth rate hit 6.9% in 2022, as compared to 3.3% for Asia Pacific and 2.6% for Europe. However, due to economic weaknesses across the regions, the US region is only forecast growth of 3.1% in 2023. Despite ongoing supply chain issues and inflationary pressures, it is expected that overall global manufacturing industry output growth reached 3.8% in 2022.

The UK and Germany are suffering a particularly bad economic period due to Germany's reliance on Russian energy and the UK's current political turbulence. Germany also strongly relies on other countries for its exports that are experiencing similar difficulties. Despite this, some sectors are still performing well in Germany, including forming machinery, where order intake grew by 7% in 2022 due to strong export demand. Overall, German growth was slow, sitting at around 0.2% for 2022, while in the UK, the situation is similarly gloomy.



The next manufacturing downturn is expected in 2026, but to a lesser extent than in 2020.

For the second year, manufacturing production has shrunk by around 0.5%, forcing the UK into a negative forecast for 2022. Many smaller regions had propped up Europe in terms of the region's overall performance.

In contrast, the outlook for China remains positive, with 2023 to 2025 anticipated to be a period of growth and recovery for the country. As a result of further covid lockdowns, manufacturing output weakened, with growth contracting to 2.9% in 2022. The predicted recessions across the US and Europe are expected to slow growth again in 2026, falling to similar rates to those seen in 2020 when the pandemic struck. In China, the highest growth rates in 2022 were seen in the chemicals and pharmaceuticals industry, which grew by 4.9%.

Cinte Techtextil China 2023 set for September

With China easing its pandemic restrictions, foreign exhibitors and buyers can look forward to quarantine-free travel when participating at this year's industry showcase in Shanghai. The technical textile and nonwovens fair is scheduled to take place from 19 - 21 September 2023 at the Shanghai New International Expo Centre, amid positive market forecasts for both sectors. The organisers are anticipating a strong showing and the conclusion of an inconsistent period for in-person textile business.

The global technical textile and nonwovens markets are both set to perform strongly over the next few years. According to Grand View Research, the technical textile market

is forecast to expand at a CAGR of 4.7% from 2022 to 2030. The nonwoven fabrics market is anticipated to display an even stronger CAGR of 5.6% during the same period, with Asia-Pacific to maintain its position as the biggest regional market.

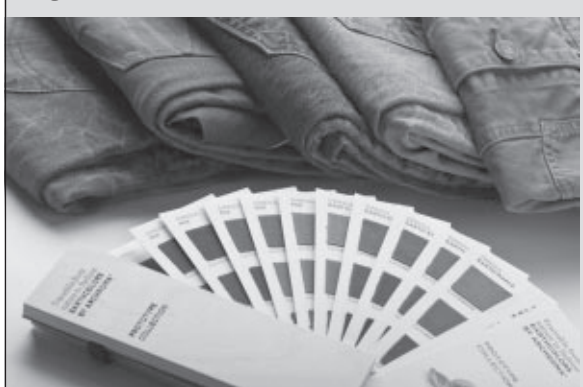
As one of Asia's leading trade fairs for the above mentioned sectors, Cinte Techtextil China is the preferred platform for multiple industry players.

The fair's product categories cover 12 application areas, which comprehensively span a full range of potential uses in modern technical textiles and nonwovens. These categories also cover the entire industry, from upstream technology and raw materials providers to finished fabrics, chemicals and other solutions. This scope of product groups and application areas ensures that the fair is an effective business platform for the entire industry.

Archroma awarded Ecovadis Platinum rating for second consecutive year

Archroma, a global leader in speciality chemicals towards sustainable solutions, recently announced the renewal of its EcoVadis 'Platinum' status and further improvement of its overall rating.

Following an in-depth assessment by EcoVadis, covering 21 criteria grouped into 4 themes - Environment, Labour & Human Rights, Ethics, and Sustainable Procurement - Archroma further improved its score by 4 points (from 78/100 to 82/100), thanks in particular to its ongoing efforts in sustainable procurement, focusing on supply chain transparency and best practice sharing with suppliers and industry peers.



More details on Archroma's sustainable sourcing activities can be found in the company's Sustainability Report for its fiscal year 2022, released on 8 December 2022 which includes an assurance report by KPMG, who conducted a limited assurance on several core ESG metrics, including CO_2 emissions, water intake, occupational safety and gender diversity. Archroma passed the audit successfully, providing yet another third-party validation of the company's deep commitment to its ESG objectives and roadmap.

'Our purpose is to lead our industry towards a more sustainable future for our customers and markets, and we are doing everything we can at Archroma to deliver on that ambition', comments Danielle Blomert, Archroma's Chief Sustainability Officer.

Daniel Madueno, Global Head of Quality Management adds: 'We see sustainability as a true team effort, and the renewed EcoVadis recognition as a tribute to the hard work and ambition of all my colleagues to achieve and maintain the highest ESG standards every day, everywhere.'

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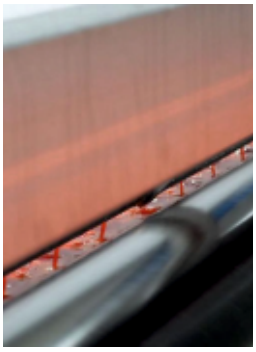

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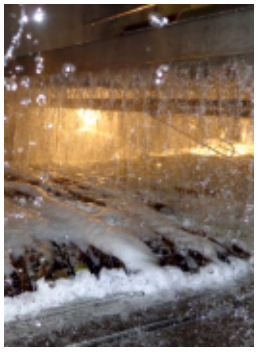

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The fair is organised by Messe Frankfurt (HK) Ltd; the Sub-Council of Textile Industry, CCPIT; and the China Nonwovens & Industrial Textiles Association (CNITA).

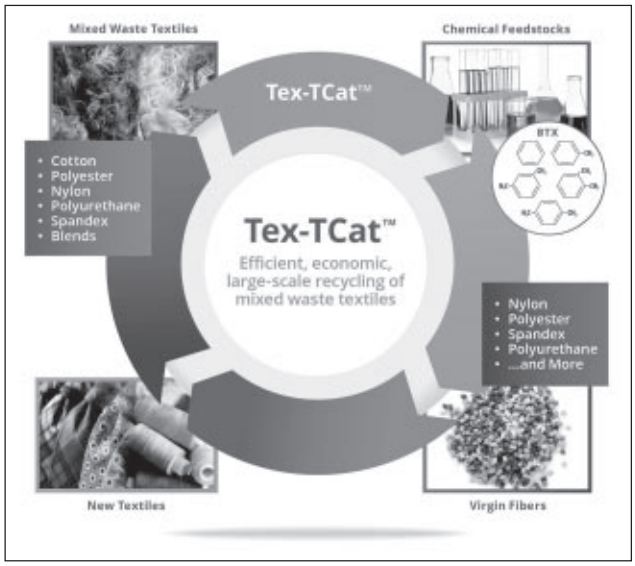
Efficient recycling technology for mixed waste textiles

Anellotech plans to begin advanced lab testing and scale-up for Tex-TCat, an innovative recycling solution to the growing problem of textile waste. Tex-TCat fluid bed catalytic pyrolysis technology is the first that efficiently recycles mixed waste textiles directly into the same chemical feedstocks (including benzene, toluene and xylenes) that are used today to make virgin synthetics like polyester and nylon - providing a closed-loop, fibre-to-fibre solution to today's textile recycling problems.

Tex-TCat delivers a direct pathway from mixed textile waste to secondary materials (BTX) instead of intermediates like pyrolysis oil. The technology involves no incineration or burning of waste feedstock. Lab-scale studies have demonstrated that Tex-TCat can process a variety of common textile materials that are incinerated or landfilled today - including cotton, polyester, nylon, elastane, acrylic and polyurethane as well as blends of these and other commonly used textile materials.

The fashion industry produces 100 billion garments each year. Although the call for circular fashion is increasingly urgent, 92 million tonnes of waste still end up in landfills. This waste is due to the lack of commercially viable recycling technologies for low-quality and mixed textiles as well as textile blends. While garments like 100% cotton or polyester are recyclable with legacy technologies, Tex-TCat is a recycling solution that complements mono-fibre garments as well as all non-recyclable blends and functional textiles.

'Tex-TCat has the potential to divert large quantities of previously unrecyclable textiles from landfills and provide major brands, through their existing suppliers, with recycled



content,' says David Sudolsky, president and CEO of Anellotech. 'The technology promises to be a key enabler of the textile industry's work to become more sustainable.'

ACIMIT introduces certification for textile machinery manufacturers

On the road to digital transformation, ACIMIT, the Association of Italian Textile Machinery Manufacturers, is introducing Digital Ready certification specifically for its textile machinery manufacturers.

The certification is designed to simplify the production process, making use of a standard language and unique data reading system that allows different types of machinery to dialogue with production systems. The certification aims to build customer loyalty, while establishing a virtuous link between textile machinery manufacturers and their customers.

It has been developed in partnership with the Manufacturing Group at Politecnico, Milan, Italy to provide standardisation of the machine's management and production data and simplify use.

The international certification body RINA, a long-standing ACIMIT partner, is authorised to issue the certification to associated member companies. A company intending to obtain Digital Ready certification for its machinery is required to abide by a framework that includes identification of the machine and collection of data, an analysis of all documents, on-the-spot audits and verifications by RINA.

The Digital Ready itinerary implemented for a manufacturer's specific machine will lead to the obtainment of certification valid for all machinery of the same production type, for which there will be no need to replicate the procedure. The certification has a duration of 5 years.

'For the textile sector, digital transformation involves achieving a complex balance between modernisation and technological advancement, while maintaining a focus on the creativity and craftsmanship that remains crucial to securing success in the international arena,' says ACIMIT president, Alessandro Zucchi.

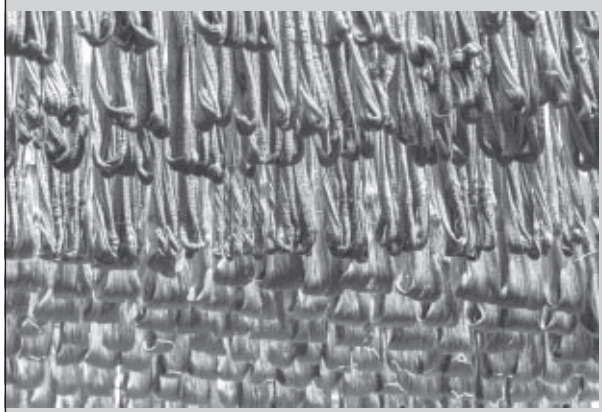
BASF division announces sustainability roadmap and expands portfolio

BASF's Monomers division has announced an ambitious sustainability roadmap: it will expand its portfolio of products with a lower CO_2 footprint and is committed to providing a circular option in every major product line by 2025. At the same time, the division will continue to prioritize technical optimization measures to cut CO_2 emissions from operations.

'As a commodity business at the heart of chemical production, we have the potential to significantly drive the sustainable transformation of both, BASF and the various customer industries that we serve,' said Dr

Life cycle assessment reinforces the need for recycling

A new life-cycle assessment (LCA) commissioned by the European textile reuse and recycling industry has confirmed significant CO_2 and water savings of reusing textiles compared to producing new clothing. The environmental impact of reusing textiles is 70 times lower even when accounting for global exports for reuse, including transport emissions.



More specifically, the study reveals that a significant 3 kg of CO_2 is saved for each high/medium-quality item of clothing that is reused, while only a mere 0.01% of the water used to produce new clothing is required for reuse. These results come on the back of the EU launching its Strategy for Sustainable Textiles conducted recently and requirements for member states to start collecting textiles separately by 2025.

While the study confirms waste hierarchy assumptions on the environmental benefits of reuse over recycling, in the case of low-quality clothing, typically entirely composed of polyester, recycling also has comparative environmental benefits when consumers are less likely to purchase second-hand clothing.

The study also makes recommendations to policy-makers, calling for initiatives that accelerate investments in state-of-the-art textile recycling facilities globally. In particular, innovation in fibre-to-fibre recycling will be key to keeping textile fibres in the loop as volumes of non-reusable clothing are set to dramatically increase. The study also notes the importance of eco-design criteria that enhance the lifespan of clothing before the need for recycling, as well as rules that mandate detailed sorting of high/medium-quality and low-quality textiles.

Ramkumar Dhruva, president, Monomers division at BASF. The Monomers division supplies key industries from food packaging, textiles, automotive or construction to wood binders and many others with base chemicals. The new divisional sustainability roadmap is an essential part of BASF's journey towards climate neutrality and net zero CO_2 emissions by 2050.

'We understand sustainability as the decisive factor for future business success and are committed to providing our customers with the right solutions to help them reach their individual sustainability goals,' he said.

Net zero greenhouse gas emission targets demand a new level of carbon transparency. The product carbon footprint (PCF) is therefore becoming a differentiating factor, even for commoditized products. BASF's Monomers division is pioneering a certified low-PCF option in all of its product lines by applying the company's mass balance approach. Examples are Lupranat ZERO, an MDI based on attributed renewable raw materials that has a PCF of zero, and Ultramid Ccycled, an innovative material for the textile industry for which chemically recycled feedstock from end-of-life tires is used in production and attributed via a certified mass balance approach. The division has major sites and more than 200 products already RedCert[2] or ISCC+ certified. It aims to have additional sites certified in all regions by the end of 2023 and will continue to expand its portfolio of certified mass balanced products for its customers worldwide.

Fiery announces independence following separation from EFI

Fiery, which provides leading Digital Front End (DFE) technology for production and industrial printing, announced recently that it has been separated from Electronics For Imaging, Inc ('EFI') and established as a separate company that will operate independently while remaining owned by EFI's owner, Siris Capital Group LLC.

Toby Weiss, long-time Chief Operating Officer and General Manager of Fiery, will continue to lead the business as CEO of Fiery, with Jeff Jacobson serving as Executive Chairman of Fiery in addition to his role as Executive Chairman of EFI.

'This realignment best positions Fiery, the leading global DFE provider, to accelerate investment and win in its current markets, while also

strategically expanding its footprint into key adjacencies - as exemplified by Fiery's recent acquisition of CADlink Technology Corporation,' said Mr Jacobson. 'I have always believed that digital imaging would not be where it is today without Fiery, and its separation from EFI will allow it to best serve customers in the DFE market.'

'Fiery solutions have always been about enabling digital print and making print engines better, and this is a milestone in furthering that mission,' said Mr Weiss. 'Fiery OEM partners will benefit knowing that they are working with a company that is completely focused on adding value to their print platforms with world-class colour management, high-performance image processing and automated workflows.

'Fiery will remain focused on working closely with its OEM partners, including the EFI Inkjet business, to continue developing cutting-edge technology that drives the next generation of automation, accuracy, and profit potential in digital printing,' Mr Weiss continued. 'Fiery now has a greater ability to serve as a neutral partner to ensure that OEMs capture success within digital print. We look forward to accelerating our investment as a standalone company, while driving our expanding product portfolio, incorporating world-class colour algorithms, and developing advanced cloud technology.'

FiltXPO to connect global companies with key decision makers

Global leading companies from more than 15 countries in the filtration and separation industry will connect with some 1,500 industry professionals and launch their innovations at FiltXPO October 10-12, 2023, at Chicago, Illinois, US. Exhibitors will connect with industry decision-makers, discover unparalleled new partnerships, and highlight their capabilities over three power-packed days.

FiltXPO, North America's only exhibition and conference dedicated exclusively to filtration and separation, is now being held on an 18-month cycle, making it an especially valuable opportunity to generate new business and grow global relationships with unique exposure to the North American market, according to INDA.

FiltXPO will draw senior-level professionals from around the world in major market segments involved in the design, manufacture, sales, and use of filtration/separation products and services.

A significant feature of the event will be the technical conference - Summit for Global Change. Five panels of global industry experts will debate filtration and separation's most compelling challenges such as indoor air quality, filtration sustainability, standards and technologies. FiltXPO will also offer a one-and-a-half day intensive training course on the development, testing and application of filtration and separation media.

Coating that prevents shedding of microplastics

When clothes made from synthetic fabrics go in the washing machine, the friction caused by cleaning cycles produces tiny tears that cause microplastic fibres - measuring less than 500 µm in length - to break off and make their way down laundry drains to enter waterways, where the particles can be difficult to remove and take decades or more to fully break down. A team of researchers at the University of Toronto, Canada have designed a solution to reduce the amount of microplastic fibres shed when washing synthetic fabrics.

A two-layer coating has been created made of polydimethylsiloxane (PDMS) brushes, which are linear, single polymer chains grown from a substrate to form a nanoscale surface layer. More than two-thirds of clothes are now made from synthetic fabrics, such as polyamide (PA), polyester (PET), acrylic and rayon. Experiments conducted by the researchers showed that this coating can significantly reduce microfibre shedding of PA clothing after repeated laundering.

One of the biggest challenges the researchers faced during their study was ensuring the PDMS brushes stayed on the fabric. Therefore, a molecular primer was developed based on the understanding of fabric dyes; the type of bonding responsible for keeping dyed apparel colourful after repeated washes works for the PDMS coating as well. Neither the primer nor the PDMS brushes work separately to decrease the microplastic-fibre shedding. But together, they created a strong finish that reduced the release of microfibres by more than 90% after 9 washes.

PDMS brushes are environmentally friendly because they are not derived from petroleum. With the addition of the primer, the coating is robust enough to remain on the garment and continue to reduce microfibre shedding over time.

Since PDMS is naturally a water-repellent material, the researchers are currently working on making the coating hydrophilic so that coated fabrics will be better able to wick away sweat. The team has also expanded the research to look beyond PA fabrics, including PET and synthetic-fabric blends.

Climate impact mapping of Swedish textile machinery

Over the past year, TMAS, the Swedish Textile Machinery Association, has been working with ClimatePartner on a corporate carbon footprint (CCF) mapping project with its member companies, as a natural step towards supporting a more sustainable textile industry.

Over half of the members of TMAS are participating in the project, which involves calculating each operation's Scope 1, 2 and 3 emissions in order to identify the current climate impact and areas where reductions can be made.

Each company is very different in terms of size, structure and operations, but all share common goals

'Integrating climate action into strategies is becoming increasingly important in Europe and we have decided to take a pro-active role,' says TMAS secretary general Therese Premler-Andersson. 'There is growing pressure from customers to be more transparant in this area and forth-coming legislation will soon make it necessary for all to take climate actions. TMAS members, however, recognise the benefit of taking action now, not least in terms of taking responsibility and demonstrating credibility.'

'Each company is very different in terms of size, structure and operations, but they share common goals in the design and production of textile machinery that is flexible and highly automated and, wherever possible, enables savings in energy, water and chemicals consumption,' says Premler-Andersson. 'The textile industry has become highly globalised over many decades and will benefit greatly from the close examination of practices and supply chains.'

The ClimatePartner measurement programme is based on the guidelines


Therese Premler-Andersson

of the Greenhouse Gas Protocol Corporate Accounting and Reporting Standard (GHG Protocol), and factors in all greenhouse gases covered by the Kyoto Protocol. These are carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFC), perfluorocarbons (PFC), sulphur hexafluoride (SF_6) and nitrogen trifluoride (NF_3).

Each of these gases affect the atmosphere differently and remain in the atmosphere for different lengths of time. Rather than reporting on each gas separately, they are expressed as a CO_2 equivalent (CO_2e) for the sake of simplicity. A CO_2e is essentially a conversion into a 'global warming potential' value that enables the influence of different gases on global warming to be compared.

The Textile Machinery Association of Sweden (TMAS) comprises the leading Swedish companies with textile technology, automation and production processes. The expertise of

Microelectronic fibres monitor health

Smart fabrics allow for the seamless integration of electronics, optics, biosensors, and mechanics into a thin strand of fibre that is intrinsically flexible and as thin as a human hair. These fabrics can then be used to monitor vital physiological signals related to our mental and physical health status.

A team of researchers from Tohoku University's Frontier Research Institute for Interdisciplinary Sciences, Sendai, Japan, has developed a microelectronic fibre with microscopic parameters that is capable of analyzing electrolytes and metabolites in sweat. Its micrometer (μm) scale allows it to be woven into clothes for healthcare applications.

To produce the fibre, the thermal drawing process was used, where heat is applied to draw out micro-structured fibre from its macroscopic preform. Two sensing electrodes for sodium and uric acid were also patterned onto the longitudinal surface of the fibre.

Although mainstream photolithography and printing technology have enabled wearable electronics, doing so often entails attaching relatively rigid electronic patches to existing fabrics or directly on the skin, leading to only a small area of the body being covered. Since most developments so far could not be considered as clothes, efforts were devoted to transforming fibre, to make truly wearable smart fabric. The fibre could lead to smart clothes that provide greater versatility in functions, larger sensing areas, and greater comfort.

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Long-term localisation pays off for Löffler and Svegea

Sports and knitwear specialist Löffler is celebrating its 50th anniversary in 2023 and its long-held belief in retaining manufacturing in Austria by investing both, in its people and the latest advanced technologies at its plant in Ried, is now paying dividends. The plant houses 25 circular knitting machines and three seamless knitting machines with an annual output of around 905,000 m^2 of fabric. In addition to product development, design, cutting and some sewing are all carried out in-house.

Löffler Plant Manager Arnold Bowier at the control of the FA350 automatic roll slitter

'Löffler is part of the family company Fischer Holding, and Ried is the hometown of its owner Josef Fischer, who has been dedicated to maintaining manufacturing here,' says Löffler plant manager, Arnold Bowier. 'While many competitors have outsourced their production to the far east in recent decades, we chose a different path. In addition to increasing sales, this strategy has reinforced the cohesion of our employees and our relationships with key partners. Due to steadily increasing sales, we have been forced to find local partners within Europe, but our core activities and 70% of all fabrics produced come from the Ried plant. Now we see many competing companies reconsidering where they site their main manufacturing operations.'

Bowier and his team built up a strong relationship with Svegea's technicians during the installation and commissioning of the new machines.

'The machines were delivered directly from Sweden and prepared and adjusted perfectly,' Bowier says. 'Because covid restrictions were still in place during the commissioning phase of the roll slitter, installation training was carried out remotely.'

Svegea's EC 300-S collarette cutter is equipped with the computer-controlled True-Drive II and high prefeed device, and is used by garment manufacturers around the world for the production of tubular apparel components such as cuff and neck tapes and other seam reinforcements. It operates at speeds of upto 20,000 m/hr. The integrated, fully automatic FA350 roll slitter FA500 roll slitter is equipped with three separately adjustable settings, enabling three different band widths to be cut within the same cutting cycle. Automatic tube sewing units are provided for sewn tubes in optional rolled or flat folded forms, depending on the customer preference.

'Advances in automation continue to make the specialised, bespoke machines we engineer more efficient,' says Svegea MD Håkan Steene. 'The garment components our collarette cutters produce make it logical for them to be integrated into a company's making-up operations and, at the moment, we see a lot of interest in the reshoring of operations by our customers, to bring final-stage manufacturing closer to the key European or US markets.'

its members ranges from advanced systems for yarn fault detection and tension monitoring, to yarn feeding technology for weaving, automated sewing production lines, cutting machines, embroidery technology, effective material handling systems, spray application system for fabric finishing and much more.

Solvay to relocate to new headquarters in Brussels

Solvay announces the relocation of its headquarters from Neder-over-Heembeek to new facilities in Brussels, specifically designed and equipped to host the group's Research, Innovation and administration activities. Located in the Brussels municipality of Haren, Solvay's future HQ site is equipped with large research spaces, a high-performance digital infrastructure and great accessibility, providing Solvay's employees with a future-ready, world class workplace that enhances innovation and collaboration.

'This is an exceptional opportunity for Solvay, offering a conducive environment for new ways of working, substantially enhancing our environmental impact relative to our existing location and providing a cost competitive solution lowering operating costs by two-thirds. The new site features state of the art science and research facilities as well as optimal collaboration conditions for our employees, partners and customers, where Solvay will be able to showcase its expertise and innovation. It responds to a need for reduced office spaces, following the implementation of teleworking for all administrative employees in 2020' said Ilham Kadri, CEO of Solvay. 'Most importantly, this relocation project is in line with Solvay's strategic ambitions. The availability of additional facilities in the vicinity makes the move compatible with our project to create two new companies, both headquartered in Brussels.'

The move of all administrative and research teams to Solvay's new home will be done gradually, over a

transition period of 12 months starting in April 2023. The site can hold approximately 800 employees.

OEKO-TEX new regulations 2023

Creating trust within the textile and leather industry and for its customers is the mission of OEKO-TEX. Since trust is based on consistently high quality, the OEKO-TEX Association is again publishing updates to the applicable test criteria, limit values and guidelines for its certifications. The new regulations will finally come into force in Q1 2023, after a transition period. Other introductions include integration of the BHive app from GoBlu into STeP, which will enable certified production companies to check sustainability requirements and chemical management in global supply chains. The new OEKO-TEX ORGANIC COTTON certification will verify reliable labelling of organic cotton textiles starting April 2023. In addition, OEKO-TEX has issued a general ban on the use of perfluorinated and polyfluorinated alkyl substances (PFAS/PFC) in textiles, leather and footwear for the STANDARD 100, LEATHER STANDARD and ECO PASSPORT certifications. Further changes to OEKO-TEX ECO PASSPORT certification will make the previously voluntary self-assessment mandatory for all production sites from April 2023.

The BHive app, developed by GoBlu, enables manufacturers to collect information on all chemical products used on site, via smartphone, and determine which products meet the sustainability requirements of different brands and retailers. All information is automatically recorded in a chemical inventory so that brands can directly access transparent and precise data. Starting April 2023, OEKO-TEX STeP customers can utilize this comprehensive chemical database to reduce labour, time and costs. The intelligent system also aligns compliance with recognized industry standards such as the STeP and ZDHC MRSLs.

Starting April 2023, the new OEKO-TEX ORGANIC COTTON certification will focus on reliable labelling of organic cotton textiles. 'More and more consumers prefer sustainable textiles, and demand for organic cotton is growing rapidly,' said OEKO-TEX Secretary General Georg Dieners. In addition to the qualitative DNA analysis of the sample material, a second step involves quantification - determining the proportion of genetically modified cotton in a cotton product. The aim is not only to check production, but to make the raw materials traceable through the supply chain. Georg Dieners explains: 'What's new is that

we will start checking for genetically modified cotton at the beginning of the supply chain - at the ginning stage when the cotton fibres are separated from the seed. Then we can follow the flow of goods through all stages.'

OEKO-TEX ECO PASSPORT certification has consisted of a mandatory CAS number screening and laboratory analysis. The self-assessment and the on-site visit to customers were voluntary. While the on-site visit will remain voluntary until further notice, the self-assessment will become mandatory for all customers' production sites from April 2023. All certifications issued after April 1, 2023, must be accompanied by a valid self-assessment. For existing customers, there is a possible transition period.

Chemours brings next generation refrigerants

Chemours, a global chemistry company with leading market positions in Titanium Technologies, Thermal & Specialized Solutions and Advanced Performance Materials, recently announced its roadmap for next-generation thermal management solutions. This three-horizon plan includes commercial product adoption, new blend development collaboration, and next-generation product development all of which are currently underway.

Horizon one, commercial product adoption, includes continuing the company's commitment to supporting the adoption of its current product offerings including its Opteon XL and XP series of zero ozone depletion potential (ODP), low global warming potential (GWP) refrigerants, which offer the optimal balance of performance, sustainability and cost, and are classified as none or mildly-flammable refrigerants. Horizon two is focused on collaborations with customers to identify the most promising development blends with lower-GWPs to meet the coming phase downs and to support Chemours' already robust portfolio of ultra-low GWP products such as Opteon YF.

Building upon the performance, safety and sustainability profile of its Opteon portfolio, horizon three is the investment in the development of next-generation thermal management solutions. Chemours expects this novel fluorinated technology to balance critical properties from GWP to flammability to degradation profile and performance to meet customer needs and the evolving regulatory landscape. It is the company's intention to have these innovative and sustainable solutions available for customer qualification in 2025.

'We are committed to fluorine chemistry and its power to enable world-changing technologies, and we believe that continued innovation will allow us to meet our customers' need to create highly-efficient systems that consume less energy,' said Alisha Bellezza, president of Thermal & Specialized Solutions at Chemours.

Textile industry softeners and latest developments

K H Prabhu
Senior Technologist, Dyeing & Finishing, Texcoms Textile Solutions, Singapore
prabhu@texcoms.com

A large number of consumers in the fast fashion world uses different sets of apparels and textile products for different end uses, namely nightwear, office wear, children's wear, winter or summer wear, gym wear etc. The most important and basic requirement of these garments are functional properties such as quick dry, crease resistance, antibacterial finish, aroma control etc. However, the most precisely important property is the softness of the material which often seems to be final decision of the consumer. Today, wearers give more importance to garment feel and comfort along with the aesthetic appeal. Thus, the apparel manufacturers are very careful in terms of providing a good softening finish with good durability without losing other performance properties. Overall, a 'softer feel' is a unique selling point (USP) parameter that leads to a final purchase decision[1]. On the other hand, during initial pretreatment preparation, textiles can become harsh since natural oils and waxes are removed. Finishing with softeners can overcome this deficiency and even improve on the original suppleness. For all these reasons, today softening of textiles is an important and essential finishing process.

Development of greener and ecofriendly softeners will reduce the environmental issues

Softeners

By definition, softeners are a chemical or blend of chemicals which, when applied to textile

materials, brings about a change of handle that is more pleasing to the touch, although the notion of 'pleasing to the touch' varies from person to person[2].

Softeners are predominantly used for textiles[3]:

- to apply the desired softness such as smooth, supple, super soft, elastic, dry, slushy etc
- to improve functional properties such as antistatic, hydrophilicity, elasticity, sewability, rub fastness etc
- to give natural touch and enhance the comfort properties (moisture regulation, smoothness etc) of synthetic fibre wearers.

Major requirement of textile softeners[3]

- Simple handling and stable to high temperatures; not steam volatile
- No influence on fastnesses; no colour changes
- Low foaming; shear stable; no roller deposits
- Exhaust processes - uniform and total exhaustion of application liquor
- Non-toxic to humans or to the environment and compatible with other auxiliaries
- Non-yellowing
- Dermatologically harmless
- Good biodegradability.

Chemistry

Most of the softeners consist of molecules with both, a hydrophobic and a hydrophilic characteristic. Hence, they can be alternative termed as surfactants (surface active agents). Typically, a softener contains a long alkyl group, sometimes branched, of more than 16 and upto 22 carbon atoms, but most have 18 corresponding to the stearyl residue. The main function of softener molecules, when applied fabric, is that it adds on the surface, penetrate and provide an internal plasticization of the fibre forming polymer by reducing the glass transition temperature T_g. Thus, the physical arrangement of the softener molecules on the fibre surface is important which, in turn, depends on the ionic nature of the softener molecule and the relative hydrophobicity of the fibre surface. On the basis of chemical nature, softeners are classified as cationic, anionic or non-ionic[3,4]. They are predominantly liquid dispersions with typical solid levels between 10-40%.

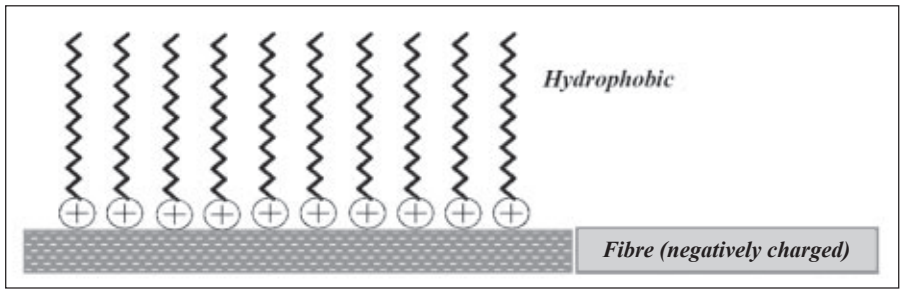

Fig 1 : Orientation of cationic softeners at textile surface

Cationic softeners

Cationic softeners are mostly widely used in the textile industry; these provide the best softness and are also reasonably durable to laundry. Cationic softeners orient themselves with their positively charged ends toward the partially negatively charged fibre (zeta potential) as shown in *Fig 1*, creating a new surface of hydrophobic carbon chains that provide the characteristic excellent softening and lubricity[4,5]. On the other hand, they are non-compatible with anionic products, cause yellowing upon high temperature exposure and, due to its ionic nature, attracts soil. The different properties and functional groups are given *in Table 1*.

Anionic softeners

Anionic softeners were the first to be employed in the textile industries. They orient outward with their anionic charged groups repelled away from the negatively charged fibre surface *(Fig 2)*. This phenomenon enables them to form a hydration layer, offering better wettability and antistatic properties, but less softness than the cationic softeners[6,7].

They are represented by the common formula $RSO_3.M$ or $ROSO_3.M$ (where R = alkyl or aryl; M = Na, K)[2]. In general, they are sulphated or sulphonated compounds, mainly used as lubricants for yarns or fibres, providing softness and pliability, stability in alkaline conditions and good resistance to yellowing. In addition, they are used as crease preventing agents in processing, sanforizing and raising, and as sizing additives. They have good compatibility for single bath application along with optical brightening agents. However, they are sensitive to metal ions present in the water and also electrolytes in the finishing bath; They are mainly applied by padding process, given their limited substantivity. They are often used for special applications, such as medical textiles, or in combination with anionic fluorescent brightening agents[8,9]. The different properties and functional groups are given *in Table 1*.

Amphoteric softeners

Amphoteric softeners represent the

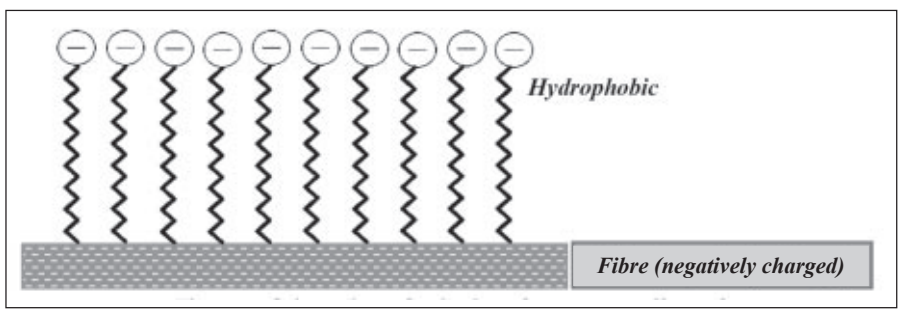

Fig 2 : Orientation of anionic softeners at textile surface

compound containing potentially anionic (carboxyl) and cationic (amine) groups within the same molecule, similar to amino acids and proteins. Typical properties are moderate softening effects, low permanence to wash and high antistatic effects because of their strong ionic character. Due to proteinic and biodegradable nature, they are recommended for white goods where antistatic and hydrophilic properties are expected[1,8,10]. The characteristics and functional groups of the amphoteric softeners are given *in Table 1*.

Non-ionic softeners

Non-ionic softeners have the general formula R(OC,H,),OH or R(C,H,),OOH (where R = alkyl) and contain different non-ionic components such as fatty alcohols, ethoxylated fatty alcohols, ethoxylated fatty amines, paraffins and oxidized polyethylene waxes as active ingredients; theoretically, they have no electric charge and, for that reason, show no significant substantivity[2,10]. They often require emulsifiers to produce stable dispersions. The non-ionic softeners chain orientation mainly depends upon the fibre surface nature; the hydrophilic portion gets attracted to hydrophilic surfaces, and the hydrophobic portion gets attracted to hydrophobic surfaces, as shown in *Fig 3*. They are applied by different methods such as padding, spray or foaming applications, or exhaust processes, namely soft flow systems, yarn dyeing devices, winches or jigs. Additionally, in some commercial products, a combination of cationic and nonionic softeners is chosen to improve the solubility at lower temperatures. They are ideal for the finishing of optically-brightened white textiles due to good stability against high temperature and have almost non-yellowing characteristics[11].

Silicone softeners

In the current scenario, silicone softeners are the most extensively employed softeners in the textile industries. Silicones are macromolecules composed of a polymer backbone with alternating silicone and oxygen atoms with organic groups attached to the silicone molecules. They are described with the general formula R_2SiO (*Fig 4*); they are often identified as being polymeric. The effect comes from the siloxane backbones, its flexibility and its freedom of rotation along with Si-O bonds.

Currently, there are five generations of silicone softeners present in the market. They are non-reactive silicone, amino modified silicone oil, polyether modified silicone oil, linear $(AB)_n$ block copolymers, and pyrogenic silicas. These softeners are supplied as aqueous emulsions, i.e. dispersing silicone oil in water using an appropriate emulsifier[12, 13]. The deposition of the softener on the fabric, the product stability and the performance of the silicone mainly depends upon the type of emulsifier, the particle size of the emulsion[14], the hydrophilicity of the polymer, the nature of the functional groups, the extent of modification and the method of emulsification[15].

Micro emulsions drop sizes are in the range of 50-150 nm; drop sizes between 150-300 nm are macro/normal emulsions. Micro emulsions provide better soft handle than normal ones, because they penetrate more inside the fibre bundle. In past decades, silicone manufacturing industries produced nano-emulsions with sizes around 10 nm; it has been determined that they impart an inner softness with a unique cool and dry handle to woven and knitted fabrics[16,17,18]. The most important organic substituents used in the commercial silicones are methyl groups, the majority of which are poly-dimethyl siloxanes. A diversity of silicone technologies applications is available in textile industry applications; these include polydimethylsiloxanes, amido, amino functional silicones, methyl hydrogen silicones, epoxy functional silicones, hydroxy functional silicones, silicone polyethers and epoxy polyether silicones[19,20]. The general functional properties of silicone softeners are given *in Table 1*. *Table 2* shows the silicone modification with different chemical groups and their properties.

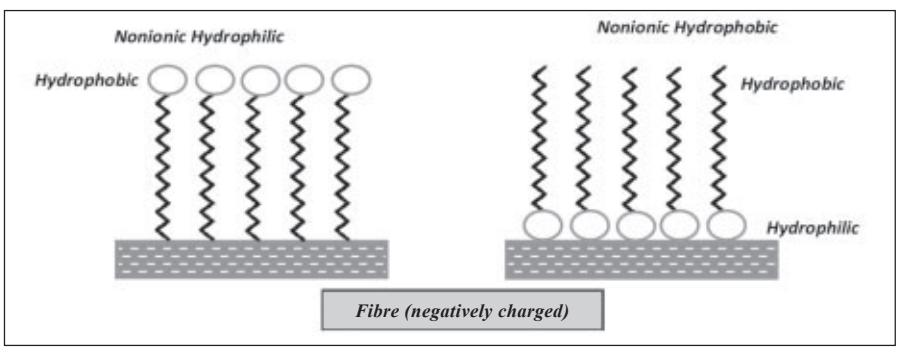

Fig 3 : Orientation of non-ionic softeners at textile surface

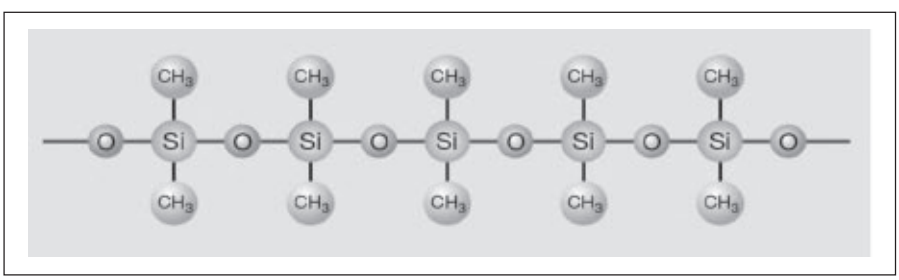

Fig 4 : Molecular structure of silicone

Fibre-dye-softener interaction

The four types of softener can be used for fibres or textile substrates that have positive or negative groups, or are largely inert, such as polyester. The dyes used may get attached to these fibres by different forces, namely electrostatic forces, non-polar forces,

Table 1 : Properties of different types of softeners used in textile industry[21,22]

Properties	Cationic	Anionic	Non-ionic	Amphoteric	Silicones
Softness	Best softening effect	Less softening effect than cationic types	Medium softening effect	Medium softening effect	Excellent softening effect
Durability	Durable to laundering	Easily washed-off	Not durable to dry cleaning	Low permanence to washing	Highly durable
Substantivity	High substantivity and can be applied to all types of fibres	Often used in special process, such as medical textiles	No ionic charge, no significant substantive effect	Better substantivity than anionic types	High substantivity
Compatibility	Non-compatible with anionic products	Good heat stability and compatible with other components of dye baths	Provides excellent compatibility in resin baths and easy to mix into a formulation	Shows good compatibility with anti-wrinkle finishes, flame retardants etc	High lubricity to the fibre owing to their low surface energy
Functionality	Provide a hydrophobic surface but poor rewetting properties	Provides strong antistatic effects and good rewetting properties	Minimal impact on fastness properties	Have no lubricity properties & good antistatic effect on especially white fabrics	Special unique hand, high lubricity, good sewability
Heat Stability	May cause yellowing upon exposure to high temperatures	Good yellowing resistant and good stability to alkaline conditions	Mostly resistant to yellowing (mainly for whites)	Medium stability to yellowing	Shows good stability to temperature and has good yellowing resistance
Functional groups	Amine salts, imidazolines, amino esters, fatty alcohol based, fatty acid and polyamine, dicyandiamidestearyl amine, Diethanolamine	Sulphated or sulfonated compounds	Polyethylenes, glycerides, ethoxylates, ethoxylated fatty alcohols and acids, paraffins and oxidized polyethylene	Betaine, substituted amino acids, sulphobetaine	Nonreactive, conventional reactive, organofunctional and amino functional silicones

dissolving effects and covalent bonds; the dyes can be anionic, cationic, non-ionic or fibre reactive. The application of surface-active chemicals can diminish the strength of the fibre-dye interaction or bond in many cases. Consequently, in considering the choice of a softener for a given fibre, the types of dye, ionic nature of softeners and the electric charges of fibres must be considered[23,2]. *Table 3* shows the classification of textile softeners, according to their ionic nature.

Interaction is possible if the softener has the opposite charge as the dye. This will be apparent itself as a loss of fastness and colour. Softeners with the same charge as the dye will also results in less effect[23]. *Table 4* shows the fibre, dye, softener choice and remarks.

Table 2 : Silicone modifications and their properties

Silicone modifications	Properties derived
Amino group	Highly exhaustible and durable softness
Hydrophilic group	Water adsorptive
Methyl group	Water repellence and antistatic finish
Hydrogen group	Water repellence and soil resistance
Other organo modifications	Drapery and wrinkle recovery property

By theory, it is very clear that certain types of softeners should not be employed on certain fibres, e.g. cationic softeners on polyamides, but these still can be used to obtain the softness and other property requirements. In such circumstances, care is needed in the choice of softeners.

The major factor to be considered while handling cotton substrates is influence of pH and residual alkalinity. Residual alkalinity on cotton substrates can disturb the pH bath and create issues where finishes necessitate acid pH. Under alkaline condition, the cationic softeners will have less propensity to 'ionize' and thus leads to lower fixation onto the cotton fabric substrate. While applying cationic

Table 3: Ionic nature and electric charge of softeners	
Softener ionic nature	Electric charge
Quaternary groups	Positive, pH independent
Pseudo-cationic	Positive at pH < 7
Amphoteric	Weakly negative to weakly positive, depending on pH
Anionic	Negative
Non-ionic	No charge, neutral

softener in an exhaust bath, the speed of exhaustion of the cationic agent onto cotton fabric depends on the strength of the positive charge that it carries. This, in turn, depends on the pH. Cationic softeners carry relatively higher positive charge at lower pH (4-5) and, therefore, get exhausted more quickly even at cold conditions. The complete exhaustion takes place at pH 4-5. This high rate of exhaustion on cotton is also very undesirable, since it develops some uneven spots and stains on the fabric surface. Thus, the pH conditions need to be properly maintained for different softeners based on the temperature and MLR ratio. Also, fabric construction and geometry influence the ease or difficulty to softener penetrations. Overall, a weakly acidic condition is recommended by the manufacturer or supplier of the softeners to achieve uniform and even exhaustion. Usually, the time of exhaustion required for the softeners will be 20-30 min. In case of cationic amino siloxanes function groups, the film formation of the siloxanes on the surface of the fabric and its reactivity with cellulose gets weakened, leading to inadequate feel. The durability to wash gets decreased because of absence of reactivity of the end hydroxyl group of the siloxane with 'OH' of cellulose due to pH disturbance. Overall, incomplete removal of anionic soaps and detergents normally used in the prior soaping operation results in precipitation of the softeners and thus lowers the softening effect. A proper rinsing cycle after soaping is to be given in order to minimize this problem.

At most times, dyers face yellowing issue after the softener finish. This yellowing is mainly due to the cationic group of quaternary ammonium compounds, where the free hydrogen atom of amine group binds with the chlorine atom to form chloramines; this also results in fishy odour. But, quaternary ammonium compounds containing tertiary amines do not cause such type of yellowing, and thus can be used for whites. Non-ionic softeners are prone to show an adverse effect on wet and dry crock fastness properties due to thermo-migration[24]. Softeners and lubricants make use of non-ionic emulsifiers based on nonylphenol ethoxylates and alkyl alcohol ethoxylates, which are responsible for bleeding of dyes and staining of the ground[25].

In case of modified silicones, such as amino silicones along with emulsifier, in acidic pH they behave cationically. On the other hand, they lose positive charge in an alkaline medium and cause aggregation and coalescence of silicone oil which results in stains on the fabric. Thus, the emulsion becomes unstable, and softness is lost. Another reason for silicone fabric staining is due to the fabric being passed through silicone emulsion with low cloud point emulsifiers, as the emulsion breaks up at these elevated temperatures. Hence,

Table 4 : Fibre, dyes, softener choices and remarks				
Fibres	Charge	Common dyes	Softener type	Remarks
Acrylics	Negative	Acid dyes	Cationic	Result in very little colour change or loss in fastness. In addition, as the fibres contain anionic groups and the softener is cationic, good substantivity can be obtained
Nylon, wool, silk	Weakly negative (neutral)/ weakly positive (acidic)	Acid dyes	Cationic	Because acid dyes are employed on these fibres, the dye interaction must be carefully considered when choosing a cationic agent
Cellulosic	Negative	Direct dyes/ Anionic OBA	Anionic	Cationic softeners result in loss of brilliance and whiteness; colour changes on direct dyed goods often occur
		Vat, sulphur, reactive natural dyes	Cationic/ silicone	Care is required while selecting the softener; if the goods have poor absorbency properties, high temperature should be avoided (to avoid yellowing)
Polyester	No charge	Disperse dyes	Non-ionic	Not much softeners are used for polyester/ synthetic fibres. With increased interest in antistatic dressings on polyester softeners, specially designed antistatic agents are being investigated.
Cellulose acetate and triacetate	Weakly negative	Disperse dyes	Cationic and non-ionic softeners	

a proper choice of emulsifiers is important[26].

Methods of application

The application method of softener on to the textile substrate depends on the type of operation and machines available at the particular processing unit. In some cases, at soft flow processing unit where the fabric is exhaust dyed, the final softener may be exhausted onto the fabric at the end of the dye cycle. In most cases, the softener is applied on a separate machine, namely padding machine or at the final stenter machine stage, in open width form. In case of garment processing, the softeners are usually applied by exhaustion method.

Padding technique is perhaps the best method of application of softeners. Since the amount of softener applied can be calculated accurately, with efficient machinery, a uniform application is ensured. Pad-dry or pad-dry-cure is the common methodology followed in the industries for knits in open width and woven fabrics. For tubular knit fabrics, the common methodology employed is balloon padding machine.

To achieve uniformity and trouble-free application, the following points need to considered[25]:

- Proper mixing of the emulsion, solution or dispersion of the softener
- Proper maintenance of the padding mangle
- Uniform moisture content of the fabric (especially in wet-on-wet process)
- Efficient rinsing of the fabric before padding to avoid chemical or anionic carry over, especially when cationic products are used
- Adequate shear resistance of the emulsion
- Finally, uniform dyeing system is necessary to avoid migration of the softener.

Effectiveness of softeners

Traditionally, fabric softness has been evaluated by a qualitative hand measurement, which is a sensory judgement given by group of panelists (subjective measurements). This methodology provides a general expression of people reaction by touching a fabric, and the same is communicated to the respective fabric

Table 5 : List of plant based or bio-based textile softeners manufacturers and claims[31-36]

Manufacturer	Base	Product name	Application	Claims
Archroma	Plant based	Siligen EH1	For both woven and knitted articles; can be applied by padding process as well as by exhaust process	35% plant-based active content; features ultralow cyclic siloxanes (D4, D5, D6)
Devan Chemicals	Vegetable oils	Passerelle Soft NTL	Natural fibres like hemp, cotton; also fit for synthetic fibres like rPES, PA etc	Wash durable & bio-content of the technology is above 85% (ASTM D6866-20)
Wacker	Plant based methanol	WETSOFT Eco 810LV, Wacker FINISH EcoWR 1100 LVFINISH EcoWR 1300 LV	810LV-Well suited for treating towels, underwear and t-shirts; WR1100 (synthetic or mixed fabrics) & 1300 LV (viscose or for natural fibres) - pants, shirts or table linen; padding as well as by exhaust process	Eco and fossil-based products differ only in the way that the methanol component is manufactured
Schutzen	Seeds of fruits	Schutzen BIOSOFT C90 & BIOSOFT-NIX	For cotton; especially excellent instant hydrophilicity for terry products	The working mechanism on textile articles is based on a novel 'Train-Loop-Tail' Technology
CHT Group	Recycled silicone & renewable bio-based emulsifiers	TUBINGAL RISE	Applied for all fibre types, apparel clothing sports textiles, outdoor clothing, home textiles	Recycled Innovative Silicone Emulsion, the world's first fabric softener made of more than 60% recycled and reprocessed silicone waste and renewable bio-based emulsifiers
Atlantic Care Chemicals	Sugarcane, bagasse, (agricultrual waste)	Novosoft LV 90 Extra	All types of garments and textiles	It is a vegan, amphoteric charged and pre-hydrogenated softener concentrated paste; very smooth hand with high moisture absorption and anti-static properties.

manufacturers and consumers. Simple methods to measure some aspects of fabric hand were described by Dawes and Owen[27]. Many factors such as the fabric colour, environmental lighting and its surroundings etc influence the physical evaluation of the fabric hand feel[28]. The American Association of Textile Chemists and Colorists has published guidelines for subjective hand evaluation[29]. One technique that has attempted to be more specific in giving an objective measure of hand is the Kawabata method. In this method, using regression technique, a relationship was established between the fabric mechanical properties, as measured by the KES-FB instruments and the fabric hand measurements, as subjectively graded by a Japanese expert panel. The regression equation was used to calculate the total fabric hand values. Although this test procedure is interesting from a scientific perspective, significant commercial acceptance is still not reached. Durability to washing of softening finishes can be evaluated by subjecting the finished fabrics to actual washing treatments using the parameters of AATCC Method 61 or the ISO 105C06 washing method, depending on the fabric type. Accelerated home laundering methods can be applied, followed by an evaluation of the retention of performance properties of the fabrics[30].

Sustainable developments

Textile is the second most polluting industry after the petrochemical industry. At textile clusters, there is an accumulation of large amounts of toxic sludge and dry toxic waste which is really no way of disposing of or handling in an ecofriendly way. Most water bodies like rivers, lakes and streams are totally contaminated by colours and other toxic chemicals. Millions of dyed garments are washed every day globally which result in heavy household effluents. During these washes, a small amount of chemicals leach in the sewage water system which, in turn, has destroyed the aquatic life and also the domestic environmental ecosystem, overall leading to negative impact on the global front. Today, sustainability and green chemistry are the major topics in the textile industries. Majority of the buyers are very conscious in buying their clothes, garments, or any other form of textiles goods due to the environmental impacts. Many textile chemical manufacturers are moving out from the chemical based raw materials to greener and sustainable raw materials for the synthesis of various textile auxiliaries. Many of the manufacturers have started to introduce plant based/bio-based softeners in the market. Most of them are based on ester-qaut based chemistry along with natural plant vegetable oils. A list of few plant-based or bio-based softeners launched recently in the market and their respective product insights/claims are given in *Table 5*.

Simple methods for manufacturing softeners for household purposes[22]

An ecofriendly and more economical alternative to the commercial fabric softeners can be made at home. The following are the simple methods which can be easily made:

Procedure 1: Essential oil and vinegar

Combine 3.8 l (0.8 gallon) of vinegar with 15 to 20 drops of essential oil which is available in local market such as lemongrass oil, cinnamon oil, lemon oil etc. Stir the essential oil directly into the container of vinegar for a minute in order to mix well. Here, vinegar is the component responsible for softening clothes and even acts as an antibacterial and antimicrobial agent. Add a few ml (1-2 teaspoon), depending upon the quantity of clothes before the dyer stage in the washing machine.

Procedure 2: Baking soda and salt recipe

Epsom salts or coarse sea salt and baking soda can be used for the formation of fabric softener in dry form, and the powder can be employed for during the home washing cycle to create a dry fabric softener that can be added into the washing machine. Use a ¼ cup of baking soda for every full cup of Epsom salt. For every cup of Epsom salt, add 10 to 15 drops of essential oils and stir well until all of the essential oil has been spread over and absorbed by the salt. Add 2-3 tablespoons of this mixture directly into the washing cycle.

Procedure 3: Vinegar and baking soda

Take two cups of water; add half a cup of baking soda in it and stir well. Once mixed completely, add half of vinegar and few drops of essential oils, and mix the mixture completely. Use 1/4th of the mixture directly for the laundry in the washing machine.

Conclusion

Textile softening agents are of great importance for textile finishing and care. The continuing development of procedural method with new machines, fabrics and fibres, as well as new trends and rising consumer demands for quality, comfort and ecological will play a major role in the creation of revolutionary textile softener solutions. Moving towards the development of greener and ecofriendly softeners and the same, if employed globally, will reduce the environmental issues, mainly the carbon footprint and the water pollution.

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Chemours unveils Ti-Pure Sustainability product series

Chemours, a global chemistry company with leading market positions in Titanium Technologies, Thermal & Specialized Solutions, and Advanced Performance Materials, recently announced a new Ti-Pure titanium dioxide (TiO_2) product portfolio: the Ti-Pure Sustainability (TS) series, which includes two high-performance grades. This new product family showcases Chemours' commitment to advancing its enterprise, business unit, and customers' sustainability goals.

'When we say we aspire to be the most sustainable TiO_2 enterprise in the world, we mean it,' says Ed Sparks, President, Titanium Technologies and Chemical Solutions at Chemours. 'Our customers are hungry for sustainable solutions, so we are proudly answering the call with both new and existing sustainably-minded TiO_2 innovations.'

The first two products in the new Ti-Pure Sustainability series include:

- Ti-Pure TS-6300, a high-opacity pigment for coatings applications designed to advance sustainability, minimize climate impact, and maximize resource efficiency through superior hiding power and reduced material consumption. To help customers quantify the environmental impact reduction of this grade, Chemours recently launched the Ti-Pure TS-6300 Environmental Footprint Calculator.
- Ti-Pure TS-6200, a super durable grade specifically designed to advance sustainability, minimize climate impact, and maximize resource efficiency through improved dispersion and reduced energy, extended product life and avoided waste.

Both are existing grades specifically designed to empower coatings formulators to create high-quality, long-lasting products that reduce material consumption and CO_2e emissions.

Union fabrics developed with soyabean protein fibres from natural sources

Samita Gupta and Rishika Didwania
Department of Textile Science, Clothing and Fashion Studies, J D Birla Institute, Kolkata, India
samitagupta@rediffmail.com

Soyabean fibre is the healthy and comfortable fibre of the 21st century. At present, only industrialized countries have invested heavily in developing new fibres for the new century[4]. Soybean protein fibres (SPF) are manufactured fibres, produced from regenerated soya Glycine Max soybean proteins in combination with synthetic polymer (polyvinyl alcohol) as a predominant component. According to textile fibre labelling, textiles from SPF can be marked as azlons from soybean. Azlons are manufactured fibres in which the fibre forming substance is composed of regenerated naturally occurring proteins[2].

China is the first country to achieve the industrial production of the soyabean protein fibre in the world. This technical achievement fills the vacancy of original and innovative Chinese technology in the field of chemical synthetic fibre, and also influences the research and development of new fibres in the 21st century[8]. The first research for developing fibres from soyabean proteins was made by the Japanese. In the year 1940, the first US patent was granted to Toshiji Kajita and Ryohei Inoue. In 1939, the American Ford Motor Company produced soyabean protein fibres for their car upholstery and seat fillings. Soyabean protein fibres were also produced in Japan under the name Silkool. The production of the mid-twentieth soyabean protein fibres ceased at the end of the World War II. After ten years of intensive research, the Chinese scientists with Guanqi Li succeeded in producing high tenacity soyabean protein fibres from soyabean protein and polyvinyl alcohol[5]. The soyabean fibres are of low strength and sensitive to moisture to the extent of losing

SPF union fabrics are unique and can develop into a new venture for the textile industry

69% of their tenacity, when wet. It has better fineness, low specific gravity, high tensile elongation, and good acidic and alkali resistance. It is similar to natural fibres such as wool, silk etc. This new fibre is considerably cheaper than real silk (around one third of the cost of silk) and can partially replace silk. Its moisture absorption performance is equivalent to cotton, and permeability is greatly better than cotton, ensuring better comfort. The soyabean protein fibre (SPF) has good affinity to human skin. The natural colour of soyabean fibre is light yellow, like the colour of silk. With good fastness to light and perspiration, it also has good dyeing brilliance and dyeing fastness in comparison with real silk products. Fabric from pure soyabean protein fibre (SPF) has natural colour and pure with abundant fluff on the surface without pilling, excellent hand and drape, and softness[4]. The development of textile process makes the soyabean fibre able to be blended with any other fibres at any proportion, without problems in production. It can be easily blended with cashmere wool, mercerized cotton, silk, combed cotton, elastomeric fibres and synthetic fibres.

At present, some key enterprises are undertaking development and production task in yarn, fabric or garments using innovations. Hence, keeping the above points in mind, this study on developing union fabrics using soya has been formulated with the following objectives: to construct union fabrics using yarns of SPF and yarns from other fibres such as wool, silk, cotton, linen and modal using different weaves; to study the physical properties of the woven fabrics; and to take preferences on general appearance and suitability of developed woven fabrics.

Experimental

The union fabric used in this experiment was made from yarns of soya, cotton, linen, modal, silk and wool. The soya yarns are used in the warp direction. In the weft direction, other yarns such as soya, cotton, linen, modal, wool and silk are used, respectively.

Table 1 : Construction details of woven fabrics

Union fabric	Weave type	Code	Yarn details	Yarn count	Direction
Control sample					
Soya x Soya	Plain Weave	SP	Soya	120s	Warp
			Soya	120s	Weft
Soya x Soya	Twill Weave	ST	Soya	120s	Warp
			Soya	120s	Weft
Test samples					
Soya x Cotton	Plain Weave	SCP	Soya	120s	Warp
			Cotton	60s	Weft
Soya x Cotton	Twill Weave	SCT	Soya	120s	Warp
			Cotton	60s	Weft
Soya x Linen	Plain Weave	SLP	Soya	120s	Warp
			Linen	60s	Weft
Soya x Linen	Twill Weave	SLT	Soya	120s	Warp
			Linen	60s	Weft
Soya x Modal	Plain Weave	SMP	Soya	120s	Warp
			Modal	60s	Weft
Soya x Modal	Twill Weave	SMT	Soya	120s	Warp
			Modal	60s	Weft
Soya x Wool	Plain Weave	SWP	Soya	120s	Warp
			Wool	48s	Weft
Soya x Wool	Twill Weave	SWT	Soya	120s	Warp
			Wool	48s	Weft
Soya x Silk	Plain Weave	SSP	Soya	120s	Warp
			Silk	70s	Weft
Soya x Silk	Twill Weave	SST	Soya	120s	Warp
			Silk	70s	Weft

Selection of raw materials

The spun soya yarns of 120s count were collected from GoGreen Products, Chennai, India in the form of cones. The 60s cotton and 70s spun mulberry silk yarns were collected from the local market of Madhan Mohan Textile, Fulia, West Bengal, India. The 60s linen, 60s spun modal and 48s wool were also collected from the local market. The soya union fabric was handwoven in Jayita Handloom, Fulia in two basic weaves.

Construction details of soya union fabrics

The soyabean union fabric was hand woven in Jayita Handloom, Fulia in two basic weaves, i.e. plain weave 1/1 and twill weave 2/2. The warp yarns were soya yarns (120s), and the weft yarns were cotton (60s), linen (60s), modal (60s), wool (48s) and silk (70s) *(Table 1)*.

Conditioning of samples

Prior to the testing, all the yarn and fabric samples were conditioned according to the moisture equilibrium in standard atmosphere at 65±2% relative humidity and 27±2°C temperature in a conditioning temperature.

Yarn testing

The yarns were tested in Kolkata based Prod Control India Pvt Ltd. All the yarn samples, i.e. soya, linen, cotton, silk, wool and modal were tested. The standard method of tests was followed to determine the count, yarn weight and twist per inch.

Fabric testing

The union fabrics were tested for

Table 2 : Standard method of fabric testing		
Properties	Standard method	Instrument used
GSM of the fabric	IS: 1964-2001	Electric weighing balance
Fabric thickness	IS: 7702-1975	Thickness gauge
Thread count	IS: 1963-1981	Pick glass
Bending length	IS: 2502-1963	Shirley stiffness tester
Crease recovery	IS: 2313-1972	Shirley crease recovery tester
Drape coefficient	IS: 8357-1977	Fabric drape tester
Tearing strength	SSEN ISO 13937 (2)-2000	MAG Mec tear
Tensile strength	SSEN ISO 13937 (2)-2000	MAG uni stretch
Abrasion resistance	IS: 12673-1989	Martindale abrasion tester
Shrinkage resistance	ASTM D2259	Shrinkage glass tester

some important fabric properties such as properties related to fabric structure (fabric weight, fabric thickness and thread count), fabric handle (bending length, crease recovery and drape coefficient) and fabric durability (abrasion resistance, tearing strength, tensile strength and shrinkage resistance) using the standard methods as mentioned in *Table 2*.

Cost of woven fabric

The cost of each prepared sample was calculated separately on the basis of raw material, weaving execution charges, finishing and profit margin. A total of 20% profit margin was added in the calculated cost for the estimation of sale price.

Subjective evaluation of woven samples

A closed ended questionnaire was framed to gather information. Fifty respondents with knowledge of textiles (textile students, teachers, designers etc) were taken for the survey as a purposive sample for assessment. Some important properties, such as handle (Rating scale: 1 - stiff, 2 - crisp and 3 - soft)[6], appearance (Rating scale: 1 - poor, 2 - fair and 3 - good), texture (Rating scale: 1 - rough, 2 - moderately smooth and 3 - smooth) and lustre (Rating scale: 1 - dull, 2 - matt and 3 - lustrous)[3] were assessed. Assessment of the constructed woven fabric was done for its properties such as handle, appearance, texture, lustre and price. Statistical analysis of data was done using one-way ANOVA factor and correlation matrix.

Results and discussion

Yarn testing

The yarns were tested for the physical properties like yarn count, twist per inch and yarn weight using standard methods, as reported in *Table 3*.

Properties related to fabric structure

- **Fabric weight:** Soya x Linen union fabrics were found to be the heaviest, and Soya x Silk fabrics the lightest. When compared to the control samples in terms of fabric weight, Soya x Silk, Soya x Cotton and Soya x Modal produced lighter fabrics in spite of lower density of soya fibre in comparison to density of cotton, silk and viscose[7]. This variation in fabric weight may be due to the difference in the fibre composition, yarn properties as well as density of the fabric[1] *(Fig 1)*.
- **Fabric thickness:** It could be elicited that Soya x Silk union fabric and Soya x Modal union fabric in plain weaves had minimum thickness as compared with other union fabrics. Soya x Wool in twill weaves had maximum fabric thickness, thus probably providing higher thermal insulation. When compared to the control samples in terms of fabric thickness, Soya x Silk, Soya x Cotton and Soya x Modal produced finer fabrics. The difference in thickness may be due to the fibre types, yarn twist and fabric structure *(Fig 2)*.
- **Thread count:** Highest value of Soya x Silk union fabrics in terms of thread count could be due to the fineness of the silk yarns. The thread count in warp direction was almost same due to the fact that similar warp threads were used for weaving of all the samples. The difference was found in the thread count of weft direction, which might be due to the reason that different types of yarns with different counts were used in weft direction, according to their suitability with soya warp yarns *(Fig 3)*.

In order to check whether fabric structure properties (fabric thickness, fabric weight and thread count) of all the union fabrics was equally acceptable or not, one-way ANOVA test was done which showed that all the union fabric used for fabric structure properties had the same level of acceptability. All fabrics were equally liked in terms of fabric structure properties.

Properties related to fabric handle

- **Bending length:** The Soya x Linen sample has a greater value than other fabric due to its fibre characteristics, yarn structure, yarn count, cloth thickness and fabric weight which indicates that the Soya x Linen sample fabric is rougher and stiffer as

Table 3 : Physical Properties of yarns						
Yarn testing	Soya spun yarn	Modal spun yarn	Cotton yarns	Spun yarns	Wool yarns	Linen yarns
Yarn count	120	60	80	70	48	60
Twist per inch	16	13	16	19	20	24
Yarn weight (gm/m)	0.4	0.55	0.52	0.57	0.75	0.86

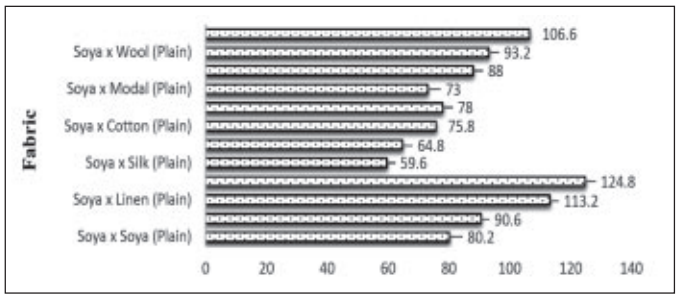

Fig 1 : Fabric weight of the woven samples

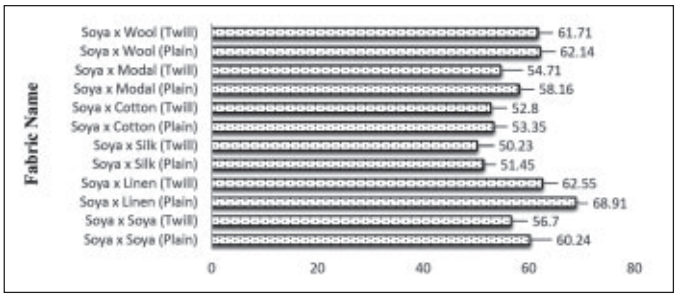

Fig 6 : Drape coefficient of the woven samples

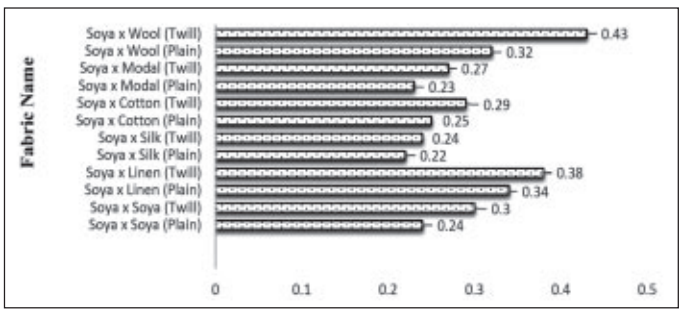

Fig 2 : Fabric thickness of the woven samples

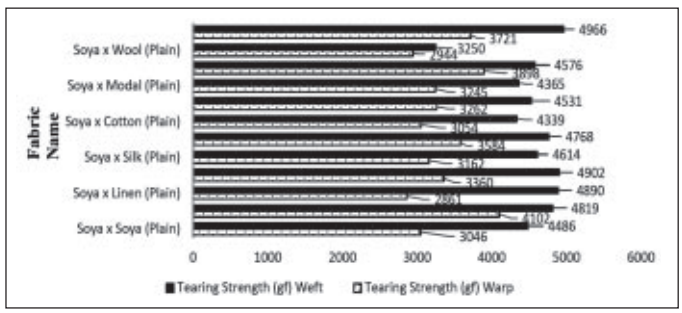

Fig 7 : Tearing strength of the woven samples

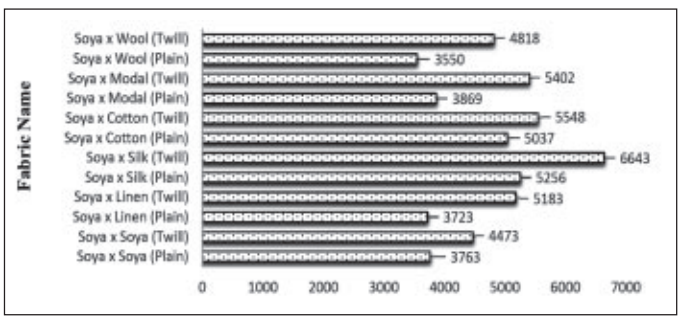

Fig 3 : Thread count of the woven samples

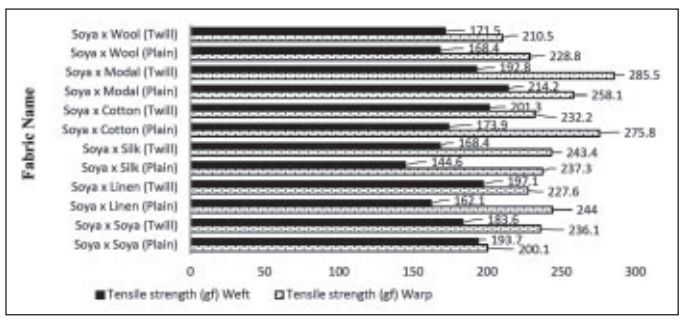

Fig 8 : Tensile strength of the woven samples

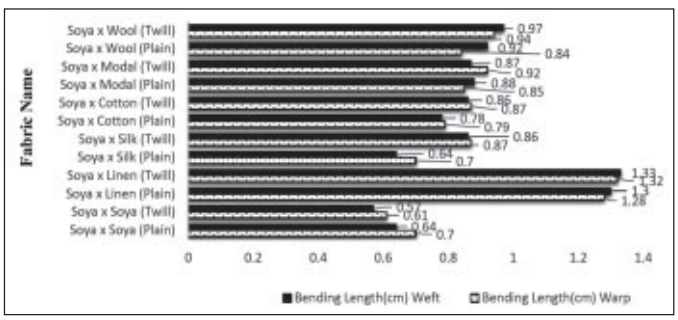

Fig 4 : Bending length of the woven samples

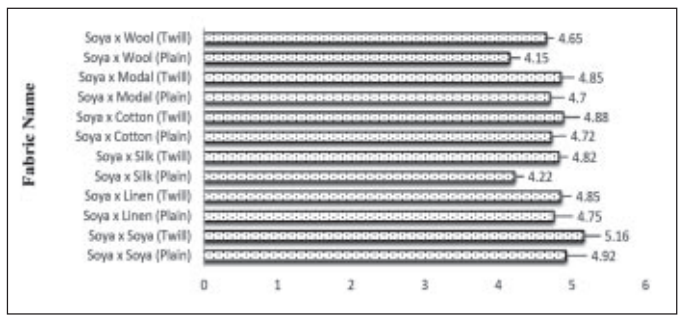

Fig 9 : Abrasion resistance of the woven samples

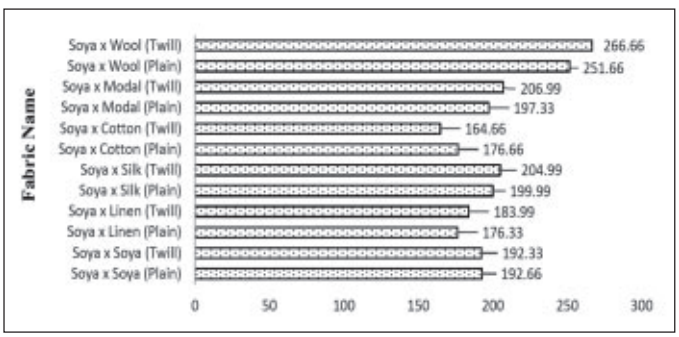

Fig 5 : Crease recovery of the woven samples

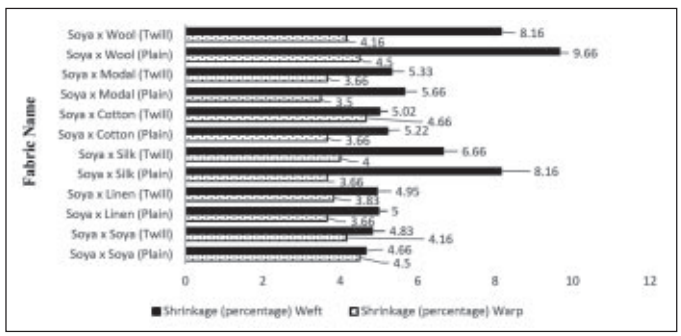

Fig 10 : Shrinkage resistance of the woven samples

compared to other fabrics. Also, linen inherently is stiff and has less flexibility. Control samples woven in Soya x Soya fibre showed the lowest bending length value, indicating that soya yarns are flexible and produce soft and supple fabrics. Soya x Silk woven samples also had similar bending length values as the control samples. It may be due to weave which has direct effect on bending rigidity of the fabrics *(Fig 4)*.

- **Crease recovery:** The crease recovery of all the woven samples were assessed and it was observed that the crease recovery of Soya x Wool fibre was the highest. Crease recovery of Soya x Wool, Soya x Silk and Soya x Modal were higher than control samples. Therefore, combining two different types of yarns in production of union fabrics enhanced the various fabric properties *(Fig 5)*.
- **Drape coefficient:** Drape coefficient of all fabrics woven in twill weave was lower than the plain weave samples of the same composition, which means that all twill weave fabrics had higher drapeability than the plain weave fabrics. Lowest drape coefficient was found in Soya x Silk union fabrics, indicating that they have the highest drapability. Drape of Soya x Silk, Soya x Cotton and Soya x Modal was found to be better than that of the control samples. Therefore, combining two different types of yarns in production of union fabrics enhanced the various fabric properties *(Fig 6)*.

In order to check whether handle properties (bending length, crease recovery and drape coefficient) of all the union fabrics were equally acceptable or not, one-way ANOVA test was done which showed that all the union fabric used for handle properties had the same level of acceptability. All fabrics were equally liked in terms of handle properties.

Properties related to fabric durability

- **Tearing strength:** Except the Soya x Wool plain weave fabric, all other fabrics have higher tearing strength than the control samples, which signifies that combining different yarns enhances the various fabric properties and can have varied end use applications accordingly *(Fig 7)*.
- **Tensile strength:** Except Soya x Linen fabric, all other fabrics have lower tensile strength than the control samples. Tensile strength of a yarn or fabric is defined as the maximum load that it will endure without breaking, when subjected to uniaxial tensile loading *(Fig 8)*.
- **Abrasion resistance:** The data revealed that maximum percentage weight loss was found in the Soya x Soya twill weave sample. Regenerated protein fibres have poor resistance to abrasion as studied by Elder and Fergusan in a research. Natural fibres have moderate to low abrasion resistance which is shown by almost similar percentage weight loss values. However, mixing soya with other materials significantly improved the abrasion resistance properties *(Fig 9)*.
- **Shrinkage resistance:** Weft shrinkage is highest in Soya x Wool, followed by Soya x Silk, Soya x Modal, Soya x Cotton and then Soya x Linen, probably due to the inherent fibre composition. Control samples have a low shrinkage in comparison to other samples, except that of Soya x Linen *(Fig 10)*.

Table 4 : Distribution of respondents on the basis of their preference towards fabric handle

Sample	Fabric composition	Weave	Weighted score	X	Rank
SP	Soya x Soya	Plain Weave	147	2.94	III
ST	Soya x Soya	Twill Weave	148	2.96	II
SCP	Soya x Cotton	Plain Weave	149	2.98	I
SCT	Soya x Cotton	Twill Weave	149	2.98	I
SLP	Soya x Linen	Plain Weave	52	1.04	VIII
SLT	Soya x Linen	Twill Weave	52	1.04	VIII
SSP	Soya x Silk	Plain Weave	130	2.60	V
SST	Soya x Silk	Twill Weave	135	2.70	IV
SWP	Soya x Wool	Plain Weave	115	2.30	VI
SWT	Soya x Wool	Twill Weave	110	2.20	VII
SMP	Soya x Modal	Plain Weave	147	2.94	III
SMT	Soya x Modal	Twill Weave	148	2.96	II

Table 5 : Distribution of respondents on the basis of their preference towards fabric appearance

Sample	Fabric composition	Weave	Weighted score	X	Rank
SP	Soya x Soya	Plain Weave	149	2.98	I
ST	Soya x Soya	Twill Weave	144	2.88	V
SCP	Soya x Cotton	Plain Weave	148	2.96	II
SCT	Soya x Cotton	Twill Weave	146	2.92	III
SLP	Soya x Linen	Plain Weave	105	2.10	X
SLT	Soya x Linen	Twill Weave	102	2.04	XI
SSP	Soya x Silk	Plain Weave	109	2.18	IX
SST	Soya x Silk	Twill Weave	110	2.20	VIII
SWP	Soya x Wool	Plain Weave	115	2.30	VI
SWT	Soya x Wool	Twill Weave	113	2.26	VII
SMP	Soya x Modal	Plain Weave	148	2.96	II
SMT	Soya x Modal	Twill Weave	145	2.90	IV

Subjective evaluation of woven fabric

- **Fabric handle:** A survey was conducted to see the response towards the fabric handle of the soya union fabrics. A three-point scoring Performa

Table 6 : Distribution of respondents on the basis of their preference towards fabric texture

Sample	Fabric composition	Weave	Weighted score	X	Rank
SP	Soya x Soya	Plain Weave	135	2.70	VI
ST	Soya x Soya	Twill Weave	138	2.76	V
SCP	Soya x Cotton	Plain Weave	142	2.84	IV
SCT	Soya x Cotton	Twill Weave	145	2.90	III
SLP	Soya x Linen	Plain Weave	50	1.00	XII
SLT	Soya x Linen	Twill Weave	50	1.00	XI
SSP	Soya x Silk	Plain Weave	126	2.52	VII
SST	Soya x Silk	Twill Weave	125	2.50	VIII
SWP	Soya x Wool	Plain Weave	116	2.32	X
SWT	Soya x Wool	Twill Weave	115	2.30	IX
SMP	Soya x Modal	Plain Weave	150	3.00	I
SMT	Soya x Modal	Twill Weave	149	2.98	II

Table 7 : Distribution of respondents on the basis of their preference towards fabric lustre

Sample	Fabric composition	Weave	Weighted score	X	Rank
SP	Soya x Soya	Plain Weave	138	2.76	IV
ST	Soya x Soya	Twill Weave	136	2.72	V
SCP	Soya x Cotton	Plain Weave	145	2.90	III
SCT	Soya x Cotton	Twill Weave	148	2.96	II
SLP	Soya x Linen	Plain Weave	85	1.70	XI
SLT	Soya x Linen	Twill Weave	90	1.80	X
SSP	Soya x Silk	Plain Weave	130	2.60	VI
SST	Soya x Silk	Twill Weave	125	2.50	VII
SWP	Soya x Wool	Plain Weave	110	2.20	IX
SWT	Soya x Wool	Twill Weave	115	2.30	VIII
SMP	Soya x Modal	Plain Weave	150	3.00	I
SMT	Soya x Modal	Twill Weave	150	3.00	I

Table 8 : Distribution of respondents on the basis of their response towards fabric selling price

Sample	Fabric composition	Weave	Fabric price/ mt in Rs	Weighted	X	Rank
SP	Soya x Soya	Plain Weave	505	131	2.62	VI
ST	Soya x Soya	Twill Weave	530	136	2.72	V
SCP	Soya x Cotton	Plain Weave	400	145	2.90	IV
SCT	Soya x Cotton	Twill Weave	410	146	2.92	III
SLP	Soya x Linen	Plain Weave	520	100	2.00	IX
SLT	Soya x Linen	Twill Weave	535	102	2.04	VIII
SSP	Soya x Silk	Plain Weave	495	110	2.20	VII
SST	Soya x Silk	Twill Weave	510	100	2.00	IX
SWP	Soya x Wool	Plain Weave	485	100	2.00	IX
SWT	Soya x Wool	Twill Weave	520	110	2.20	VII
SMP	Soya x Modal	Plain Weave	390	149	2.98	II
SMT	Soya x Modal	Twill Weave	395	150	3.00	I

was used for this purpose. The samples were scored as 1, 2 and 3 corresponding to stiff, crisp and soft, respectively, against the various attributes. Majority of the respondents liked the fabric handle of the Soya x Cotton plain and twill weave fabrics. This probably could be due to the fact that the respondents felt that the fabric was soft than the other union fabrics.

In order to check whether fabric handle of all the union fabrics was equally acceptable or not, one-way ANOVA test was done *(Table 4)*. All the fabrics were equally liked by the respondents in terms of fabric handle.

- **Fabric appearance:** The samples were scored as 1, 2 and 3 corresponding to poor, fair and good, respectively, against the various attributes. With respect to fabric appearance, majority of the respondents liked the Soya x Soya plain weave fabric appearance, followed by Soya x Cotton plain and Soya x Modal plain weave *(Table 5)*.

All the union fabric had equal levels of acceptability.

- **Fabric texture:** The samples were scored as 1, 2 and 3 corresponding to rough, moderately smooth and smooth, respectively, against the various attributes. With respect to fabric texture, majority of the respondents liked the Soya x Modal plain weave fabric texture. This probably could be because the respondents felt that the fabric texture was smoother than the other union fabrics, followed by Soya x Modal twill weave *(Table 6)*.

The fabric texture of all the union fabrics developed had equal levels of acceptability.

- **Fabric lustre:** The samples were scored as 1, 2 and 3 corresponding to dull, matt and lustrous, respectively, against the various attributes. With respect to fabric lustre majority of the respondents liked the Soya x Modal plain and twill weave fabric texture. This probably could be because the respondents felt that the fabric appearance would be high than the other union fabrics followed by Soya x Cotton twill weave *(Table 7)*.

The one-way ANOVA test showed that, in terms of fabric lustre, all the union fabrics had equal levels of acceptability.

- **Fabric price:** The samples were scored as 1, 2 and 3 corresponding to will not buy, might buy and will buy, respectively, against the various

attributes. With respect to fabric price, majority of the respondents liked the Soya x Modal twill weave fabric. This probably could be because the respondents felt that the fabric price was less than the other union fabrics and that the quality and the feel of the fabric was good *(Table 8)*.

Correlation matrix test showed that, if the fabric price increased then the fabric appearance will also increase and it showed that the fabric appearance plays a major role in determining the acceptability of the fabric price.

Conclusion

Soya protein fibre is made from the waste products of the soya bean industry. It is a soft fibre with good performance and appeals to the environmental issues. In this study, the fabric was prepared with two different weaves, i.e. plain and twill weave. Fabric testing was done to find out the weight, thickness, abrasion, drape, strength and shrinkage. Costing of all the woven fabrics was done. A comparative subjective evaluation was done based on fabric quality by the panel of 50 respondents with textile background. Based on the fabric testing, aesthetic properties such as handle, appearance, texture and lustre and considering the cost of the fabrics, these developed fabrics were found suitable for various textile applications. One way ANOVA was done to suggest that all woven samples were equally acceptable in terms of fabric structure, handle, durability and aesthetic properties. Thus, the newly designed SPF union fabrics are unique and can develop into a new venture for the textile industry.

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SpecialChem and Agilis launch ionicPIM for the chemical industry

Agilis, a provider of digital commerce solutions for the chemical industry, and SpecialChem, the world's largest materials selection platform, announced recently their partnership to bring to market a cloud-based Product Information Management (PIM) system designed specifically for the chemical industry.

A PIM is a digital platform that companies use to centralize, organize and distribute product information. The new product, ionicPIM, is designed for chemical producers and distributors, helping them maintain a single source for all product data and documents. ionicPIM is preconfigured for chemicals, so its easy to implement and adopt. It also allows for producers and distributors to connect their PIMs to share product information.

'The chemical industry is unique,' says Jay Bhatia, founder and CEO of Agilis. 'One product can be used in multiple industries and applications; and customers in each market want to see a different set of data. It is essential for chemical suppliers to be able to create and manage these variations in one place and share the most up-to-date product information with people inside and outside their organizations, with various IT systems, while controlling access through role-based permissions. ionicPIM is equipped with all core capabilities of a cutting-edge PIM system, plus a collection of specialized features for the chemical industry, such as industry nomenclature, multi-industry product views, built-in chemical data models, and more.'

'The complexity and volume of product information in the chemical industry is growing exponentially,' says Christophe Cabarry, SpecialChem Founder & CEO. 'Suppliers are required to provide extensive documentation to comply with HSE regulations, while buyers expect convenient self-service options for access to product data through digital channels. SpecialChem has been managing the world's largest online catalog of commercial chemicals for over 20 years. ionicPIM is offered as a SaaS solution and the data entered by the suppliers in their ionicPIM instance remains 100% their ownership and control.' adds Cabarry. 'Also, you do not need to be an Agilis or a SpecialChem client to use the ionicPIM.'

SpecialChem and Agilis Commerce were founded by seasoned industry professionals with prior experience with leading companies like Arkema and BASF. Both companies share a mission to bring modern digital buying, selling, promoting and information management practices to the chemical industry.

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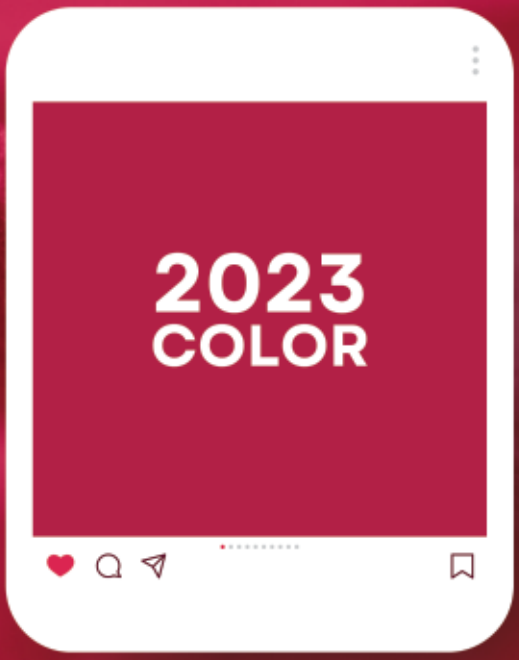

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Protective textiles - Part I

Sanjukta Majumdar and Sankar Roy Maulik
Visva Bharati (A Central University), Department of Silpa Sadana, Sriniketan, West Bengal, India
***Correspondence author email** : s_r_moulik@yahoo.co.in*

Maslow's hierarchy of needs rightly states that clothing is essential for human survival alongside food, shelter, air, water, rest and reproduction. In layman's terms, a textile is a piece of cloth or fabric made by interlacing and interlocking yarns through weaving, knitting, and various nonwoven techniques using specific natural or manufactured materials. In other words, textile is an integral part of clothing. Textiles can be further classified into two groups, i.e. conventional textiles and commodity textiles. Conventional textiles majorly comprise textiles that have been used in our daily lives like the clothes, textile products used to cover our bodies, showcase our social status and wealth, provide us psychological satisfaction on modesty, and cover oneself which was the primary reason behind the creation of textiles. It does not have any particular property or functional aspect. On the other hand, commodity textile refers to products with specific or functional properties. Today's world focuses more on the functional part of textiles, rather than just their look and feel. In the world's most developed markets, the manufacturing and supply of such technical textile products account for around 50% of all the textile products combined. The technical textile industry is one of the most promising divisions of future textiles worldwide[1].

The market of the protective textile industry requires innovation along with cost-effectiveness

Technical textile, as the name suggests, is a textile manufactured using special techniques to perform specific functions and not for its aesthetic appearance. Specialised textile products are application-specific, keeping their end-use focused[1]. Though the term technical textile has gained attention in recent years, it is not a new concept, nor is it only a by-product of modern artificial advancements. Researchers have found evidence of woven fabrics and meshes used in Roman times to support the marshy ground for road building and agricultural soil support purposes, which exemplifies geotextiles or geo-

grids, an essential aspect of technical textiles[1].

Technical textiles can be classified as:

- Agro tech (agricultural, horticulture, and forestry textiles)
- Build tech (buildings and related construction textiles)
- Cloth tech (technical clothing textiles)
- Geo tech (civil engineering related textiles)
- Home tech (domestic textiles)
- Indu tech (industrial textiles)
- Medi tech (medical, healthcare and hygiene-related textiles)
- Mobi tech (transportation, automotive, and aerospace textiles)
- Oeko tech (ecological and environmental protection textiles)
- Pak tech (packaging textiles)
- Sports tech (sport and leisure textiles).

Depending upon the end use, protective textiles are prepared for various sectors such as military; industry workers who are exposed to radiation, chemicals and bio-hazards; construction people who continually work in dust, dirt and sweat; people working in the fire department; people belonging to the medical/ health and hygiene sectors. These people are exposed to extreme heat or cold[2]. ITA (Importers of Textile and Apparel) have categorised the market for protective textiles into the following segments:

- Textiles that protect from extreme heat and fire
- Textiles that provide radiation protection
- Protection from bacteria and viruses
- Textiles that give ballistic or mechanical protection
- Protection against harmful particulate matters
- Protection of delicate items while manufacturing
- Protection against harmful chemicals
- Protection against extreme cold.

Classification of personal protective textiles is a complicated process as it is difficult to classify all the protective functions; hence, depending on the end use, individual protective materials can be differentiated as textiles for thermal protection, radiation protection, flame or fire protection, and mechanical protective textiles[3]. This article focuses on protective fabrics that allow humans to work and function under hazardous or extreme conditions. In this article, the first three areas, i.e. textiles that protect against heat and fire, materials that protect against radiation (ultraviolet) and textiles that protect against bacteria and viruses, have been discussed along with some other advancements currently going on in the industry.

Protection against extreme heat and fire

Fire is a significant source of energy on the face of the earth. Without fire and heat, humans would have been impossible to survive. However, the fire could be equally or even more fatal to human lives[4]. When an object is heated, its temperature automatically increases, making it undergo irreversible chemical changes which lead to the production of non-flammable gases (carbon dioxide, water vapour, and higher oxides of nitrogen and sulphur), tars, flammable gases, and carbonaceous char. When the object reaches combustion temperature, the flammable gases combine with oxygen, and the process is called combustion which leads to the formation of flames. Fire accidents are a common occurrence that result in non-lethal and lethal victims. Out of the most of the fire disasters that occur in residential properties, occupied buildings, and outdoor fires, the most dead casualties resulted from fires in residential places[5]. It has been noticed that textiles were the main object that caught fire and spread it, especially the textiles used in upholstery and furnishings[5]. It has also been noticed that the leading cause of death is not direct burning, but suffocation due to the smoke and toxic gases released from the fire[5]. Hence, textiles with non or low-toxic materials should be used for fire protection.

Almost all textile fibres are flammable, so if they catch fire, they may not only get damaged but also potentially threaten the wearer or the object it is being placed upon. Hence, flame retardant textile is an essential and in-demand requirement for the protective textile sector. Protection against fire and extremely high temperatures is a requirement for workers working in these industries. Along with other safety measures and protection, their clothing also needs protection. The most important and widely recognised part has been the protection of the fireman, the people who work in the primary metal industry with molten metal, and other areas such as welding, ceramics manufacture etc which involve exposure to high heat[6]. The flammability of textiles depends on various factors like fibre type, fabric weight and construction, ignition method, heat extent, and absence or presence of flame retardants. The flame resistance capacity of a textile material is commonly evaluated by determining the LOI (Limiting Oxygen Index), which is 'the minimum concentration of oxygen, expressed as a percentage that will support combustion of a polymer.

LOI can be measured by passing a mixture of oxygen and nitrogen over a burning textile sample, then reducing the oxygen level until the critical level is reached. It is known that the oxygen content of air is 20% in volume. Hence all the textiles with LOI values equal to or lower than 20 will catch fire easily, but the materials with LOI values higher than 20 will not catch fire easily. Cotton and viscose, which have LOI of 18.4 and 18.6, respectively, will readily burn; whereas polyester and nylon having LOI of 20-21, and acrylic with an LOI of 18.2 are also expected to be flammable. However, modacrylic, which has an LOI of 29-30, and wool which has an LOI of 25, are expected to be highly flame resistant.

Human tissue or skin is highly heat sensitive. It has been studied that the pain sensation is experienced at 45°C, and the skin is completely burnt at 72°C[5,7]. The main objective of fire-protective clothing is to reduce the heating rate of human skin so that the wearer gets enough time to react to the situation and escape. The time that the wearer stays in fire and the heat flux he

is exposed to are essential factors for designing protective clothing. In normal conditions, only 3-10 sec are available for a person to escape from a fire with a heat flux of 130-330 kW/m^2 [8].

Factors initiating combustion

The rate of burning, ease of ignition, and the amount of heat released are the most critical factors of a textile material that determines the extent of risk and danger caused by fire. The other properties that affect the fire or heat protection level include synthetic fibres' shrinkage and melting behaviour, and the amount of smoke and toxic gases released during burning[1]. Hence, before selecting fire or flame protective clothing, the following points should be considered:

- The burning or thermal behaviour of textiles
- The fabric structure and shape of garments
- Choosing non-toxic, smoke-free flame-retardant additives or finishes
- Designing of the protective garment with comfort properties depending on its end use
- The strength of the burning source
- The supply of oxygen.

Flame or heat-protective textiles need to provide insulation for better heat protection and high dimensional stability so that the fabric does not shrink or melt when exposed to heat fluxes. If they do, they decompose to char. These qualities are not present in thermoplastic fibres, but in high-performance fibres like aramid (Nomex), flame retardant wool, and cotton; partially oxidised acrylic fibres are used to make fire or flame protective clothing. The aramid fibres, even with their high oxygen index and thermal stability, are unsuitable for skin burns in molten metal splashes due to their high thermal conductivity[1].

Selection of fibres suitable for heat or flame protection

While selecting fibres for flame or heat protection, it must be noted that the fibres can be classified into three categories:

Inherently flame resistant fibres

DuPont has produced fibres, e.g. Kevlar R and Nomex R have flame resistance built into their chemical structures. Modacrylic is a fibre that has excellent permanent flame resistance properties. The flame protection quality of these fibres can never be worn away or washed out.

Fibres modified by the addition of flame retardants in dope

Fire retardant fibres can be produced by adding flame-resistant chemicals to the dope during fibre production. This method has flame-resistant fibres like HEIM polyester and Extra FR polyester. To make such products, several phosphorous and bromine-based compounds are added to the thermoplastic fibres.

Flame resistant finishes

Applying a suitable finish can also manufacture flame-resistant fabrics through the pad-dry-cure technique. The chemicals used while finishing are attached to the fibres' surface through various physical or chemical bonding or their performance in the fibre structure, and prevent combustion or ignition. Few commonly used flame-resistant chemicals/finishes are as below:

- Mixture of borax-boric acid and ammonium chloride-ammonium sulphate. These are non-durable but effective in the case of cotton. These finishes remove heat and enhance the decomposition temperature. When they come in contact with heat, the chemicals coat the fibre with a glass-like insulating polymeric film and cut off the supply of heat and oxygen.
- Aluminium hydroxide and calcium carbonate is another non-durable finish that decomposes through strong endothermic reactions. These reactions initiate heat absorption; hence it does not reach the pyrolysis temperature, and combustion does not happen.
- Phosphorus and nitrogen-based chemicals are also used to create non-durable, semi-durable, and durable flame retardant finishes. Nitrogen is not adequate for flame retardancy, but it acts synergistically with phosphorous to produce non-combustible decomposable materials when exposed to heat. Some other non-durable and commercially important flame-retardant finishes for cellulose fibres are diammonium phosphate, ammonium sulphate and ammonium bromide. THPC (tetrakis hydroxymethyl phosphonium chloride), THPOH-NH_3 (tetrakis hydroxymethyl phosphonium hydroxide plus ammonia), Pyrovatex CP (N-methylol-dimethyl propionamide) and Proban (THPC- urea-based system) are some examples of durable phosphorous and nitrogen-based flame retardant finishes.
- Halides such as chlorine and bromine act by producing free radicals, which combine with hydrogen and hydroxyl radicals and are the most important entities that react to initiate combustion. The effectiveness of halides as flame-resistant material can be highly increased by using it with antimony which has a collegial effect.
- Important finishes used for wool are

Table 1 : Top fire-retardant manufacturing companies listed under Trade India

Company name	Location	Operating years
Asadeep Furnishing Pvt Ltd	Delhi	16
Ginni Spectra Pvt Ltd	Jaipur	16
Super Safety Services	Pune	15
Daga Impex	Ahmedabad	13
Woven Fabric Company	Mumbai	09
Shri Radhika Nonwoven Pvt Ltd	Jaipur	05
Ful Shanti Gujrat Industries	Ahmedabad	06
Aartex Industries	Panipat	04
Mohan Merchandise Pvt Ltd	Kolkata	06
Radhe Krishna Nonwoven Enterprise	Gurgaon	02

hexafluoro zirconate and titanate salts based finishes (Zirpro process).

Flame retardant finishes have a few requirements which must be met:

- The physical property of the textile should have no severe effect
- The aesthetic and functional property of the textile should be maintained
- Simple processes using conventional methods and inexpensive chemicals should be used to produce the product
- The finish applied should be durable enough to undergo several dry cleanings, home launderings, and tumble dryings.

Ecofriendly flame retardant materials

Providing flame-retardant finishes to textiles has numerous downsides such as toxicity, high cost, carcinogenic action etc. Researchers have been working on ecofriendly flame retardant textiles to impart flame retardant functionality in cellulosic and protein fibres. Basak et al have experimented with plant-based fibres like banana pseudo stem sap, green coconut shell extract and protein-based fibres such as DNA, casein, whey protein and hydrophobin for this purpose[9].

Manufacturers

The NewTex Extreme Protective (NPH) line showcases heat/flame protective clothing, including high-temperature gloves, proximity suits and aluminised clothing from high-temperature fabrics. These clothing items are primarily used in industrial fire-fighting, ship-building and metalworking[10]. A significant production house of fire-retardant textiles and clothing is NewTex, US. *Table 1* shows some important companies producing flame retardant textiles.

Protection against ultraviolet radiation

Solar rays that reach the surface of the earth consist of light waves with wavelengths varying from infrared (IR) to ultraviolet (UV). The intensity of UV radiation is only around 6% as compared to visible and infrared radiation, but the energy per photon is significantly higher. UV rays are segregated as UV-A (320-360 nm) UV-B (280-320 nm), and UV-C (200-290 nm). The very high energy of the UV-C photons is mainly absorbed by ozone, and their relative intensity to the earth's surface is almost zero; around 0.1% of it reaches the earth's surface in places where the ozone layer is not depleted. The energies of UV-A and UV-B photons that reach the earth's surface exceed the C-C single bond energy of 335 kJ/mol[6]. The actual damage to human skin from UV radiation is a function of the wavelength of the incident radiation. The most damage takes place at wavelengths less than 300 nm. Wavelength and the intensity of the incident radiation are the main factors responsible for damage to human skin from UV radiation. Influenced by these two factors, the wavelengths considered the most harmful are 305-310 nm. Hence, UV protective textiles can be called as effective if they protect the wearer from solar radiation having wavelength ranges of 300-320 nm. The most likely candidates for UV protective finishes are lightweight woven and knitted fabrics for producing t-shirts, shirts, beach wear etc. Industrial materials designed for tents, canopies etc may also benefit from UV-protective treatment.

Long-term exposure to UV light can cause many negative impacts, including acceleration of skin ageing, sunburn, photo dermatosis, phototoxic reaction to drugs, increased risk of melanoma and erythema, and can even lead to eye and DNA damage. The stratospheric ozone depletion is the primary cause of the increased incidence of skin cancers. As the ozone layer acts as a very effective UV-absorber, it is predicted that, with each 1% decrease in ozone concentration, the rate of skin cancer increases by 2% to 5%[10].

Mechanism of UV protective textiles

The protection provided by textiles against UV rays is quantified through laboratory testing in vivo or instrumental measurement in vitro. Depending on the testing method, two terms used are Sun Protection Factor (SPF) for vivo testing, and Ultraviolet Protection Factor (UPF) for instrumental evaluation in vitro. UPF or SPF is determined as below:

UPF= Potential erythemal effect by the radiation/actual erythemal effect transmitted through the fabric by the radiation.

The higher the UPF value, the more protection will be provided by the fabric against UV radiation. The term SPF is commonly used in the case of sun-blocking creams. It depicts how long a person can be exposed to sunlight before the radiation damages the skin. Fabrics with SPF higher than 40 are considered excellent UV protection. Like every other surface, when light rays fall on a cloth, they can either be reflected, absorbed or transmitted. The number of radiations reflected, absorbed or transmitted by the fabric is influenced by many factors like the fibre type, fibre texture, fabric cover factor, the presence or absence of fibre delusterants, dyes, and UV absorbers.

Fabrics for UV protection

Cotton and silk fibres provide very little to no protection against UV rays as the radiation can pass through them without being absorbed. However, polyester and wool give higher UPF protection as UV radiation is absorbed well by synthetic fibres like nylon and polyester due to delustering titanium dioxide.

UPF value of undyed fabric

- Cotton and silk have UPF values ranging from 4 to 7
- Polyester has a UPF value of around 26
- Wool has a UPF value of 45.

A textile is considered UV protective if it has at least a UPF value of 40. Hence, textile materials with UPF values below 40 must undergo various treatments, and chemicals are added to increase their absorbency of UV rays.

Fabric construction for UV protection

The fabric's permeability, weight and thickness are the most critical factors

determining the amount of UV protection the material offers. Fabrics with compact construction or high cover factor provide higher UV protection as the UV rays cannot penetrate through these fabrics into the skin. Various studies have shown that fabric's porosity is the best predictor of UVR transmission through white and undyed fabrics. Fabric porosity means the openness or the tightness of the weave, e.g. Utopian fabrics used for UV protection are the ones in which yarns are entirely opaque to UVR, and the openings or pores of the fabric are tiny; hence they block the UVR transmission quite well[10]. Tight micro-fibre fabrics will provide better UV protection than fabrics made from normal-sized fibres with the same fabric construction.

Cover factor of UV protection

The formula for understanding the relationship between the cover factor and UV protection is[6]:

UPF=1/(1-cover factor).

Case I: when cover factor=0, UPF=1;
Case II: when cover factor=0.5, UPF=2;
Case III: when cover factor=0.9, UPF=10.

If UPF=50 is to be achieved, then the cover factor must be 0.98, and the fabric should be composed of fibres that absorb all non-reflected UV radiation. If the fibres absorb all of the incident radiation, then the spacing between the yarns is the only source of transmitted rays. *Table 2* shows the relationship between the cover factor and UPF value.

Hence, the textiles can be completely UV protective by increasing the cover factor. However, materials with such a high cover factor will not be suitable for clothing purposes as they cannot breathe in moderate temperatures. Hence, several other processes increase the textile's UV protection ability.

Finishes and other processes for UV protection

The objective of UV protection finishes is to tackle the prevention of harmful effects of solar ultraviolet radiation on human skin. Fabrics dyed with deeper shades provide higher UPF as compared to light shades. Black colour offers more UV protection as it absorbs the harmful rays, preventing them from entering the skin. Some chemicals that provide UV protection are phenyl salicylate, benzophenones, benzotriazole derivatives, and oxalic acid anilide derivatives. The most commonly used chemicals are benzophenones, phenylsalicylate and a few others that provide UV protection but harm the skin and the environment. Hence, researchers are working on ecofriendly ways of providing UV protection using natural substances and other processes.

Table 2 : Cover factor and UPF value

Cover Factor	UPF Value
0	1
0.5	2
0.9	10
0.98	50

The requirement for a material to be practical as a UV protective finish is an i) efficient absorption of UV radiation at 300-320 nm; ii) quick transformation of the high UV energy into vibration energy and finally into heat energy; iii) easy to apply; and iv) lack of added colour for the treated fibres.

Fibre chemistry of UV protection

A study conducted to measure the performance of 30 different commercial summer textiles noted that white cotton, linen and viscose rayon provided very little UV protection. It was also pointed out that bleached cotton easily transmitted almost all UV radiation to the skin as bleaching removes the natural pigments and lignin that absorb some amount of UV radiation. Regarding silk fabrics, bleached silk has four times higher UVR transmission than unbleached silk. On the other hand, it has been reported that wool fibres have excellent UV protecting properties, except for wool muslin which has high porosity. When it comes to protection against UV radiation, polyester is less effective as its UV transmission significantly increases at 313 nm, which is close to the boundaries of UVR spectral regions. However, this drawback can be easily corrected by adding titanium dioxide delustering, which increases the protective ability of polyester by blocking the UV rays. It has been recorded that the polyester and polyester blends with other fibres are the most suitable fabrics that provide maximum UV protection, especially regarding white and undyed fabrics[10].

Standards to measure UV protection ability of textiles

There are multiple standards for UV protective fabrics; hence, before fabric development, particular standards for the intended market should be consulted. Before developing instrumental methods, the SPF values of cloth should be determined. The standard test methods commonly used to measure the protective ability of textiles are: AS/NZS 4399 (Australia/ New Zealand), American Association of Textile Chemists and Colorists (AATCC) Test Method 183 (US), BS 7914 and European standard EN 13758-130.

Manufacturers

The major manufacturing houses of UV protective textiles are KweHwa (Taiwan) and Creora (Korea).

Protection against microorganisms

Microorganisms are present almost everywhere in the environment. The basic requirements for their growth and multiplication are water, nitrogen, carbon source and inorganic salts. Textiles are considered suitable for developing microorganisms, which can hamper the functionality and aesthetic appeal of textiles and raise various hygienic issues. Bacteria and fungi are the most problematic organisms. Textiles provide favourable conditions for the growth of bacteria and fungi by giving them with a suitable amount of moisture, temperature and nutrients. Some significant problems caused by fungi are the discolouration of textiles,

coloured stains and fibre damage. Bacteria, on the other hand, makes textile slimy, produces a foul odour, and may cause functional damage to textiles such as elasticity and tensile strength. Such fibres contain antimicrobial agents based on metallic salts, which control the fungal growth. These agents are implanted in the origin of fibres, making them permeable to washing and wear[10]. Hence, providing antimicrobial finishes to textiles is very crucial, mainly for two reasons:

- Protection of textiles against damage caused by mildew and rot-producing microorganisms. Also, to protect the textiles from the pathogenic odour-causing microorganisms and being digested by insects or pests.
- Protection of the wearer from bacteria, yeast, dermatophytes, fungi, and other microorganisms that cause aesthetic, hygienic or medical problems[3].

Antimicrobial finishes are crucial for industrial fabrics that are exposed to the weather. Materials used for awnings, screens, tents, tarpaulins and RO needed to be protected from rotting and mildew. Home furnishings like carpets, shower curtains, upholstery and mattress also need an anti-microbial finish. Antimicrobial textiles are also used where the risks of infection from pathogens are enormous, e.g. schools, hospitals, nursing homes, hotels and crowded areas. The textiles used in museums also have such finishes for preservation. Microbial growth is much higher in the presence of size/starch. Textiles left wet between processing steps for long periods also need antimicrobial treatment. It has been studied that the antimicrobial properties of silk have been used for centuries in medical practices. Natural fibres contain lignin and other substances that have inherent antimicrobial qualities. Textiles made from natural fibres mostly have better antimicrobial properties than artificial fibres due to lignin and pectin. Chemical finishing is most commonly used for imparting antimicrobial properties to natural and manufactured textiles[3]. The permeability of textile materials and garments to microorganisms is crucial, firstly to wearers in health-related workplaces and, secondly, in various industrial processes like laundries, filtration plants etc. The subject is increasingly important as employers and manufacturers struggle with health and safety requirements for protective clothing that provides actual protection. The porosity of apparel to micro-organisms needs to be considered in terms of the flow of air and liquids (e.g. air, water, blood, serum, urine and other fluids varying in viscosity), dimensions of the microorganism, and its carriers such as dust particles and skin debris (e.g. the diameter of bacteria 300-10,000 nm, virus 30-300 nm, water 0.2 nm; weight), properties of fabrics and fabric layers, and test conditions (differences in temperature, pressure, number of layers etc)[3].

The necessity of antimicrobial finishes is:

- to avoid cross infection by pathogenic microorganisms
- to arrest metabolism in microbes to reduce the formation of odour
- to safeguard the textile products from staining, discolouration and quality deterioration
- to control the infestation by microbes.

Properties of antimicrobial finishes

The growth rate of microbes is very rapid. Under ideal conditions, i.e., 36-40°C and pH 5-9, the bacteria population will double every 20-30 min. At this rate, one single bacteria cell can increase to 1048576 cells in just 7 hr. Hence, antimicrobial finishes must be quick and effective. Effective antimicrobial finish must have the following properties:

- It should prevent or control microbial growth
- It should not be toxic to the human body
- Effective on any substrates like cellulose, synthetic or its blends
- It should not affect the handle and other desired fabric properties
- It should be compatible with different finishes
- It should be colourless and odourless
- It should be fast to washing and sunlight
- It should be cost-effective
- It should endure multiple wash cycles.
- It must meet the strict regulations of the government and also must have a minimal environmental impact.

Types of antimicrobial products

Antimicrobial finishes that control the growth and spread of microbes are called bacteriostats, and products that kill microbes are called bacteriocides. Besides medical textiles, antimicrobial finishing is also essential for clothing textiles worn close to the skin, socks, stockings, underwear, and sports clothing. All antimicrobial products are divided into two basic types depending on the mode of attack on microbes.

Controlled-release mechanism

The antibacterial finish is slowly released from the reservoir on the fabric surface or the fibre's interior. This is also known as the leaching type of antimicrobial finish. This technique is very effective against microbes on the fibre surface or in the surrounding environment. Eventually, the reservoir will deplete, and the finish will extinguish. The antimicrobial released into the environment may interfere with other desirable microbes. Another widely used biocide and preservative is formaldehyde. Bound formaldehyde is released in small amounts from common easy-care and durable press finishes. Triclosan (2,4,4'- trichloro-2'-hydroxy diphenyl ether), a chlorinated bis-phenol, is a synthetic, non-ionic broad spectrum antimicrobial agent extensively used in mouthwash, toothpaste, liquid hand soap, deodorant, etc. It is effective against most bacteria, but has poor antifungal properties. It can be applied on silk and cotton following exhaust and pad-dry-cure techniques. Microencapsulation is the most recent approach for the controlled release of the antimicrobial agent. In this method, microcapsules are incorporated either in the fibre

during primary spinning or in coatings on the fabric surface.

Bound mechanism

In this method, the antimicrobial agent is bound to the fabric surface. It controls those microbes that are present on the surface of the fibre and not the ones present in the surrounding environment. Due to their attachment to the fibre, bound antimicrobials tend to be abraded away or become deactivated and have poor long-term durability. Several antimicrobial finishes that function in bound mechanism have been commercialised and can be applied either padding or exhaust method. During curing, the fibre surface is coated with siloxanes polymer which immobilises the antimicrobial part of the molecule and provides durability to laundering. The antimicrobial agent depicting bound mechanisms is polyhexamethylene biguanide. Another novel approach is the application of chitosan; this modified biopolymer is manufactured from inexpensive natural waste. The advantages of the antimicrobial finish with chitosan include high absorbency properties, moisture control, and non-toxic and biodegradable properties.

Agents used for antimicrobial finishing

Some of the majorly used antimicrobial agents used are metals/ metal salts, ionising agents, N-halamines, organic chemicals, and natural polymers. Silver-based compounds are considered anti-microbial finishes. Some cationic softeners can also be deemed to have varying antimicrobial action. Textiles are treated with organic compounds such as triclosan, quaternary ammonium, polyhexamethylene biguanide, N-halamines, chitosan, and inorganic materials such as silver and titanium oxide (TiO_2) for antimicrobial functionality. Inorganic salts, organometallics, phenols, thiophenols, heterocyclics with anionicgroups, nitro compounds, urea, formaldehyde derivatives and amines are also used for antimicrobial finishing[3]. Some commercial antimicrobial agents are Sanitized T 90-04 and RUCO-BAC AGP. RUCO-BAC AGP is a silver-based anti-bacterial finishing agent. Hygienic finish for all types of fibres, bacteriocidal and slightly fungicidal properties, highly resistant to washing and dry cleaning, does not affect the hydrophilic property, rubbing, perspiration and light fastness properties of dyed materials. 2:1 zinc metal complex dye has prominent antimicrobial properties against the uncomplexed mono-azo dyes.

Ecofriendly antimicrobial agents

Many natural and ecofriendly products can be used as antimicrobial agents like neem, aloe vera, tulsi, eucalyptus, clove, gall nut, Indian madder etc, which exhibit good antimicrobial activity[11]. Some researchers used natural extract for antimicrobial activity. Koh et al applied gall nut extract for cellulose and protein fibres to obtain antimicrobial protective textiles. Organosilicone, one of the most popular softeners in the textile industry, can impart unique softness, smoothness, elasticity and cotton-like hands, and confers the fabrics with a perfect drape, anti-wrinkle, wettability, and breathability. In recent years, organosilicone antimicrobial agents have been prepared through chemical grafting or the physical blending of micro biocides and organic silicone[3].

Insect and mite-resistant finish

Insect-resistant finishes are chemically treated textiles that protect keratin-containing wool and other animal fibres from attack by larvae of some moths and beetles. Mites are not insects; they belong to the arachnid (spider) family. Mite-resistant finishes protect from dust mites that increase rapidly in bedding, mattresses and quilts. The most important market for insect-resistant finishes is the carpet industry. Other applications of insect-resistant textiles are upholstery fabrics, blankets, uniforms, apparel, and furs. Some measures to protect materials from damage by insects and micro-organisms are repeated airing of products, maintaining lower room temperature, regular washing, and cleaning products, especially before storing them.

Types

- Digestive poisons: These specific poisons interfere with the keratin-digesting process of the larvae and kill them by blocking enzymes needed for digestion. Such agents include chlorinated triphenylmethane, chlorphenylids and sulcofenuron. These poisons have minimal environmental hazards.
- Nerve poisons: These chlorinated hydrocarbons attack the nervous system of the insects. Such agents include dieldrin, permethrin and hexahydropyrimidone. These poisons are more effective than digestive poisons, but are not used since 1970s because of their harmful environmental effects and danger to aquatic life.

Manufacturers

Some significant manufacturers of anti-bacterial and insect resistant textiles are:

- DuPont's Biowear materials for protection against bloodborne pathogens.
- A Japanese product, Bactekiller (Kanebo), has bacteriocides built into the polyester fibre during the extrusion process. Based on zeolite salts, the bacteria-killing agent stays in the fibre, even when dyed, processed or washed. A unique feature is that the bacteriocides medium (sodium alumino silicate) makes it applicable where dehumidifying, deodorant and absorbent properties are essential.
- Celanese acetate has a microbial acetate based on Microban that may be applicable for some areas, though such products are usually limited in their effectiveness. They are primarily for odour control, like in socks. Other work is being done - for hospital upholstery, drapes and other applications, using different methods[12].

Conclusion

Textiles have come a long way from

just being interlaced warp and wept, shielding the skin against minimal weather conditions and being adorned for their beauty. Textiles have evolved and become a shield that protects human bodies from lethal risks. The protective textile industry is evolving regarding technological advancement and respect for its growing demands worldwide. The market of the protective textile industry requires innovation along with cost-effectiveness. There is a huge opportunity, and high demand for such functional and protective products as people are becoming more concerned about their health and safety issues, especially at work. The current market might be small, but is anticipated to have tremendous growth in the near future.

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Beyond big data and tailored for textiles

Over the past three years, a dedicated AI development team at BTMA member Shelton Vision has been developing tailored machine learning solutions for the textiles industry. The aim has been to elevate the detection process and the accuracy of naming and grading subtle defects in textiles, in real time within production environments. 'Big Data 'off-the-shelf' systems such as those behind technolgies like facial recognition and Google Maps involve reading many thousands of single images each second and simply take too long to accumulate sufficient data for what's required in this specific case,' says Shelton Vision CEO and MD Mark Shelton. 'A feature of the textile industry is that, in many sectors, the product range changes several times within a year and it is not uncommon to have to inspect hundreds, if not thousands of different styles in a year based on precise settings.' In terms of defect types, he adds, there may typically be over 100 that need to be accurately detected, classified (named) and graded in real time. 'Added to this is the need to 'filter out' the random occurrence of 'non defects', such as loose threads, lint and dust on the surface - the number of which can be higher than actual defects - and it is clear that a bespoke system is required.'

The development team has consequently established metadata for identifying defect properties, enabling the successful identification of faults from a much smaller number of images. 'The system employs a unique combination of machine learning for automated style training and novel algorithms for defect detection, to provide high quality images for the AI real time defect classification and grading software,' Shelton explains. 'Due to the inherent variation in fabric features - raw materials, construction, texture, colour and finishes, as well as the differing product quality standards in value chains and the regional variations in what defects are called - our AI engine uses models built for each individual company or group of companies, or product value chain.'

The AI models are constructed so that the user operatives can populate them with their own data produced by the vision system or by obtaining defect images from another imaging source. A further feature is a tool enabling the user to periodically 'clean up' the AI data during the set up phase. This is used to resolve conflicting data and to correct mis-named images. There is a need for the real time detection of defects that are being created in separate processes, such as printing or coating and for real time automated systems that can accurately determine the defects and their severity and provide a reliable signal for an operative to rectify the issue, This can result in considerable savings.

'Studies show that the intelligent fabric inspection systems of Shelton Vision's WebSpector with tailored AI solutions outperform human inspection in terms of speed, accuracy and consistency,' says Jason Kent, CEO of the British Textile Machinery Association (BTMA). 'In addition, there is a global drift of people away from the type of activity that fabric inspection requires, making the company's technology increasingly valuable to forward-looking mills.'

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Application of Musa acuminate extract on cotton textiles as antibacterial agent

Arunava Das[1], P Deepesh, G Shanmuga Priya, S Soundariya, J Bindhu and Subrata Das

Molecular Diagnostics Lab, Bannari Amman Institute of Technology, Tamil Nadu, India
[1]Faculty of Life Sciences, Mandsaur University, Mandsaur, Madhya Pradesh, India
subratactl@gmail.com

Antimicrobials from plants have enormous therapeutic potential. They are effective in the treatment of the infectious diseases while simultaneously mitigating many of the side effects often associated with synthetic compounds. The beneficial medicinal effects of plant materials typically result from the combinations of secondary products present in the plants. *Musa acuminata* is a species of banana native to southeast Asia. Many of the modern edible dessert bananas are from this species, although some are hybrids with *Musa balbisiana*. First cultivated by humans around 8000 BCE, it is one of the early examples of domesticated plants. Recently, *Musa sp* (Musaceae), also known as banana, has evolved to be one of the largest herbaceous flowering plants recognized all over the world. *Musa sp,* being a most popular fruit, is widely exported to a number of industrialized countries. Tropical and sub-tropical regions of the world consume more bananas in common. Having southwestern pacific as native, banana is recognized as a tropical fruit.

People are rediscovering finishing compounds through natural sources

Almost every part of banana plant has its own significant use that is useful to mankind in many aspects. Being highly polymorphous, *Musa acuminata* is a spindly plant that is grown in clumps. The optimum temperature for the growth of *Musa acuminata* is 80ºF (26.67ºC) and the optimum mean rainfall is 4 in (10 cm) per month.

Musa species, highly known for its medicinal purposes, is beneficial to mankind. Heart pain, asthma, endocrine problems like diabetes etc can be treated by the flowers of banana. Stomach cramps and diarrhoea can be treated by consuming banana leaves; menses pain and bleeding due to menopause can be reduced by the uptake of banana leaves by women; infantile malnutrition and weak body can be suppressed with the help of banana blossoms etc. Being a weak primary antioxidant source, *Musa acuminata* has proven to be a powerful secondary antioxidant source. Ascorbic acid, beta carotene, phenolic groups, dopamine etc are the antioxidant compounds found in *Musa acuminata*. Being a good source of bioactive phytochemicals, *Musa acuminata* provides opportunities for the functional food industry.

Today, people around the globe are rediscovering finishing compounds through the use of renewable and non-toxic natural sources. For successful commercial use of natural products for any particular fibres, the appropriate scientific standardized techniques/procedures are to be derived. Thus, relevant scientific studies and its output on standardization of finishing methods have become very important. In order to identify ecofriendly antimicrobial agent and its application on cotton fabric, an investigation has been conducted to characterise and explore *Musa acuminata* for the possibility of using it as an antibacterial agent.

Experimental

Identification and handling of sample

Arid flowers of *Musa acuminata* were collected from Sathyamangalam, India, forest.

Using plastic bags, the flowers collected were transferred to the lab, dried, finely powered and stored in a non-toxic polyethylene bag.

Plant extract preparation

10 gm powdered mass was extracted using 200 ml Methanol solvent. Dark maceration for 72 hr at 27°C was considered for the extraction process, and muslin cloth was used for filtration. The pasty layer of extract was formed after the filtrate was condensed at 45°C and used for further assays.

Fabric

The bleached and mercerized cotton fabric used as a substrate in the study was procured from the retail sector at Tirupur, India. The processes involved for producing the fabric were singeing, desizing, scouring, bleaching and mercerization.

Treatment of cotton fabric with alum

Alum is a representative name of potassium aluminium sulfate. Its appearance is slight crystalline powder and chemical formula is $KAl(SO_4)_2.12H_2O$. It is a good soluble salt in water. The bleached and mercerized cotton fabric was treated with 5% alum. The MLR was 1:30. The alum was dissolved in water and kept at water bath temperature of 70°C. The cotton fabric was treated for about 1 hr and dried in hot air oven.

Applications of the methanolic extract

The alum treated samples were treated with purified powder mass solution of 30% concentration for 1 hr at 70°C. Then, the samples were dried in hot air oven at 100°C for 10 min.

Testing and analysis

Phytochemical screening

Test for alkaloids

To 3 ml of the extract, 1 ml of Mayer's reagent was added and shaken well. Presence of alkaloids was indicated by the white precipitate at the bottom.

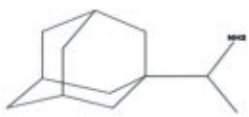
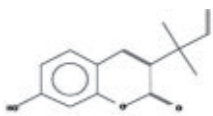
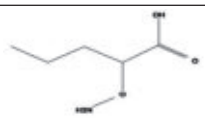
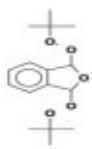
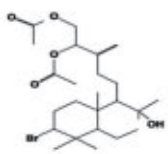
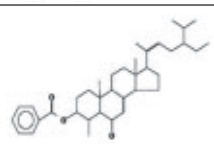
Test for phlobatannins

10 ml of aqueous extract of flower was boiled with 1% HCl. Presence of phlobatannins was indicated by the thick red precipitate deposition at the bottom.

Test for triterpenoids

Salkawasaki test was used to

Table 1 : GCMS analysis result for major phytocomponents in Musa acuminata flower

RT	Compound name	Molecular formula	Molecular weight	Peak area	Molecular structure
25.933	1-adamantanemethylamine, alpha.-methyl-	$C_{12}H_{21}N$	179	3.555	
26.108	7-hydroxy-3-(1,1-dimethylprop-2-enyl) coumarin	$C_{14}H_{14}O_3$	230	4.025	
26.508	pentanoic acid, 2-(aminooxy)-	$C_5H_{11}O_3N$	133	10.832	
27.663	1,3-bis-t-butylperoxy-phthalan	$C_{16}H_{24}O_5$	296	5.798	
29.364	1,2-pentanediol, 5-(6-bromodecahydro-2-hydroxy-2,5,5a,8a-tetramethyl-l-naphthalenyl)-3-methylene	$C_{24}H_{39}O_5Br$	486	18.411	
29.544	Carpesterol dehydrate	$C_{37}H_{52}O_3$	544	57.378	

indicate triterpenoids in the extract. 2 ml of extract was taken and 5 drops of concentrated sulphuric acid was added, shaken and allowed to stand. Presence of triterpenoids was indicated by the appearance of greenish blue colour.

Test for flavonoids

Alkaline reagent was used to indicate the presence of flavanoids in the extract. To 1 ml of the extract, few drops (3 drops) of 10% NaOH solution were added. Flavonoids was indicated by intense yellow colour, which disappeared on addition of a few drops of dilute acid.

Test for lipids

To 10 ml of the extract, 0.5 N alcoholic potassium hydroxide was added along with a drop of phenolphthalein. The mixtures were heated on water bath for 1 hr. The presence of lipids was indicated by the formation of foam or soapy layer.

Test for steroids

To 5 ml of aqueous extract, 2 ml of chloroform and few drops of concentrated H_2SO_4 were added. The presence of steroids was indicated by the appearance of red colour in the upper layer; while yellow with greenish fluorescence appears in the H_2SO_4 layer.

Test for terpenoids

To 1 ml of the aqueous extract, 1 ml of chloroform was added and mixed well and left for 5 min, 1 ml concentrated H_2SO_4 was added after 5 min. The presence of terpenoids was indicated by the appearance of greyish layer.

Antioxidant assay

The antioxidant capacity of *Musa acuminata* was identified through 2,2-Diphenyl-1-picryhydrazyl (DPPH) assay. Equal volumes samples at different concentrations were made with 0.1 mM of DPPH. Then, the mixture was stored in dark place for 30 min. The colour change from violet to yellow indicated the presence of antioxidants. Quantification was calculated by absorbance. The absorbance was performed in triplicates. Ascorbic acid was used as the standard to compare with samples; IC50 (inhibition concentration) was calculated for both, the sample and the standard. The percentage of inhibition was calculated using the following formula:

% inhibition= $[A_o-A_1/A_o] \times 100$

where, A_o is absorbance of control (i.e. DPPH solution without sample); and A1 is absorbance of sample or standard (i.e. DPPH solution with sample/standard).

GC-MS

The treated sample was subjected to GC-MS analysis to quantify the number of molecules and its structures. The analysis was carried out using GCMS (Perkin Elmer model: Clarus 680) equipped with mass spectrometer (Clarus 600 EI) and analysed using TurboMass 5.4.2 software. Fused silica was packed with Elite-5MS. At a constant flow rate of about 1 µl/min, carrier gas such as helium was used to separate the components. The temperature of the injector was adjusted to 260°C while performing the experiment. The extract sample of 1 µl was injected into the equipment; the temperature of the oven were 60°C (2 min), followed by 300°C at the rate of 10°C min^{-1}, and 300°C for 6 min. The temperature of transfer line of the mass detector was 240°C; ionization mode electron impact at 70 eV; the duration time of scan interval was

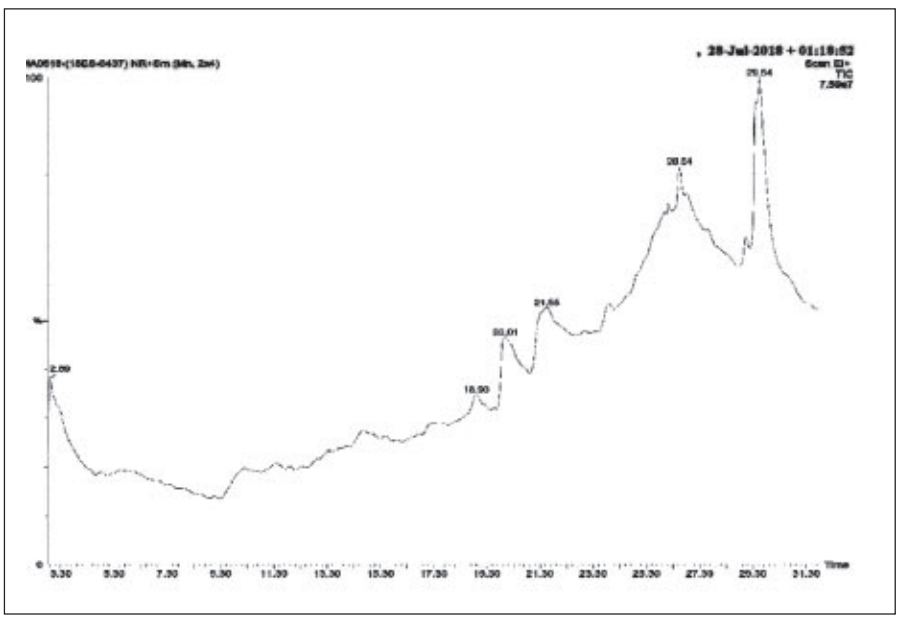


Fig 1 : Chromatogram of compounds present in Musa acuminata

Table 2 : Different bacteria and its zone of inhibition

Microorganism	Zone Of inhibition in extracts (mm)
Streptococcus agalactiae	6
Bacillus cereus	5.4
Staphylococcus aureus	10
Enterobacter aerogenes	7
Eschericia coli	6.6
Bacillus subtilis	8

Table 3 : Phytochemical constituents of Musa acuminata flower extract

Phytochemical constituent	Presence
Alkaloids	+
Phlobatannins	+
Triterpenoids	+
Flavonoids	+
Lipids	+
Steroids	+
Terpenoids	+

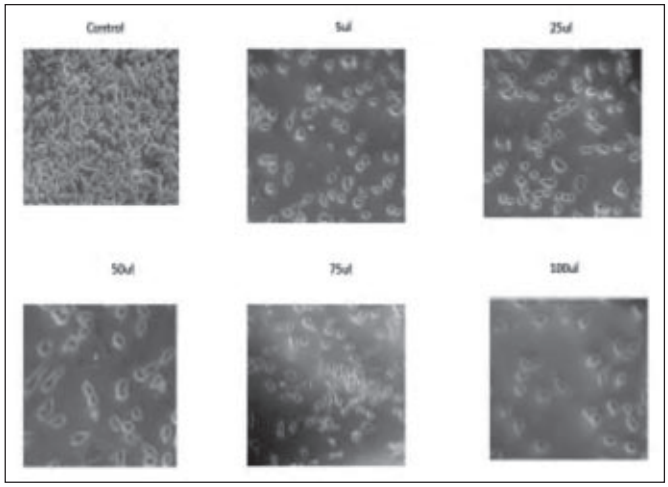


Fig 2 : Hela cell reactions at different sample concentrations

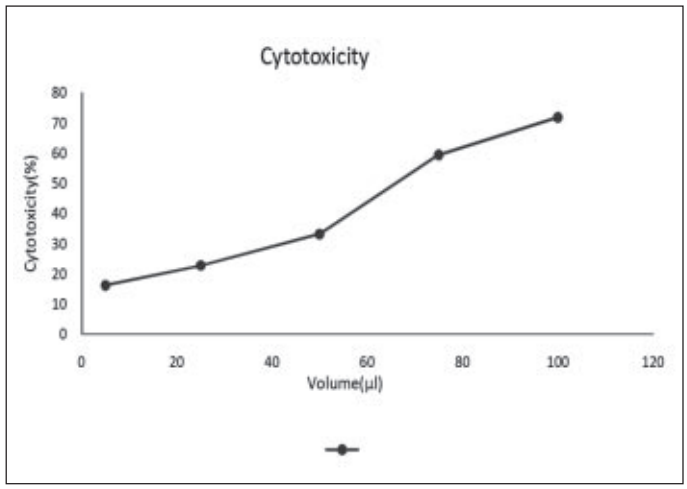


Fig 3 : Cell death percentage of hela cells against Musa acuminata

Table 4 : Cytotoxic reactivity of Musa acuminata flower extract

Vol (µl)	Cytotoxicity (%)	Cell viability (%)	Cytotoxic reactivity
5	16.2	83.8	Slight
25	22.8	72.8	Mild
50	33.2	66.8	Mild
75	59.5	40.5	Moderate
100	71.9	28.1	Severe

0.2 sec; and scan interval was 0.1 sec. The fragments ranged from 40 to 600 Da. The spectrum of components was corresponding to the database of the spectrum of the established components gathered in the GC-MS NIST library.

Antibacterial assay

Antibacterial activity was determined by agar well diffusion method. Swabbing using sterile cotton swabs was done on nutrient agar (NA) plates with 8 hr old broth culture of different bacteria such as *Streptococcus agalactiae, Bacillus cereus, Staphylococcus aureus, Enterobacteraerogenes, Eschericia coli* and *Bacillus subtilis*. In each of these plates, wells (10 mm diameter and about 2 cm apart) were made using sterile gel puncher. From the methanolic flower extract, 1 mg/ml concentration of stock solution was prepared. Cotton fabric samples were treated with flower solvent extracts, placed into the wells and allowed to settle at room temperature for 2 hr. Inoculums without plant extract were set up for control experiments. Incubation of the plates was done at 37°C for 18-24 hr for bacterial pathogen. The zone of inhibition was observed and the diameter of the inhibition zone (mm) was measured. Triplicates were maintained and the experiment was repeated thrice; for each replicates, three readings were taken and the average values were recorded.

Cytotoxic assay (MTT method)

The sample was performed with an in vitro cytotoxicity test method. The culture medium from the hela cells was replaced with fresh medium. The triplicates of the test sample were added on the cells. Incubation at 37°C for 18 hr was done. After incubation, MTT (1 mg/ml) were added in the wells and incubation was done for 4 hr. DMSO was added in the wells after incubation and read at 570 nm using photometer. Cytotoxicity and cell viability were calculated as:

Cytotoxicity = [(Control-Treated)/ Control] x 100

Cell viability = (Treated/Control) x 100

Results and discussion

The chemical composition of the extract was studied using GC-MS analysis. The peak was identified as pentanoic acid, 2-(aminooxy) - an aromatic phenolic group of salicylic acid, at a retention time of 26.508 min. The next compound was identified as 1,3-bis-t-butylperoxy-phthalan belonging to aromatic phenolic group of salicylic acid giving a peak at 27.663 retention time. The next peak was observed at 29.364 retention time which was identified as 1,2-pentanediol, 5-(6-bromodecahydro-2-hydroxy-2,5,5a,8a-tetramethyl-1-naphthalenyl)-3-methylene that belongs to the aromatic phenolic groups of salicylic acid. The final peak was observed at 29.544 retention time and the compound was identified as carpesterol dehydrate, an aromatic phenolic group of salicylic acid compound. The GCMS analysis result for major phytocomponents in *Musa acuminata* flower is given in *Table 1*.

The chromatogram of compounds present in *Musa acuminata* is represented in *Fig 1*.

The crude extract of *Musa acuminata* was obtained from maceration with 80% methanol. Antibacterial assay of the flower extract against gram positive and negative

bacteria were determined by the formation of zone of inhibition around the wells. The negative control (methanol) showed zero zone of inhibition. The zone of inhibition of *S aureus* shows greater diameter of 10 mm over the flower extract; while the zone of inhibition of other bacterial strains ranges from 5 mm to 8 mm. The antibacterial activity, i.e. the formation of the zone of inhibition in the agar well diffusion method, is due to the presence of active compounds in the flower extract. Different bacteria and its zone of inhibition are tabulated in *Table 2*.

The phytochemical constituents of *Musa acuminata* flower extract is tabulated in *Table 3*.

The MTT assay result in the sample showed slight to severe cytotoxic reactivity to hela cells. The cell death increased with the increase in concentration on the sample. Another experimental study of anthocyanin extracted from *Musa acuminata* bract showed a strong anticancer activity against of MCF-7 cell lines (breast cancer). Another experimental result tested against carcinoma of cervix (hela) showed increased effect in a dose-dependent manner against the extracts from rhizome of *Musa acuminata*. The control gave no cytotoxic reactivity. The activity of sample at different concentrations against the cells is displayed in *Fig 2*. The cytotoxicity is represented in *Fig 3*. The cytotoxic reactivity of *Musa acuminata* flower extract is displayed in *Table 4*.

Conclusion

Banana tree, being one of the most economically important trees worldwide, is cut once the fruits are harvested. However, other parts of the tree are used in medicine worldwide. In this study, the flower extract of *Musa acuminata* is extracted by maceration with methanol, and the phenolic and aliphatic compounds present in the flower extract are identified using GC-MS analysis. Phytochemical screening of the banana extract showed the presence of alkaloids, phlobatannins, triterpanoids, flavanoids, lipids, steroids and terpenoids. Potent antibacterial activity is observed from the cotton fabrics treated with the flower extract against the gram positive and negative bacteria.

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Extraction and application of ecofriendly natural dye from tree barks on silk fabrics

Aditi Dhama and Deepa Tyagi
Amity School of Fashion Technology, Amity University, Greater Noida, India
adhama@gn.amity.edu.in

Plant source means any part of plant: bark, fruit, flower, leaf, wood, root, twig or seed. There are different types of trees around us: shrub, small and big trees. Every tree is planted or cultivated around not only for shade and ornamental purpose, but also for other uses, such as buildings, paper, medicine, fuel, adhesive, plants, inks, textiles etc[5]. The components of the natural dyes present in minerals, plant parts and animals give colour to the fabric materials. Awareness about environmental protection is increasing these days. The need of the day is to give importance to natural dyes which are an alternative to synthetic dyes.[6]

Synthetic dyes have some advantages such as colour fastness, good reproducibility of shade, colour brightness and use, but these are allergic, carcinogenic and harmful to the human health. Interest in the use of natural dyes is increasing rapidly today due to the introduction of environmental standards, resulting in the avoidance of synthetic dyes, which cause side effects[4]. During the past decades, global interest in the study of various medicinal plants has increased rapidly due to their antibacterial and antioxidant activities, low toxicity and potential to be a cheap alternative to expensive synthetic drugs[1].

Silk can be successfully dyed with tree barks for satisfactory fastness results with or without mordants

In the current research work, the bark (Acacia Nilotica, Toona Ciliata, and Eucalyptus's tree) was used for the extraction of dye, the dyeing of the selected silk fabric at optimized conditions, and evaluating the colour fastness of the dyed sample.

Materials and methods

Raw materials

The barks of Acacia Nilotica, Toona Ciliata and Eucalyptus tree were collected from Tanshipur

village, Haridwar district, India.

The mordants were purchased from Muzaffarnagar, India. Their names are given as: sodium carbonate and tannic acid.

The silk fabric was purchased from Muzaffarnagar, India.

The collected bark and leaves were thoroughly cleaned under running tap water and then dried in shade for 3-4 days, and then ground into a fine powder using an electronic grinder.

Initial process of fabric dyeing

Scouring with ECE phosphate detergent was done to prepare the fabric for dyeing.

Final fabric preparation

A solution containing 0.5 ml of mild detergent per 100 ml of water was prepared and heated to 50°C. These clothes were dipped in the solution and stirred gently for about 30 min. It was then washed under tap water until free of traces of the detergent.

Experimental

Dye extraction

The bark dried in clean air was cut into small pieces and coarsely ground using an electric grinder. The aqueous medium was prepared in 300 ml of water without using chemicals; pH 6 was maintained separately by adding 30 gm of dyestuff; the dye was extracted for 90 min at 90°C; and the solution was filtered by muslin cloth.

Optimization of parameters for fabric dyeing

A series of following experiments were conducted to determine the dyeing time and temperature:

- **Dyeing time:** Three options were considered for optimizing the dyeing time, i.e., 45, 60 and 90 min. The best result was found at 90 min and was selected for the study.
- **Dyeing temperature:** There were 3 options for customizing the dyeing temperature 45°C, 60°C and 80°C. 80°C was found to have the best result and hence selected for the study.

Identification of the obtained dyes

The dyed samples were placed on a black background to obtain smoothness from the natural dye, grouped on the basis of colour difference and given a colour name.

Determination of concentration of extracted dyes

The extracted dyes were assessed for concentration using transmittance made from CCM (Computer Colour Matching System).

Testing and analysis

The dyed fabrics were tested for their following colour fastness properties as below:

Colour fastness to wash

This method is designed to determine the effect of washing on the colour fastness of a garment. A sample of cloth is brought into contact with specified cloth pieces which are mechanically stirred in a soap solution, washed and then dried. The change in the colour of the sample and the staining of adjacent fabrics are assessed with standard grayscale. The test pieces were randomly selected from the entire dyed fabric and drawn from it as 10x4 cm test pieces. An appropriate mechanical washing apparatus (launder-o-meter), ISO 105 C06 and AATCC 61 was used.

Table 1 : Optical density

Name	Optical density
Water	0.042
Kikar bark	1.381
Toona Ciliata bark	2.454
Eucalyptus bark	1.786

Colour fastness to light

The colour fastness of textile materials to daylight is of great importance to consumers. Since daylight takes a long time to complete the test, artificial light (xenon), ISO 105 B02 and AATCC 16 is a quick way to determine the colour fastness. The purpose of this method is to determine the resistance of fabric colour to the action of a standard artificial light source. Xenon lamps have an emission wavelength profile close to that of daylight. A 10x4 cm test specimen and a blue wool standard specimen were used for testing.

Colour fastness to rubbing

Rubbing fastness determines the colour fastness of a textile material to rubbing and staining. The test specimen was fixed using a clamp on the rubbing device. Two tests were set, one with a dry scrubbing cloth, and the other with a wet scrubbing cloth. The tests pieces were randomly selected from the dyed fabric. Two pieces, each of 14x5 cm, were drawn from the samples; one piece with the long arm parallel to the warp

Table 2 : Colours obtained from barks

Dye	Fabric sample	Dyed sample without mordants	Dyed sample with mordants	
			Sodium carbonate	Tannic acid
		Obtained colour	Obtained colour	Obtained colour
Acacia Nilotica bark	Silk fabric	Pale brown colour	Soil brown colour	Soil brown colour
Toona Ciliata bark	Silk fabric	Light peach colour	Peach colour	Darker peach colour
Eucalyptus bark	Silk fabric	Light human skin colour	Human skin colour	Darker human skin colour

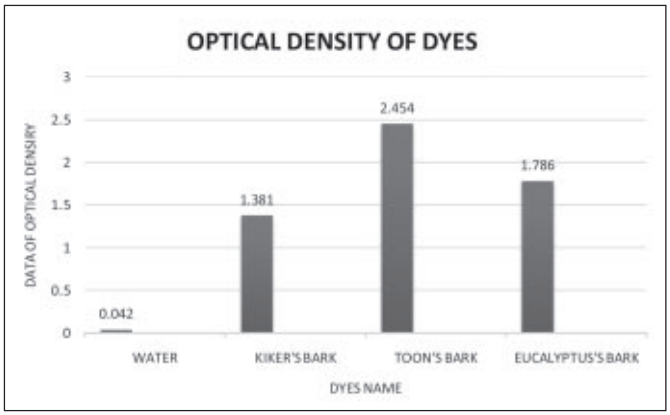

Fig 1 : Optical density of dyes

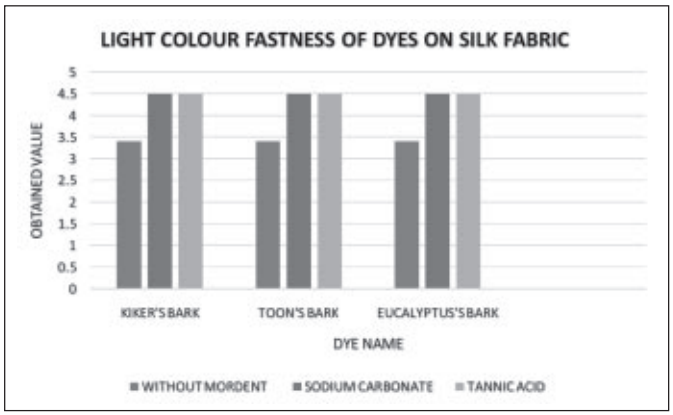

Fig 2 : Light colour fastness of dyes on silk fabric

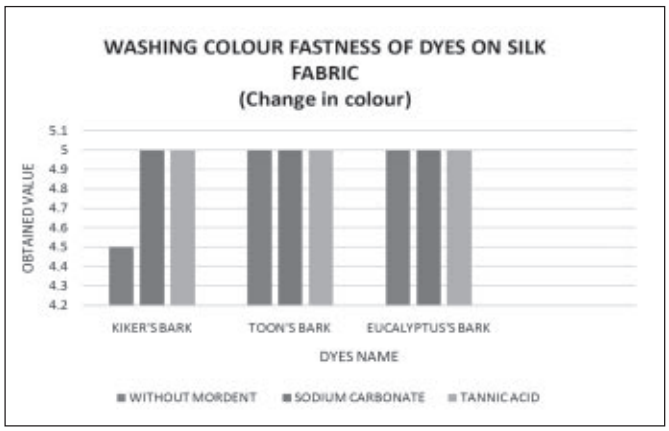

Fig 3 : Washing colour fastness of dyes on silk fabric (Change in colour)

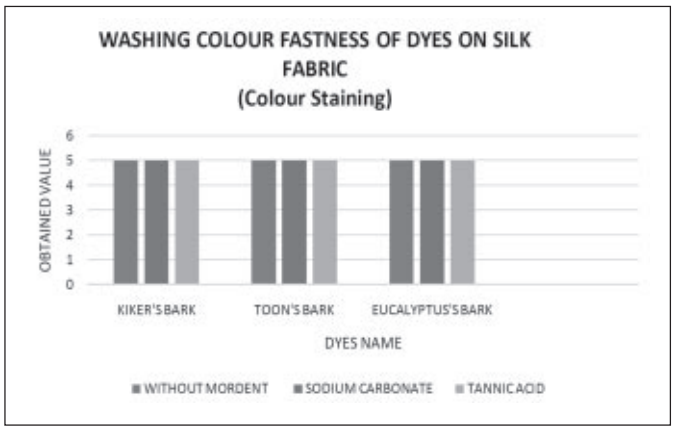

Fig 4 : Washing colour fastness of dyes on silk fabric (Colour staining)

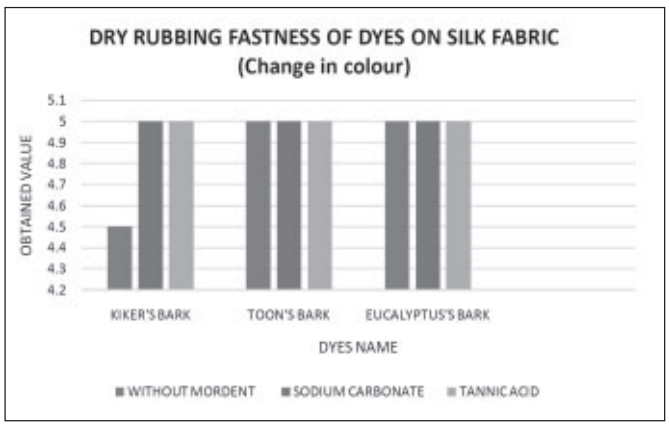

Fig 5 : Dry rubbing fastness of dyes on silk fabric (Change in colour)

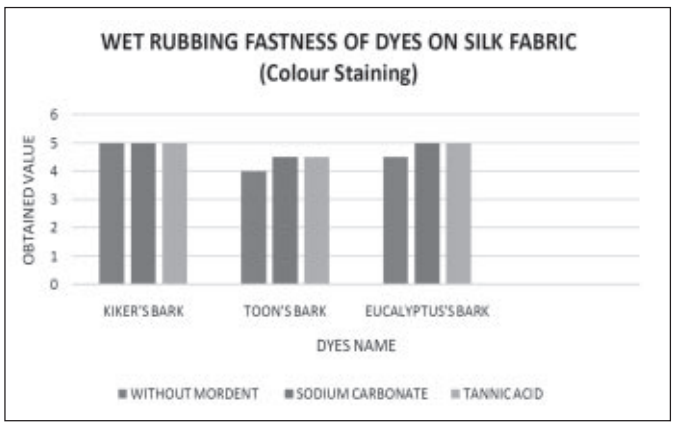

Fig 6 : Wet rubbing fastness of dyes on silk fabric (Colour staining)

thread, and the other parallel to the weft thread. A suitable mechanical device, crock-o-meter, ISO 105x12 and AATCC 8 were used.

Colour fastness to perspiration

Clothing that comes in contact with the body, where sweating is high, may suffer from a series of local discolouration. This test is to determine the resistance of a dyed garment to the action of acidic and alkaline perspiration. This type of test is specifically used for sports and heavy outfits. An appropriate mechanical device such as perspirometer, ISO 105 E04 and AATCC 15 were used. A 10x4 sample size is taken and stitched on one side with a 10x4 multi-fibre.

Results and discussion

Concentration of extracted dye

The value of the dye solution concentration in OD (optical density) is

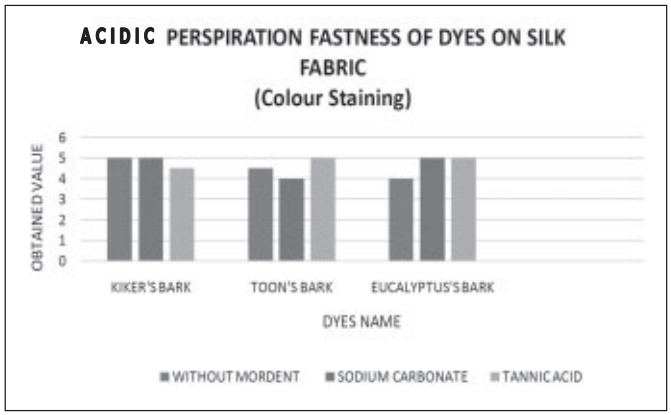

Fig 7 : Acidic perspiration fastness of dyes on silk fabric (Colour staining)

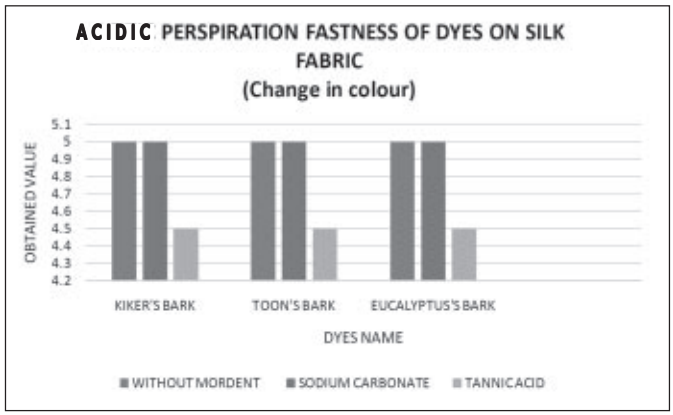

Fig 8 : Acidic perspiration fastness of dyes on silk fabric (Change in colour)

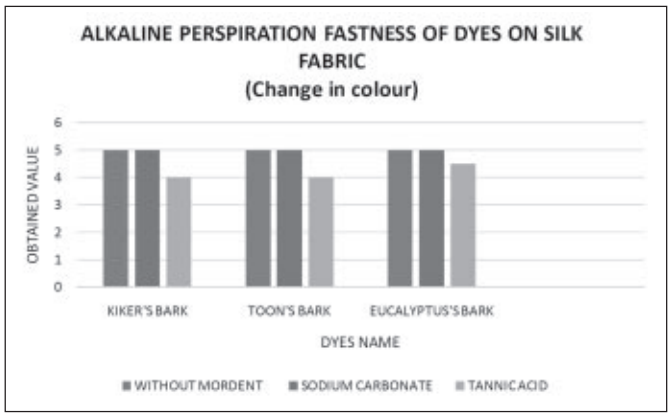

Fig 9 : Alkaline perspiration fastness of dyes on silk fabric (Change in colour)

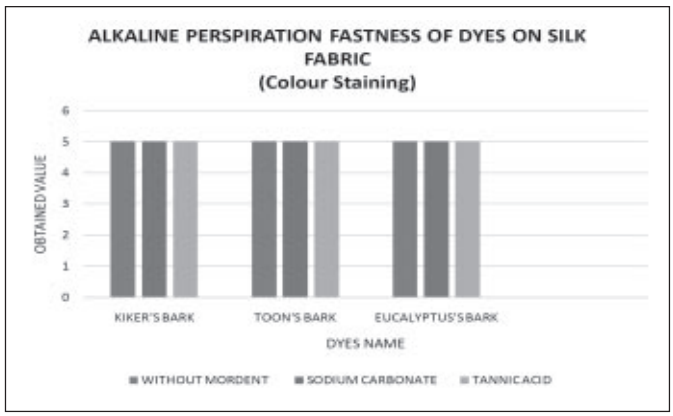

Fig 10 : Alkaline perspiration fastness of dyes on silk fabric (Colour staining)

Table 3 : Light fastness

Dye	Fabric sample	Dyed sample without mordants	Dyed sample with mordants	
			Sodium carbonate	Tannic acid
		Obtained colour	Obtained colour	Obtained colour
Acacia Nilotica bark	Silk fabric	3-4	4-5	4-5
Toona Ciliata bark	Silk fabric	3-4	4-5	4-5
Eucalyptus bark	Silk fabric	3-4	4-5	4-5

given in *Table 1 (Fig 1)*.

From the optical density, it is clear that the dye extracted from Toona Ciliata's bark is darker than water as well as the other two barks (Acacia Nilotica and Eucalyptus).

Colours obtained

Different colours were obtained from the various barks, as given in *Table 2*.

The dyed sample gave good range of colours. Two mordants, namely sodium

Table 4 : Colour fastness to wash

Dye	Fabric sample	Dyed sample without mordants		Dyed sample with mordants			
				Sodium carbonate		Tannic acid	
		Change in colour	Staining	Change in colour	Staining	Change in colour	Staining
Acacia Nilotica bark	Silk fabric	4-5	5	5	5	5	5
Toona Ciliata bark	Silk fabric	5	5	5	5	5	5
Eucalyptus bark	Silk fabric	5	5	5	5	5	5

Table 5 : Colour fastness to dry rubbing

Dye	Fabric sample	Dyed sample without mordants		Dyed sample with mordants			
				Sodium carbonate		Tannic acid	
		Change in colour	Staining	Change in colour	Staining	Change in colour	Staining
Acacia Nilotica bark	Silk fabric	4-5	5	5	5	5	5
Toona Ciliata bark	Silk fabric	5	4	5	4-5	5	4-5
Eucalyptus bark	Silk fabric	5	4-5	5	5	5	5

Table 6 : Colour fastness to wet rubbing

Dye	Fabric sample	Dyed sample without mordants		Dyed sample with mordants			
				Sodium carbonate		Tannic acid	
		Change in colour	Staining	Change in colour	Staining	Change in colour	Staining
Acacia Nilotica bark	Silk fabric	4-5	4	5	4-5	5	5
Toona Ciliata bark	Silk fabric	5	4-5	5	4	4	3-4
Eucalyptus bark	Silk fabric	5	4	5	4-5	5	4-5

Table 7 : Acidic medium results (Colour fastness to perspiration)

Dye	Fabric sample	Dyed sample without mordants		Dyed sample with mordants			
				Sodium carbonate		Tannic acid	
		Change in colour	Staining	Change in colour	Staining	Change in colour	Staining
Acacia Nilotica bark	Silk fabric	5	5	5	5	4-5	4-5
Toona Ciliata bark	Silk fabric	5	4-5	5	4	4-5	5
Eucalyptus bark	Silk fabric	5	4	5	5	5	4-5

Table 8 : Alkaline medium results (Colour fastness to perspiration)

Dye	Fabric sample	Dyed sample without mordants		Dyed sample with mordants			
				Sodium carbonate		Tannic acid	
		Change in colour	Staining	Change in colour	Staining	Change in colour	Staining
Acacia Nilotica bark	Silk fabric	5	5	5	5	4	5
Toona Ciliata bark	Silk fabric	5	5	5	5	4	5
Eucalyptus bark	Silk fabric	5	5	5	5	4-5	5

carbonate and tannic acid were used to achieve a wider range of colours. The obtained dye colour was identifed by the Nerolac deck colour shade card booklet.

Analysis of fastness properties

Light fastness

The dyed silk fabric was treated with three different natural dyes and mordants, and then given the light test. The results are given in *Table 3 (Fig 2)*.

All three (Acacia Nilotica, Toona Ciliata and Eucalyptus barks) natural dyes showed fair to fairly good (3-4) light fastness on silk fabric. Silk fabric, when mordanted with sodium carbonate and tannic acid, showed fairly good to good (4-5) light fastness.

Colour fastness to wash

For colour fastness to wash, the samples were rated on the basis of change in colour as well as degree of staining of adjacent fabrics. Five point scale was used to evaluate both, change in colour and staining. Results obtained are recorded in *Table 4 (Figs 3 & 4)*.

All three natural dyes showed no change (5) in colour and the staining on adjacent fabric was nil (5). Silk fabric, when mordanted with Sodium carbonate and tannic acid, showed no change (5) in colour; the staining on adjacent fabric was nil (5).

Colour fastness to rubbing

The samples of silk fabric were rated for colour fastness to rubbing within wet and dry conditions with respect to change in colour and staining on adjacent sample for the dyed sample. The results obtained are recorded in *Tables 5 & 6 (Figs 5 & 6)*.

All three natural dyes showed

satisfactory results in colour, and the staining on adjacent fabric was no change (5). Silk fabric, when mordanted with sodium carbonate and tannic acid, showed no change (5) in colour; the staining on adjacent fabric was slightly change to no change (4-5) and no change (5).

Colour fastness to perspiration

The selected sample was rated for colour fastness to perspiration in both, acidic and alkaline, with respect to change in colour and degree of staining on the adjacent fabric. The reading with the greyscale was taken and recorded in *Tables 7 & 8 (Figs 7-10)*.

All three natural dyes showed no change (5) in colour; the staining on adjacent fabric was no change (5). Silk fabric, when mordanted with sodium carbonate and tannic acid, showed no change (5) in colour; the staining on adjacent fabric was slightly change to no change (4-5) and no change (5).

Conclusion

It can be concluded that silk fabric can be successfully dyed from bark of Acacia Nilotica, Toona Ciliata and Eucalyptus trees, with or without mordants, giving satisfactory results. Among all the dyes selected for the study, the Toona Ciliata bark rendered the best result for fastness properties, next to the Acacia Nilotica bark. After these was the Eucalyptus bark dyes which gave satisfactory results for the fastness properties. The obtained natural dyes had soft colour, a wide range of colours and satisfactory fastness to light, washing, perspiration and crocking on silk. Further research can be done to explore the possibility of dyeing with these dyes on other textile materials.

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Rollout of multiple sustainability certifications at BASF's plants

BASF's Performance Materials Asia Pacific has achieved multiple certifications at its Pasir Gudang and Pudong plants as part of its ongoing initiatives aimed at supporting customers to achieve their sustainability targets. BASF's engineering plastics compounding plant in Pasir Gudang, Malaysia, is now International Sustainability and Carbon Certification (ISCC+) and REDcert² certified. The thermoplastic polyurethane plant in Pudong, China, is also certified with the Global Recycled Standard (GRS) and Recycled Claim Standard (RCS).

'The certifications attest to our commitment to being an industry leader in driving sustainable chemistry, innovation, and best practices,' said Andy Postlethwaite, senior vice president, Performance Materials, Asia Pacific. 'With the certifications, we are in a strong position to support our customers in achieving their sustainability goals.' With the mass balance certifications, BASF offers customers certified low-carbon engineering plastics with equivalent product performance. The GRS and RCS certifications validate the quantity of the recycled content used in the manufacture of thermoplastic polyurethanes. The use of recycled content reduces fossil-based raw material consumption.

ISCC is an internationally recognized certification scheme in the mass balance methodology. The standard covers all stages of the value chain and is used worldwide. ISCC+ includes further certification options that cover all types of agricultural and forestry raw materials, food, chemical/technical substances, bio-based products, and other areas where practical use of biomass is possible. REDcert² is a certification system for the sustainable use of biomass. Mass balance, according to the REDcert² standard, ensures the correct attribution of renewable resources into sales products. The GRS and RCS are active contributors to sustainable development. Apart from verifying recycled input material, the certifications track it from input to the final product and ensure responsible social and environmental practices, and chemical use through production.

Dyes, Auxiliaries and Polymers

Archroma starts the Fibercolors revolution

92 million tons of textile waste is produced every year, a number that is expected to soar to 134 million tons by the end of the decade.

Archroma had already developed a way to turn waste from the herbal and food industry into its range of EarthColors featured by brands such as G-Star, Patagonia, Esprit, Tom Taylor, Pangaia, UGG, and Primark. It is now introducing another ground-breaking innovation: the FiberColors technology. With this technology, Archroma upcycles textile waste into gorgeous colours. The colours are synthesized from a minimum content of 50% waste-based raw material.

Archroma's R&D experts have developed a way to use cotton and/or polyamide and their blends (with a >95% purity) to substitute the major part of the petroleum-based raw material usually used to make dyestuff.

The resulting FiberColors range, which is patent-pending and therefore exclusive to Archroma, includes five dyes covering a palette of timeless shades: Diresul Fiber-Teak (brown shades), Diresul Fiber-Ochre (olive shades), Diresul Fiber-Maroon (bordeaux shades), Diresul Fiber-Slate (blue grey shades) and Diresul Fiber-Graphite (dark grey shades).

The dyes are especially suited for cellulose fibres such as cotton, viscose, linen and kapok, and can be used in continuous, exhaust, denim and garment dyeing and printing processes.

FiberColors are ideal for forward-thinking companies who want to help find a solution to textile landfills and, at the same time, give value to waste including articles collected in their take-back schemes that cannot be reused.

Detergent to reduce microfibre release from textiles

Recently, Inditex brand Zara Home launched the first laundry detergent designed to reduce microfibre release during washing. Developed jointly by Inditex and BASF Home Care and I&I Solutions Europe, in Spain and Germany, the innovative solution may reduce microfibre release by upto 80%, depending on fabric type and washing conditions. These results have been tested by several research institutions.

The detergent formula containing efficient ingredients was tested in the laboratory using different textile types and washing conditions. The results show that the detergent is particularly suitable for washing at low temperatures which brings additional advantages: end users can lower their energy consumption - by reducing the temperature, for example, from 40°C to 20°C - and thereby reduce their carbon footprint. Colours stay bright for longer, extending the life of the textiles.

The developed solution can also be adjusted to enable the use of this technology by other detergent manufacturers. 'Innovation and collaboration are key to meeting the challenges of the textile industry. We strive to be more creative and efficient by driving innovative new technologies. This project with BASF is a good example of this approach as it shows the effectiveness of cross-industry collaboration and goes one

step further as it can be adjusted to extend the use of this technology in the industry,' says Javier Losada, chief sustainability officer of Inditex.

Magnetic solution removes toxic chemicals from water in seconds

Scientists in Australia have developed an intriguing new technique for removing toxic 'forever chemicals' from water. Adding a solution to contaminated water coats the pollutants and makes them magnetic, so they can easily be attracted and isolated.

Per- and polyfluoroalkyl substances (PFAS) are a group of chemicals that have been in wide use around the world since the 1950s, thanks to their water- and oil-repelling properties. However, more recently PFAS chemicals have been linked to a concerning number of health problems, including increased risks of diabetes and liver cancer. Worse still, a recent study has found that their levels in rainwater almost everywhere on earth exceed the EPA's guidelines, and to cap it all off, these stable molecules are very hard to break down, earning them the nickname 'forever chemicals.'

Now, researchers at the University of Queensland have developed a technique that could help remove PFAS chemicals from water. The team designed a solution called a magnetic fluorinated polymer sorbent which, when added to contaminated water, coats the PFAS molecules. This makes them magnetic, so then its a relatively simple process to use a magnet to attract the pollutants and separate them from the water.

A sample of contaminated water being treated using the new technique, with the PFAS chemicals being attracted to the side with the magnet.

In tests with small samples of PFAS-laden water, the team found that the technique could remove over 95% of most PFAS molecules, including over 99% of GenX - a particularly problematic chemical - within 30 seconds.

Plenty of teams have investigated ways to break down PFAS, usually involving catalysts triggered by UV light or heat. Others have made use of hydrogen or supercritical water. But the researchers on the new study say their magnetic solution has a few advantages over existing PFAS removal techniques. The solution itself can be reused upto 10 times; it can work much faster than others, and does not require any extra energy to trigger the reaction.

Devan launches Purissimo NTL

Belgian textile innovator Devan Chemicals launched Purissimo NTL, a biobased and readily biodegradable allergen control technology, at the Heimtextil trade show in Frankfurt recently. It is based on the well-known probiotic encapsulation technology and aims to improve the lives of people who suffer from allergies. It can be applied to textiles during the finishing stage of the textile manufacturing process. The technology is based on encapsulated probiotics, which are natural micro-organisms similar in kind to those one can find in yoghurt, cheese and other probiotic food.

Purissimo NTL is based on Devan's already well-established probiotics, incorporated into a new microcapsule shell. The shell is based on a natural crosslinked biobased polymer, which results in microcapsules that are up to 97% biobased and readily biodegradable.

Firstly, dormant probiotic bacteria (spores) are encapsulated. The microcapsule product is then integrated into textiles. Friction opens the capsules and releases the spores. The spores absorb humidity, self-activate and start to multiply. The probiotic bacteria start to consume the allergens that cause allergic reactions and asthma. Due to lower allergen concentration, individuals with respiratory allergies such as house dust mite matter, pet allergens and pollen allergens will have milder to no symptoms and hence a better well-being feeling.

Purissimo NTL can be used on a wide range of textiles such as mattresses, pillows, bedcovers, blankets and also upholstered furniture, carpets, curtains and public transportation and pet items, such as bedding. It is Oeko-Tex compliant, has a long-lasting effect and a wash durability upto 30 washes is achievable.

Recycled laminates for workwear

A new product technology for protective workwear with a significantly reduced environmental impact is being launched under the Gore-Tex Professional brand. The environmental footprint of the waterproof, windproof and breathable 'Soft Gore-Tex Shell'

Odour-resistant apparel that is ready for adventure

Jack Wolfskin, a leading provider of premium quality outdoor apparel and equipment, has partnered with Microban International to incorporate Scentry Revive odour-neutralising technology into its range of clothing. This odour-capture innovation from Microban seamlessly integrates into fabrics during manufacture to prevent odours from building up between washes, keeping garments fresh for longer. In addition, the non-biocidal technology has earned an Oeko-Tex certification and is Bluesign approved.

A common issue with polyester, nylon and elastane - textiles which impart breathability and comfort to activewear - is their predisposition to odour retention. With long term use, athletic garments are susceptible to the accumulation of sweat, dead skin cells and body odours. Perhaps surprisingly, frequent washing of these fabrics is not a viable solution; laundering alone is inefficient at removing malodours, can reduce the robustness of fabrics, and contributes to costly water and utility bills. Therefore, there is high demand for sustainable built-in scent control in the textile industry.

Jack Wolfskin has decided to include Scentry Revive technology - which complements the contemporary, adventure-ready nature of its products - to extend the useful lifetime of apparel and reduce washing requirements. Integrating an odour-neutralising technology from Microban, the world leader in antimicrobial and odour-control solutions, provides Jack Wolfskin with confidence that its products will remain fresh wear after wear, for upto 50 laundry cycles.

Regina Goller, Director of Fabric and Trim Management Apparel at Jack Wolfskin, commented on the benefits of Scentry Revive: 'The team at Jack Wolfskin takes pride in applying revolutionary technologies to our product range. We wanted to produce odour-resistant garments that required less washing, to benefit both our customers and the environment, and Scentry Revive has made that goal attainable.'

technology is greatly reduced through 3 levers: durability of materials, textiles derived from recycled PET bottles and, finally, a textile circular knitting and solution dyeing process. In total, this results in almost 54% CO_2 savings, 64% less water consumption, and reduced chemical usage.

For the production of the new 2- and 3-layer Soft Gore-Tex Shell laminates, W L Gore & Associates, Newark, US, relies on recycled PET drinking bottles. The use of recycled materials in the outer textile or inner lining significantly reduces the proportion of new raw materials and the consumption of water and energy. The production processes also contribute to a lower footprint, e.g, the outer material as well as the lining of the 3-layer Soft Gore-Tex Shell laminate are made using the knitting process, which is less energy-intensive than the warp-weft weaving process. Another advantage of this process is the high wearing comfort, soft drape and hand of the laminate.

The inner lining of the laminate is also solution dyed. In this dyeing

process, the dye is added to the polymer before the yarn is spun. The yarn thus obtained is permanently depth-dyed and can be knitted directly into a textile. Since no further dyeing processes are required, consumption of CO_2, water and chemicals is reduced accordingly.

Solution dyeing uses upto 90% less water than conventional dyeing methods. Chemical use is reduced by 60% and CO_2 emissions by upto 58%. In addition, solution dyed textiles are 10 times more lightfast than traditionally dyed textiles and, therefore, do not fade as quickly.

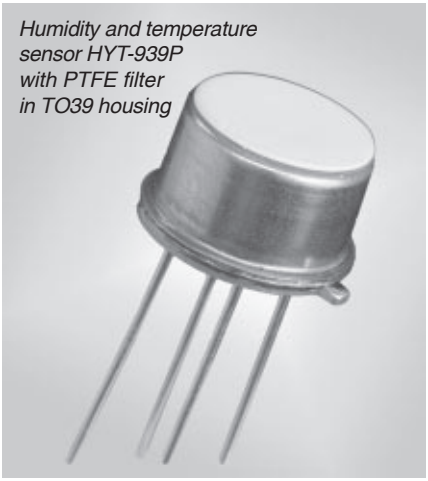
Ancillaries

Robust humidity and temperature monitoring

In industrial drying processes, humidity measurement is vital in providing early warning of fluctuations in moisture content or for providing an indirect indication of how close dried materials are to their desired final moisture content.

The HYT939P with PTFE filter is the optimal humidity and temperature sensor component for industrial drying

applications. The factory calibrated sensor module comes in a standard TO39 housing and is equipped with a PTFE filter. This compact housing allows for easy positioning within the monitored process, while the filter minimizes the influence of solid particles and VOC compounds on the humidity sensor. HYT939P is ideal for demanding industrial settings which require a reliable and robust sensor which is insensitive to contamination and has a long-term stability.



Humidity and temperature sensor HYT-939P with PTFE filter in TO39 housing

The sensor is based on a capacitive polymer measurement principle with a fast response time, low drift and hysteresis. The sensor remains stable in a high humidity environment and can sustain condensation conditions. It comes fully calibrated, and temperature compensated and is therefore interchangeable without adjustments.

If a higher accuracy or different sensor design is needed, the modular design of the HYT product family allows for high flexibility; the sensor, its calibration and assembly can easily be adapted to develop tailor-made modules fulfilling individual requirements. Application specific humidity modules from IST AG feature extraordinary reliability that can be trusted to perform process control or accurate monitoring.

High-efficiency water filter removes 99.9% microplastics

Microplastics are a growing environmental problem, but now researchers in Korea have developed a new water purification system that can filter out these tiny fragments, as well as other pollutants, very quickly and with high efficiency.

Various materials are being tested to help filter out microplastics, including magnetic 'nanopillars,' nanocellulose, semiconductor wires, and filtration columns containing sand, gravel and biofilms. Now, researchers at Daegu Gyeongbuk Institute of Science and Technology (DGIST) in South Korea have found promise with a new design.

The key is a material known as a covalent triazene framework (CTF). This is a highly porous material with a large surface area, meaning they have plenty of room inside to store molecules they capture. Similar materials have recently been demonstrated to be effective at removing organic dyes from industrial wastewater.

The team carefully designed the molecules in the CTF to be more water-attracting, and exposed the material to mild oxidation. The resulting filter was shown to be effective at very quickly removing microplastics from water - reportedly over 99.9% of the pollutants were removed within 10 sec. The material can also be reused multiple times without reducing its performance.

In another test, the researchers developed a version of the polymer that can absorb sunlight, convert the energy into heat and use that to purify another pollutant, known as volatile organic compounds (VOCs). This was able to remove over 98% of VOCs under the power of one sun irradiation. A prototype combining both types of membranes was able to remove over 99.9% of both types of pollutants.

'The technology we developed here is an unrivaled water purification technology with the world's highest purification efficiency, removing more than 99.9% of phenolic microplastics and VOC contaminants in water at ultra-high speeds,' said Professor Park Chi-Young, lead author of the study. 'We expect that it will be a universal technology with high economic efficiency that can purify contaminated water and supply drinking water even in areas where there is no power supply.'

An artist's impression of the prototype water filtration system Daegu Gyeongbuk Institute of Science and Technology (DGIST)

Xaar Aquinox printhead for reliable aqueous inkjet printing

The Aquinox is the latest development from Xaar's ImagineX platform, and its revolutionary aQ Power Technology provides a radically new approach to how water-based fluids are jetted reliably, delivering a truly transformational industrial printhead.

Xaar's aQ Power is a combination of ground-breaking technologies designed to optimise the Aquinox's lifespan and robustness when handling aqueous fluids. These include a redesigned internal architecture, new water compatible materials capable of coping with an extended working range of pH levels, and a

UltiMaker launches S7 3D printer

UltiMaker, a global leader in desktop 3D printing, recently announced the launch of the UltiMaker S7 - the latest entry in the company's best-selling series of 'S' 3D printers.

The UltiMaker S7 introduces a range of new features designed for ease of use and print reliability. A new flexible build plate makes removing prints a breeze, and the integrated Air Manager filters out up to 95% of UFPs and improves temperature regulation. The S7 also features improved automated bed leveling for reliable first-layer adhesion.

Advances in temperature regulation on the S7 allow users to capitalize on the large 330 x 240 x 300 mm build volume - with reliable accuracy from the first printed layer to the last. The flexplate also provides easy part removal post printing, reducing labour so users can get on with other tasks.

The S7 will be compatible with the UltiMaker ecosystem of over 200 materials and offers seamless integration with industry-leading software, UltiMaker Cura, easy printing with the widest range of materials on the market, and support dedicated to customer success.

With the S7 ProBundle, users can also pair the S7 with the UltiMaker Material Station to print with upto six spools with automatic material switching and humidity control.

revolutionary new drive system enabling optimum drop ejection. This, together with Xaar's TF Technology ink recirculation, ensures the Aquinox delivers significantly increased nozzle open time as compared to typical aqueous printheads.

Water-based inkjet printing has never been more effective or versatile, thanks to the Xaar Aquinox's unique technologies, exceptional print speeds and compatibility with multiple aqueous fluid types. Speeds of over 100 m/min can be achieved, and a high native resolution of 720 dpi and firing frequency of up to 48 kHz, enables high fluid laydown, with maximum productivity. And with Xaar's High Laydown Technology, the drop size capability is extended, making the Aquinox ideal for printing textiles, highly absorbent substrates, or thick film coatings.

Thanks to Xaar's Ultra High Viscosity Technology, the Aquinox is capable of jetting fluid viscosities of upto 100 cP. By enablinga wider colour gamut and fluids with larger particles and more pigment for higher opacity, colours are more vibrant and whites and blacks stronger, ensuring the Xaar Aquinox can bring the latest imaginative designs and finishes to life.

The Aquinox comes with development kit that gives OEMs everything they need to get up and running. This includes the ink supply system and printhead drive electronics.

X-Rite announces Ci7830 and Ci7630 spectrophotometers

X-Rite Incorporated and Pantone LLC, global leaders in colour science and technology, announced the release of the Ci7830 and Ci7630 reflectance benchtop spectrophotometers ideal for textiles, paint and coatings, plastics etc. Used as part of a digital workflow, the Ci7830 and Ci7630 deliver the measurement precision required to seamlessly communicate, share, and coordinate colour-critical values and specifications across the supply chain. These instruments are designed to provide high value at an affordable cost to help manufacturers maximize productivity and manufacturing uptime and improve sustainability efforts.

The Ci7830 reflectance benchtop sphere spectrophotometer offers high inter-instrument agreement and repeatability to meet tight colour tolerances across the supply chain. The Ci7630 is a mid-range reflectance device ideal for manufacturers that need to control colour with less demanding tolerances. Both instruments bring a level of reliability, traceability, and accuracy to the digital colour workflow. In addition, the devices' internal sensors report humidity and temperature as part of the measurement audit trail.

The Ci7830 and Ci7630 support an end-to-end digital colour workflow and integrate with X-Rite software to improve colour communication, prototyping, formulation, production, and quality control for predictable colour results. With ColoriMatch formulation software, customers can quickly identify optimal initial colour matches and reduce wasteful formulation attempts. Using ColoriQC quality assurance software helps determine whether a sample is within tolerance, and if not, provides feedback to get it on target.

Processing and Machinery

Brückner line for finishing of elastic sportswear

The biggest Irish jersey producer O'NEILLS finishes their elastic high-quality sportswear on a BRÜCKNER line.

The 100% Irish owned company was founded in 1918 by Charles O'Neill to produce Gaelic footballs. Today, the family-run company employs more than 900 people across Ireland, UK, France, Australia etc, and is the biggest sportswear producer in Ireland. With their own knitting mill and dye factory as well as printing and

sewing machines, they are able to react rapidly to changing market requirements and to create their own new designs. This flexibility provides a big competitive edge for the company.

The family-run German company BRÜCKNER develops since more than 70 years drying and finishing lines for the textile industry and technical products which are based on textiles or nonwovens. The lines are completely produced in Germany; tests and developments can be made together with customers in BRÜCKNER's own Technology Center. The line supplied to O'NEILLS has also been developed in cooperation with the customer and is tailor-made to the customer's needs. Special attention was paid to a tensionless fabric transport and improved dimensional stability of the product with the highest possible energy efficiency. In addition, O'NEILLS produces often small lots with heavy nonwovens which leads to an increased formation of fibre fluffs. Therefore, the dryer access has been adapted to simplify and accelerate the cleaning.

The Brückner Power-Frame stenter features a web guider system in the entry to ensure proper decurling as well as accurate centric web running into the padder with minimum liquor pad trough. The machine has a vertically moving chain system and is built with alternating arrangement of the heating units/fans and nozzles. The side of the heating and circulating air elements alternates thus every 1.5 m, which leads to a perfectly homogeneous air impingement over the complete fabric width.

The extended cooling zone at the end of the dryer improves the heat-setting results further. At the same time, the fabric is led in the exit area over a special transport belt to finish the very delicate and elastic articles perfectly. This is essential for the high quality of O'NEILLS.

Exit with cooling zone and special transport belt for delicate, elastic fabric

After several years of operation, O'NEILLS recently ordered maintenance and optimization of the line together with BRÜCKNER's technologists. John Towell, maintenance manager with O'NEILLS says: 'We have been using BRÜCKNER machines for almost 20 years, and have found them to be reliable, flexible and efficient. BRÜCKNER have helped us to find consistency with drying and heat-setting a varied range of our fabrics. We have also found them excellent to work with regarding repair and maintenance issues that have occurred over time.'

BRÜCKNER POWER-FRAME entry with padder, weft-straightener and entry transport belt

Data-based success for fabric manufacturers

Producing quality fabrics is much easier with automated inspection. Uster EVS Fabriq Vision gathers quality data and presents it in an album, which is used to certify the quality of each fabric roll, with total traceability. It combines quality assurance and process optimization, automatically, in a solution which is already popular in technical textiles.

Fabric producers need to guarantee reliable quality, which demands a consistently high rate of defect detection. Uster EVS Fabriq Vision ensures this is by using automated control during intermediate and final inspection, removing the need for manual inspection.

Multiple spectroscopes inspect the material. Unique image processing algorithms identify all defects automatically, recording them in a dataset for each produced roll - which is also used for traceability. A defect map is automatically generated, to help operators understand the allocation of defects in the fabric roll. This information is also available at an offline PC in the Fabriq Album software, which is a valuable tool for optimizing data for final cutting or further processing steps.

The staff working daily with this fabric inspection system soon recognize that its a game-changer, because the inspection routine is increasingly automated. It works smoothly and quickly, in real time, checking every roll and locating every defect, at line running speeds.

The Fabriq Album software ensures optimum inspection efficiency and throughput. Machine learning capabilities and the implementation of AI-assisted defect classification extend the use of quality data generated by Fabriq Vision.

The quality report, automatically created by Fabriq Album, can be provided to customers as an addon, to

give full transparency for every metre of the fabric. In technical textiles, and wherever fabric inspection is needed - or should be - Uster Fabriq Vision can tap the potential to deliver major benefits for any business.

Tecnorama right-first-time solutions for dyehouse automation

As a consolidation of its presence in India, Tecnorama, at India ITME 2022, showcased the latest innovations in fully-automatic philosophy for dyeing laboratory automation. The widely known Dos&Dye system is the first and the only one to develop the Right Recipe for bulk dyeing

Tecnorama DOS&DYE

machines, in order to avoid correction and re-dyeing in production with considerable time and resource savings. Composed of a Dosorama dispensing machine and a robotized dyeing module, Dos&Dye works independently for 24 hr a day and 7 days a week. It automatically performs the entire dye-bath process without any operator intervention and matches the features complying with Industry 4.0.

Fully integrated in Dos&Dye, the new Dosorama Smart and the Dosorama Clever laboratory dispensing machines present the innovative 'Mono-Plunger' system maintaining all the features of Dosorama dispensing machines, such as speed of execution, dispensing accuracy and elimination of contamination typical of the obsolete mono-pipette systems. They have been specifically designed to considerably reduce the need of technical intervention and to guarantee an easy maintenance.

Textile functionality with Baldwin's Corona Treatment technology

Based in Tavernerio (Como), Majocchi has cemented itself as a leader in the global textile market by focusing extensively on applying the latest research and innovation within the field to achieve superior results.

Majocchi has a well-documented history of being a technological innovator in the textile industry. Within a decade of its conception in 1941, Majocchi became the leading global supplier of waterproof cotton for rainwear manufacturers. In the 1960s, the company began producing nylon and technical fabrics, which paved the way for it to become a leading provider of textiles for urban fashion, technical workwear and the military today.

Taking it to the next level, for over a year, Majocchi has partnered with US -based Baldwin Technology Co to utilize its unrivaled corona surface-treatment technology to produce superior wettability and adhesion.

Corona treatment is a technique that temporarily modifies a substrate's surface tension properties. The corona oxidation process improves the penetration and absorption of liquids on cellulosic and synthetic fabrics. Utilizing corona treatment before resin application on fabrics such as lycra and nylon facilitates superior adhesion and resin distribution. As a result, corona-treated fabrics provide exceptional colour and tonal quality.

Majocchi uses Baldwin's Corona Pure Model to apply polyurethane and acrylic-based coatings to its fabrics. The system allows Majocchi to administer a controllable, uniform coating to achieve the desired functionality and aesthetics.

The system is 2,000 mm wide with a discharging station and four ceramic electrodes designed for textile applications with the flexibility of customizing plasma dosage for a given fabric structure, width and process speed. The Corona Pure model allows for fabric treatment up to 300 gm/m² in thickness. The system is highly customizable, with single-sided and dual-sided treatment capabilities.

Rick Stanford, Baldwin vice president of Global Business Development, Textiles commented: 'We appreciate Majocchi's continued confidence in Baldwin's textile technologies. As textile manufacturers and brands are increasingly looking for process solutions to assist in reaching their sustainability goals, Corona Pure treatment is another tool alongside TexCoat G4 digital finishing in Baldwin's portfolio of sustainable technology.' Baldwin's corona treatment system is built with the operator in mind. The 'Easy Change' feature allows for a seamless replacing of electrodes and rapid cleaning and removal of fibre and dust residue, maintaining optimal exhaust air flow. The treatment system is built with a swiveling housing mechanism, which provides clearance for changes in textile thickness and protects the ceramic electrodes.

Corona Pure in action at Majocchi

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CALENDAR

2023

March

15-16 **Performance Days**, Munich, Germany www.performancedays.com

29-30 **Membrane & Filtration Expo 2023**, Bangkok, Thailand www.expo.technobiz.org

April

03-07 **Aghema**, Frankfurt, Germany www.achema.de

27-29 **IFAT Eurasia**, Istanbul, Turkey www.ifat-eurasia.com

May

10-12 **Texprocess Americas**, Atlanta, US www.texprocess-americas.us.messefrankfurt.com

11-13 **Denim Show**, Mumbai www.denimshow.com

22-24 **Outdoor by ISPO**, Munich, Germany www.ispo.com

June

08-14 **ITMA 2023**, Milan, Italy www.itma.com

July

17-20 **World of Wipes (WOW) International Conference**, Atlanta, GA www.worldofwipes.org

September

26-27 **RISE (Research, Innovation & Science for Engineered Fabrics)**, Raleigh, NC www.riseconf.net

30-4/10 **WEFTEC 2023**, Illinois, USA www.weftec.org

October

10-12 **FiltXPO 2023**, Chicago, Illinois, USA www.filtxpo.com

November

13-16 **Hygienix 2023 (The Premier Event for Absorbent Hygiene & Personal Care Markets)**, New Orleans, LA www.hygienix.org

2024

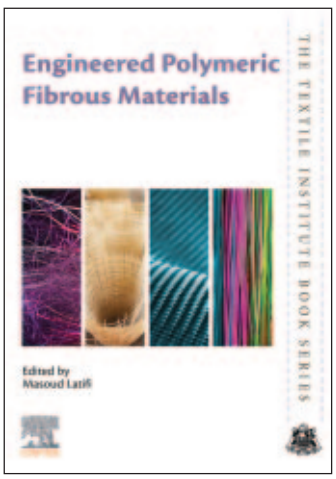
April

22-25 **IDEA 2024**, Miami Beach, Florida www.ideashow.org

BOOKREVIEW

Engineered Polymeric Fibrous Materials

Woodhead Publishing; Pages: 392

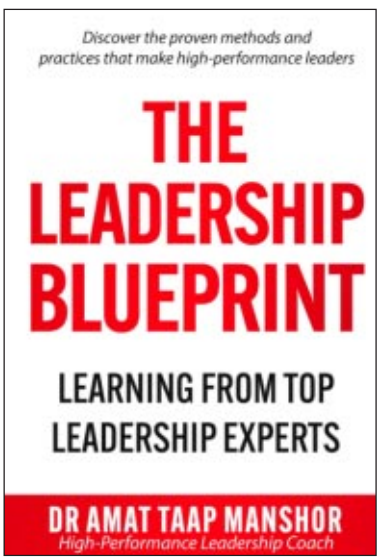


This book explains cutting-edge techniques for the engineering of fibrous materials from physical, mechanical, and chemical points of view. Both conventional and nanofibres are described in this uniquely comprehensive book for a wide range of applications including biomedical, automotive, aerospace, agriculture, energy, and environmental.

It also provides a state-of-the-art review of the different applications for fibrous materials, and comprises 14 chapters covering the basis of fibrous structures, nanofibres, piezoelectricity, triboelectricity and the emerging research results for the use of fibrous structures and materials in different areas. This book refers to recent advances made in both academia and industry, in topics such as fibre reinforced composites, fibrous thermal insulators, drug delivery and tissue engineering, and smart textiles and energy, and explains how fibrous structures are engineered to offer new solutions to important problems.

The Leadership Blueprint

Dr Amat Taap Manshor; Pages: 181



This book provides valuable insights and practical advice on how to become a more efficient leader. It explores the key points and lessons, providing a convenient and accessible resource for readers looking to enhance their leadership skills. It is suitable for seasoned leaders looking to improve their skills and newcomers to the field, and offers valuable insights and practical advice on becoming a more effective leader. The author hopes that readers will be inspired and motivated to strive for personal, professional growth and development by reading this book.

At the end of the book, there is a call to action section that encourages the reader to take the knowledge and insights gained from the book and put them into practice. The call to action includes specific exercises and activities that the reader can do to apply the lessons learned from the book.

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