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TeTex.

EUROPEAN TECHNICAL TEXTILES MAGAZINE

SUMMER 2017

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TECHTEXTIL FRANKFURT 2017
Full Summary

MAGNET FOR VISITORS
Innovative Apparel Show

STUDENT COMPETITION
Textile Structures for New Building

LIVING IN SPACE
High-tech Textiles for the Aerospace Sector

Editorial

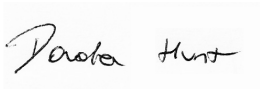
Dear readers!

We hope you have had time to recharge your batteries after the busy and exciting Texprocess and Techtextil 2017 trade fair. This event witnessed all the major textile companies showcasing their latest products, materials and developments. We are sure it was an exciting and successful time for all those businesses involved.

For us, this event was not only an opportunity to make new contacts, but also to see for ourselves the great condition that the technical textiles industry is in at the moment. Four exhibition days, 1789 exhibitors and more than 47500 visitors from around the world - these numbers speak volumes!

Especially for you we have condensed the most important information about the fair and its accompanying events to give you a summary of what happened over these few days in Frankfurt am Main.

We wish you every success in the pursuit of your business goals and look forward to a reunion at the next event in two years time!



Publisher:
Tetex Limited
Europe's Leading Technical Textile Website
Great Britain
167 Askham Lane, YO24 3JA York
+44 788 497 7809
Poland
Klobucka 7, 02-699 Warsaw
+48 22 101 399 8
www.tetex.com / info@tetex.com

Editor in Chief:
Dorota Hunt

Editorial Team:
Łukasz Cichoszewski
Mark Hunt
Agata Sibilska
Katarzyna Topolska

Graphic Design
Jakub Jankowski

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Techtextil and Texprocess 2017 General Summary of the Event

Once again, the textile industry has shown its power and conquered Techtextil in Frankfurt am Main.

Here is this year's Techtextil in numbers: months of preparation, **4** days of exhibition, **1,789** exhibitors, over **47,500** visitors from **114** countries from the entire world. It was also a record edition in terms of visitor turnout.

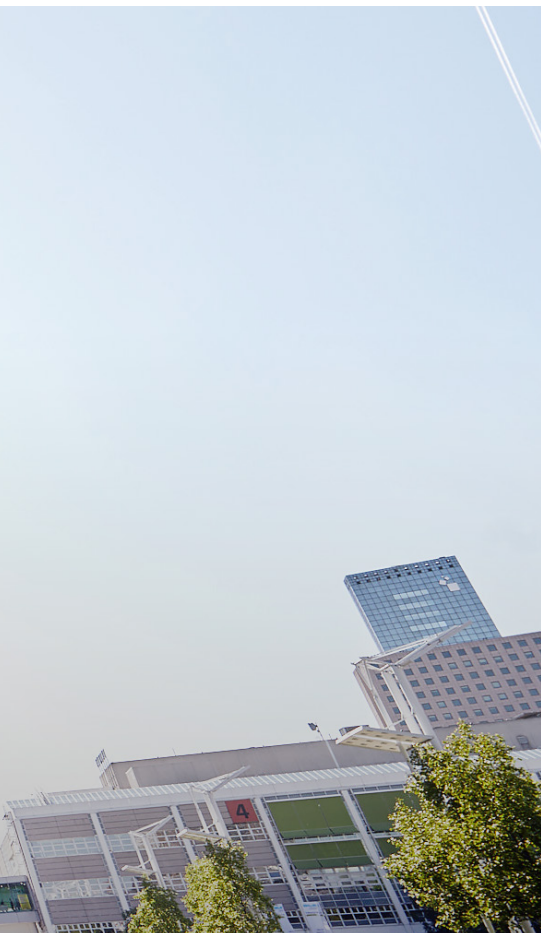
'Once you enter the premises of the fair, there is no room for doubt – intelligent and functional textiles are no longer a song of the past; they are present here and now. If any branch of the world industry is ready to take a step into the future, it is definitely the textile industry', says Detlef Braun, Member of the Executive Board of Messe Frankfurt. 'Those who were unable to be in Frankfurt in the past few days missed the opportunity to witness the dynamic development of the textile industry'.

The number of visitors went far beyond the expectations of the exhibitors. Despite the full crew on board at the stalls, many visitors had to wait in queues to see the presentation of the products.

From clothes of the future, sewn on the basis of the scanned measurements of our body, through computer-assisted fashion designing, modern cutters, to exceptionally efficient sewing and

embroidering machines – at Texprocess the level of interaction between the man and the machine was taken to an entirely new level.

Similarly at Techtextil, an event held simultaneously to Texprocess, visitors could find high-quality technical textiles with various applications, ranging from textile reflectors, intelligent wound dressings, clothing regulating body temperature, not to mention LED integrated products, fire-proof fibres and carbon bicycle frames.



At Techtextil the largest numbers of delegates were from Germany, followed by Italy, France and Turkey. At Texprocess, the largest numbers were from Italy, followed by Romania and Portugal.

Visitors' high spirits were reflected in the results of a survey whose aim was to check the satisfaction with the economic situation of the textile industry. 33% of the visitors surveyed at Texprocess rated it as good; at Techtextil, this result was even higher and reached 42%. It is worth mentioning that, according to the surveys, the level of visitors' satisfaction with the events was found to remarkably high, at 96 and 97% for Texprocess and Techtextil respectively!

About Messe Frankfurt

The largest organiser of fairs, conferences and artistic events in the world, Messe Franfurt has its own exhibition space, 2,400 employees in 30 different locations, and an annual turnover at the level of €640 million. Owing to far-reaching connections with key sectors and international sale network, Messe creates unusually effective conditions for business growth.

Living in Space

Special Exhibition at Techtextil

During space travel the number of equipment which needs to be transported to the orbit is enormous. Technical textiles find more and more application in this field – they are compact and occupy relatively little space. When necessary, they can adopt a great number of new functions (e.g. through special applications), which makes them perfect for use in extreme conditions.

'Living in Space', a special event held at this year's Techtextil and Texprocess in Frankfurt am Main, featured products and intermediates made from technical textiles. The event was divided into the following parts:

- **Architecture**
- **Civilisation**
- **Clothing**
- **Mobility**

which featured, among others, materials and technologies presented

by the exhibitors, architectonic solutions designed by Ben van Berkel as well as fashion inspired by space travel. Those interested could also take a trip to Mars thanks to virtual-reality glasses.

'Living in Space' was also an opportunity to see textiles and technologies which can be combined with various types of applications. *'In cooperation with our partners and exhibitors, we are creating an area of entertainment and information, unlike any other which has been featured at Techtextil and Texprocess to date'*, says Micheal Jänecke, Brand Manager at Messe Frankfurt.

A perfect house in Space

Visitors could see for themselves what space clothes designing and construction is all about. These were the themes of the part 'Architecture' held under the patronage Stylepark, an architecture and design magazine.

Lightweight and MDT-tex combined efforts with a world-famous architect, Ben van Berkel, to create 'Space habitat' especially for this occasion. The habitat consists of 60 independent modules, each of them double-twisted and under tension. The Lightweight Pavilion had an area of 40 m^2 and comprised specially designed aluminium profiles covered with PTFE aluminium sheets. This fabric was specially designed by MDT-tex and has an extremely light grammage, while at the same time retaining its technical properties and high-temperature resistance.

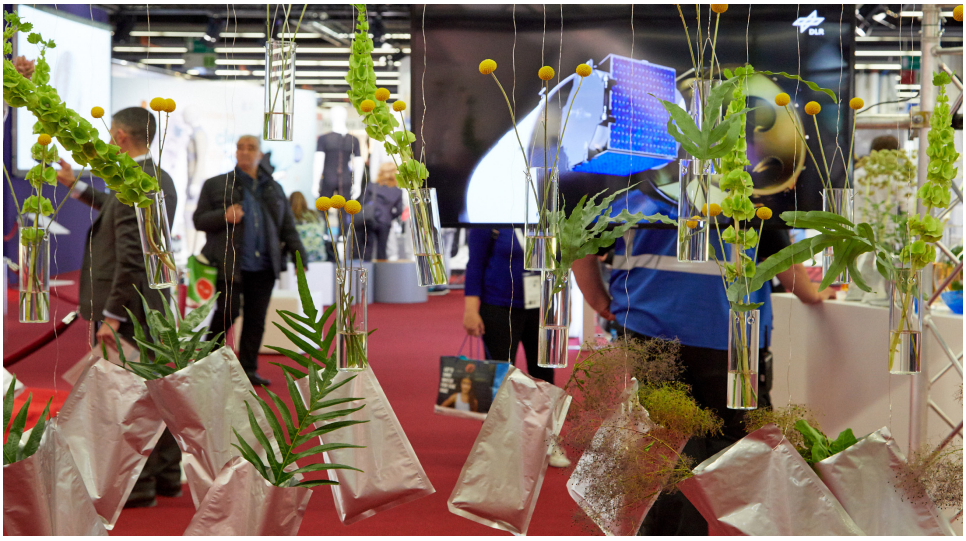
Ultra-thin materials have a leading role in space travel as they considerably decrease the total weight of the capsule, and consequently lower the travel cost.

Fashion in orbit

No one likes being too hot or too cold. Space clothing should not only protect the user against extreme temperatures but also regulate the body heat, appropriately release humidity, be resistant and easy to clean.

In the part 'Clothing' guests could see clothes with such properties and a designer look. The clothing presented in this part of the event was designed by students from Fashion School in Berlin within the framework of the project.

'Living in Space' featured over 40 of this year's exhibitors and enjoyed a great popularity among guests.



Innovative Apparel Show a Magnet for Visitors

The Innovative Apparel Show during Techtextil and Texprocess showcased new garment textiles and innovative processing technologies in the form of a fashion show. With live shows twice a day, visitors had the chance to see visionary fashion designs, made of technical textiles and produced using modern processing technologies, by students of four international design universities.

The event combines innovative apparel textiles and new processing technologies. This year, the universities were Esmod from Paris, ESAD College of Art and Design from Portugal, Accademia Italiana, Florence, and Hochschule Trier.

The TextilWirtschaft media brand supported the awards ceremony with a special award, the TextilWirtschaft Public Award. In this case, visitors were asked to vote via Facebook for their favourite from eight models pre-selected by a jury. The winner of this award was also Mariana Almeida.

On all the days of Techtextil and Texprocess, international colleges of fashion and design presented their visionary designs for technical textiles created with modern processing technologies.

Schools participated in the show:

- Esmod Paris, France
- ESAD College of Art and Design, Matosinhos, Portugal
- Accademia Italiana, Florence, Italy
- Hochschule Trier, Germany

The young designers presented their creations in three categories:

- Textile Effects
- Creative Engineering
- Smart Fashion

Fashion show with Kevin Oakes

A fashion show in the Foyer of Halls 5.1/6.1 staged the creations professionally. The South African show producer Kevin Oakes choreographed and hosted again the show in English.

Innovative Apparel Public Award

Throughout the entire fair the audience had the opportunity to vote for the winner of the audience award „Innovative Apparel Public Award“. It was awarded on the last day of the fair.

Julia Gross-Müller of Hochschule Trier won the first prize of the Innovative Apparel Public Award. Entitled ‘World Folklore’, her model was chosen as the visitors’ favourite at the Innovative Apparel Show during Techtextil and Texprocess 2017. *“I pick up on visual aspects of traditional costume, but I also use plastic at various points in the outfit to introduce the notion of how problematic recycling the material has become,”* says Groß-Müller.

THE WINNERS

2nd Prize

Mariana Almeida, ESAD College of Art and Design

1st Prize

Julia Groß-Müller, Hochschule Trier

3rd Prize

Eleonara Beni, Accademia Italiana

Techtextil Innovation Award

The Techtextil Innovation Award was held for the 14th time at the Messe Frankfurt Trade Fair. It honours some of the most outstanding products and technologies in the textile industry.

The competition was open both to exhibitors and other persons and institutions not participating in the Fair. The reported innovations could have been available on the market for a period not longer than 2 years and could not participate in another competition at the same time.

The innovation awards were given in four categories:

- **new technology**
- **new material**
- **new application**
- **new product**

The award ceremony was held during the Techtextil opening ceremony. An international jury selected 8 products that were awarded.

The winners of the Techtextil Innovation Award

In the 'new application':

Centexbel, a Belgium-based non-profit organisation, presented the smart knee brace that can support patients during the rehabilitation phase after knee operations. A textile sensor identifies the angle of the knee in real-time and accordingly informs the patient.

Peterseim Strickwaren - designer of the basalt knitted fabric. The fabric protects elements sunk in water, such as buoys, from environmental influences, which cuts maintenance costs by 40%.

In the 'new technology':

V. Fraas Solutions in Textile presented the SITnet - a load-securing net. The net is distinguished by its use warp-knitted pattern instead of its sewn counterpart. Thus, the net is completely flat and even, which enables it to move larger loads than conventional products.

Vetex NV, a company specialising in coating and laminating technologies, has gained the appreciation of the jury with its OC2PUS technology. This technology makes possible the application of polyurethane coatings on flexible substrates without the use of solvents.

In the 'new product':

The Germany-based start-up Texlock was awarded for its innovative textile-based bicy-

cle lock. It is extremely lightweight, flexible and does not scratch the bike frame due to its soft surface.

Penn Textile Solutions, specialising in the production of elastic textiles, received an award for Ombra-DLS, a shading net for use in facade construction and window installation. The net allows for modifying the amount of light entering the building, depending on the current needs.

In the 'new material':

The ITCF (Institute of Textile Chemistry and Chemical Fibres in Denkendorf) received the award for PURCELL - a durable composite made of pure cellulose that can be used not only as a high strength reinforcing fibre, but also as a matrix component.

The France-based world's leading producer of polyester fibres, fabrics and materials, Durafiber Technologies, was awarded for its alkaline-resistant polyester HT yarn. Tests have shown that this yarn maintains almost up to 100% of its original technical characteristics even after prolonged contact with alkaline products at high temperatures.

The jury consisted of:

- Braz Costa, CITEVE, Centro Tecnológico das Indústrias téxtil e do Vestuário, Portugal
- Sabine Gimpel, TITV Greiz Textilforschungsinstitut Thüringen-Vogtland e.V., Germany
- Dr Klaus Jansen, Forschungskuratorium Textil e.V., Germany
- Dr Jan Laperre (Chair), Centexbel, Belgium
- Dr René Rossi, EMPA – Swiss Federal Laboratories for Materials Science and Technology, Switzerland
- Dr Thomas Stegmaier, ITV Institute for Textile and Process Technology Denkendorf, Germany
- Dr Hartmut Strese, VDI/VDE Innovation + Technik GmbH, Germany

Review of Exhibitiors

The Most Interesting Stands

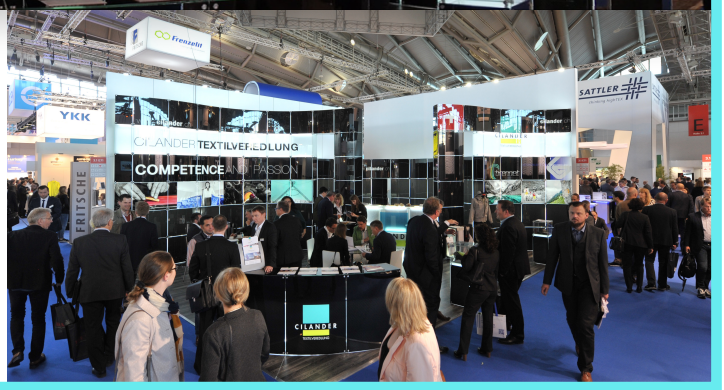
The Techtextil trade fair is an enormous exhibition space that houses more than 1700 exhibitors. During the fair we tried to visit as many companies and institutions as possible to talk about their latest products, technologies and research. In the course of our search we had the opportunity to meet many interesting people passionate about textiles.

We have selected the most interesting stands which attracted us with their unique approach, innovation and technological advancement and present them to you in our review.

1

CILANDER

Based in Herisau, Switzerland, AG Cilander is an innovative textile company boasting a rich tradition and a reputation for high-quality finishing services that extends well beyond the borders of Switzerland. A leading supplier on the international scene, the company owes its success to the development of customer-focused solutions in the core areas of selected finishing services. Its strengths are a broad-based know-how, high flexibility and a pronounced sensitivity to the needs of the market.



TEXMIND

Texmind UG presented their software products in the area of braiding, warp knitting and weaving for second time during the Techtextil Fair in Frankfurt.

2

3

DITF

DITF form the largest textile research center in Europe with more than 300 scientific and technical staff.

4

FOLLMANN

Innovative chemicals for function and design.

ICAP-SIRA

ICAP-SIRA a primary international supplier of chemical specialties, characterized by innovation, flexibility and high-quality production capabilities, with deep knowledge of our markets and technical service excellence.

5

6 LENZIG AG

The Lenzing Group is a world market leader headquartered in Austria, with production sites in all major markets as well as a worldwide network of sales and marketing offices. Lenzing supplies the global textile and nonwovens industry with high-quality, botanic cellulose fibers.

LENZING INSTRUMENTS

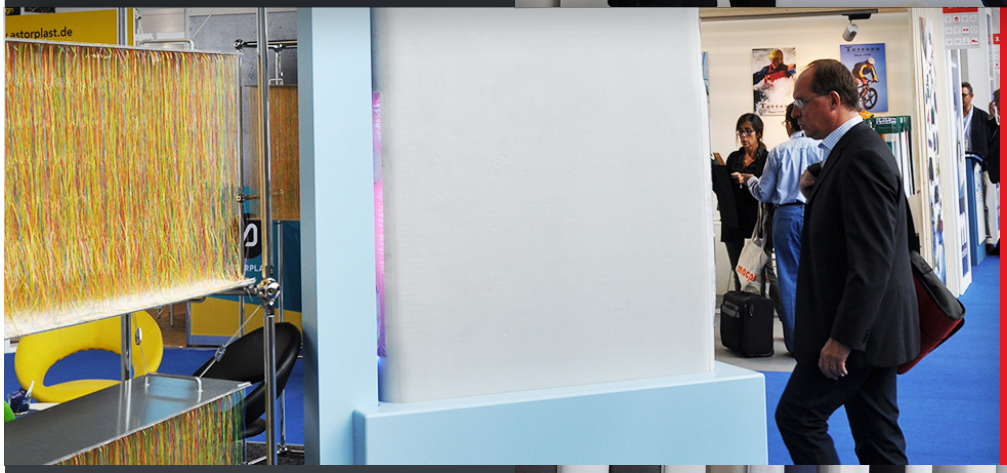
Lenzing Instruments provides testing technology for process- and quality control of staple fiber, filament, non-wovens and film.

7

NOMACO

NOMACO GmbH & Co KG develops, manufactures and distributes machinery and turnkey lines for manufacturing of non woven products. NOMACO provides a variety of solutions from individual single machines up to turn key plants from a single source.

8



9

PILEFABRICS

Developing and manufacturing of high quality plush, fabrics and three-dimensional textiles.

POLONTEX

"POLONTEX" S.A is one of the biggest and most modern textile factories in Poland. Production range includes: - decorative goods: knitted, woven and embroidered curtains and table cloths, soft furnishing goods, voiles, sheers

10

PONGS

Owing to expertise, creativity and a pioneering innovative edge we are a global leader in the production of technical textiles and textile digital print media. www.pongs.com

11

SATTLER 12

Sattler PRO-TEX GmbH has developed to become one of the global leaders in the manufacture of coated technical fabrics for various applications such as truck tarpaulins, covers, tensile structures, tents & halls and biogas storage tanks among others.

13

CONTITECH

ContiTech Uses Innovative Fabrics to Ensure High Level of Safety at Extremes of Heat and Cold

Materials from international technology company and industrial partner ContiTech ensure safety and security in a wide range of operating environments. For example, a chemical protection suit– manufactured using ContiTech's innovative "Next Generation" fabric – is now certified to American fire safety standard NFPA. The flame-retardant material guarantees a high degree of safety in working environments where gases form and there is a risk of fire. It is therefore a reliable aid for firefighters as well as in industrial environments such as refineries, oil rigs and in shipbuilding.

STFI

The institute is working as a non-profit research institution in the Free State of Saxony and is continuing the long-standing traditions of the Saxon textile research and textile industry.

14

VANDEWIELE

We imagine, build and integrate innovative textile systems for flooring qualities, home linen, fashion fabrics and technical textiles.

15

ZEMAT

Our company focuses on advanced High Frequency Technologies used in various industries: packaging, medical, advertising, furniture, automotive, interior decoration, construction, agriculture among others.

16

17 CONTEC

Many years of experience allows us to offer you the best solutions for apparel, upholstery and automotive production. We are long-term supplier for the largest manufacturers delivering sewing, cutting and ironing machines, spare parts, sewing accessories and consumables.

SAULEDA

Sauleda, an experienced company which provides solutions for the most demanding sectors: Solar Pro, Textile, Nautic, Technical Solutions, Office Screens. Our fabrics respond to industrial challenges that set the most exacting standards.

18

SIOEN 19

Sioen Industries is a diversified stock quoted Group with an extensive portfolio of products and activities: spinning, weaving, and coating of technical textiles, manufacturer of professional protective clothing and producer of fine chemicals.

20

SAKO-EXPO

The main area of SAKO-EXPO business activities is the wholesale of PVC coated textiles, including tarpaulins, banners, fire resistant textiles, media to digital solvent wide format printing and other specialist fabrics and accessories. The wholesale of PVC coated fabrics is our business priority. Our product range includes a large number of technical textiles available in different colours and weights. We have the biggest warehouse of tarpaulin materials in Poland, in first and second choice fabrics. Our latest, proprietary product is anti-burglary tarpaulin equipped with an alarm and GPS system - SAPLAN - High Security.

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A VARIETY OF PROMOTION CHANNELS

PRESENCE ON THE MOST IMPORTANT EVENTS

UNITING THE TEXTILES

Tetex is present at the most events from the technical textiles

LOOKING FOR NEW CLIENTS AND CONTRACTORS? CHECK OUT OUR OFFER!

Our marketing channels is your company's opportunity!

Choose the most interesting type of promotion:

✓ *Website*

Publication of an article or a graphic ad is a great opportunity to thoroughly present your services and products as well as grab the attention of persons already interested in the textile area. The rate of our daily visitors reaches 1000.

✓ *Mailing base*

Our mailing database features over 4000 addresses of Polish companies and over 2500 addresses to companies all over the world. These addresses are held by companies tied to the textile industry, ensuring that each email is read by persons potentially interested in your offer.

✓ *Product presentation*

Tetex Magazine is a regularly issued magazine devoted to everything related to the textile market. We publish information on recent scientific achievements, state-of-the-art innovative products and current events in the sector.

✓ *Social Media*

Use our Facebook fanpage with over 2500 followers! We offer all kinds of posts – graphic, video, carousel, product-based. Average reach of each post is about 10 thousand users.

OEKOTECH PROTECH SPORTTECH AGROTECH MEDTECH PACKTECH CLOTHTECH

ADVERTISE WITH US!

TECHNICAL INDUSTRY

important industry

We are present on the most important textile-oriented events from all over the world:

techtextil

texprocess

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fast textile

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Show your products, technologies or new ideas directly to the branch industry. You won't find better targeted group of your potencial clients.

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info@tetex.com | www.tetex.com

Tetex LIMITED

Tetex Ltd.

Great Britain
167 Askham Lane, YO24 3JA York
+44 788 497 7809, +44 190 420 6905

Poland
Kłobucka 7, Warsaw
+48 661256 017, +48 22 101 39 98

Student Competition

‘Textile Structures for New Building’

The ‘Textile Structures for New Building’ contest demonstrates the potential of textiles in the construction industry. The added value of the contest is the opportunity to exchange ideas and experience between students and companies. The contest was held for the 14th time.

Students of civil engineering, design and related disciplines were invited to submit their projects related to the use of textiles in the construction industry. The scientific and technical aspects of the contest were taken care of by Professor Werner Sobek, director of the Institute for Lightweight Structures and Conceptual Design of the University of Stuttgart.

Winners selected by the jury received prizes of a total worth of €8000, with the awarded projects presented during the Techtextil Trade Fair in a special exhibition.

‘The winning projects were selected by the jury for their innovative approach and the potential architectural perspectives they can open.

The scope of the projects was very wide; ranging from visually appealing air-inflated halls and improved tent

‘Shifting Stone’ - basalt tissue system

‘Stone Web’ - fibre-based structures in the building industry

dwellings for refugee camps, to textile interior-furnishing systems,' explains Michael Jänecke, Brand Manager of Technical Textiles and Textile Processing at Messe Frankfurt. *'The projects illustrate the variety of applications for textile structures in architecture and building.'*

The jury decided to give three awards in the micro-architecture category, two in the material innovation category and one in the composites and hybrid structures category.
Projects awarded in the competition:

Macro-architecture category

First prize in the category of macro-architecture went to Katrin Fleischer of the Technical University of Munich for her '**Deployable Roof**' - a canopy made out of a folding support grid in the shape of a barrel vault and an integrated membrane cover held under tension by flexible slats.

Second prize in this category was awarded to Margarita Fernández Colombás, Miguel Ángel Maure Blesa, Raquel Ocón Ruiz and Hugo Cifre from the University of Madrid for the project named '**Espacio de La Nube**'. The design is based on pneumatic-tent technology known from covered tennis courts, among others. The jury was particularly impressed with the project's aesthetic, structural and spatial complexity.

Third prize in the category of macro-architecture was given to Ahmad Nouraldeen of the Anhalt University of Applied Sciences in Bernberg for his design of a **tent dwelling for refugees**. As far as form and function are concerned, the tent is reminiscent of a Native American wigwam but is much more advanced. It can store renewable energy and improve the quality of living by means of integrated insulation and ventilation systems.

Micro-architecture category

First prize in this category was awarded to Luani Costa from the University of Minho in Portugal for a **smart façade element**. This adaptive system consists of triangular membrane elements which you can close or open in any configuration depending on current weather conditions.

'Betontextil' fabric tube made of concrete

'Deployable Roof'
a canopy made out of a folding support grid

'Espacio de La Nube' - development of the constructive technique on pneumatic structures

The second prize went to Julia Mayer of the Technical University of Vienna for **'Tryplo'**- a reinterpretation of a modular system using textile components. The modules are based on tetrahedrons and can be combined to make three-dimensional structures. These can be applied in the production of toys, furniture or other spatial structures.

Innovative materials category

First prize went to Natascha Unger and Idalene Rapp from the Berlin-Weissensee Academy of Arts for their **'Stone Web'.** The project perfectly demonstrates the significance of lightness in design and constitutes a pioneering contribution to the application of fibre-based structures in the building industry.

Second prize in this category was awarded to Malu Lücking, Rebecca Schedler and Jack Randol for the project entitled **'Shifting Stone'** - a prefabricated basalt tissue system which can be integrated into a building façade. The project is an example of a perfect use of fibres of one of the hardest stones as it exhibits their flexibility.

Composites and hybrid structures category

In this category the only prize was awarded to Anne-Kathrin Kühner for her idea of the **concrete textile.** A textile tube is filled with high-performance concrete. The resulting 'fibres' can be shaped and create into woven and knitted fabrics.

TOP 5 of Techtextil 2017

The Techtextil Trade Fair offers a large exhibition space that attracts textile giants from around the world. Every day, thousands of people pass by thousands of stands, and the exhibitors have only a few seconds to draw their attention. The trick is to stand out from the crowd. We have prepared our top 5 ranking on the things that most caught our attention during Techtextil!

Technology

Smart kneebrace

Centexbel is a Belgium-based non-profit organisation which presented the smart kneebrace that supports patients during the rehabilitation phase after knee operations.

A textile sensor identifies the angle of the knee in real-time and informs the patient accordingly. The technology can significantly help to increase the effects of rehabilitation of patients after knee operation. The brace has been awarded in the Techtextil Innovation Awards contest in the 'new applications' category.

Stand

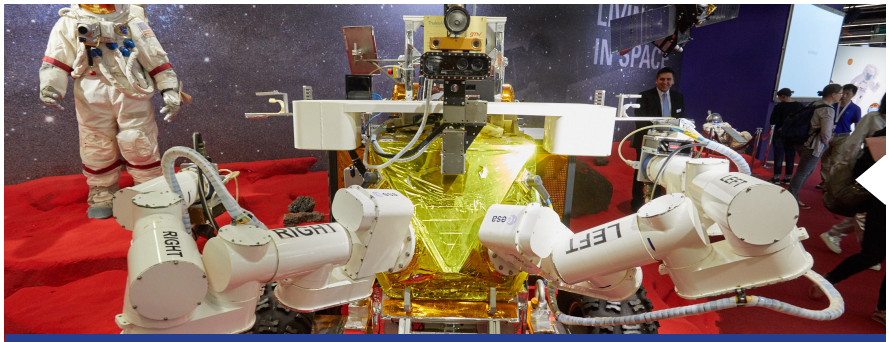
SIOEN Industry

In our opinion it was the most spacious stand of all prepared for this year's edition. The open and spacious stand structure was perfectly visible and encouraged visitors to stop by. Apart from friendly subdued colours and modern equipment, an additional advantage of the stand was a floor which the visitors could enter freely. And we can't forget to mention the Belgian pralines available all over the place!

Product

SAPLAN-High Security

In an age of the increasing threat of cargo theft, more and more emphasis is placed on the protection of goods. Sako-Expo presented its anti-burglary tarpaulin SAPLAN – High Security. This cutting-edge solution combines two main protective functions: mechanical – a steel cord prevents cutting with, for example, a knife - and electronic – in the case of circuit breakage an alarm is activated. The system can also be connected to GPS, which allows you to identify trailer location in the event of theft.



Supporting event

'Living in Space'

The leading theme of this year's edition was space travel, and one of the accompanying events celebrating this occasion was the exhibition "Living in Space'. Its main purpose was to present products, technologies and materials which may be or are already applied in space technologies. The exhibition featured a show of clothing inspired by space travel and an opportunity to take a virtual trip to Mars by means of special glasses.

Gadget

Sattler

The tradition of giving small gifts to fair visitors is nothing new. What is changing, however, is the approach to designing promotional gadgets. Until recently, corporate gifts were limited to pens, mugs or lanyards with company logo. Now, gifts given to guests are even more practical and much better designed. The Sattler company prepared bags that demonstrated very good quality as well as interesting design. This gadget really encourages you to show it off to your friends, which the thing that we normally do with gadgets, isn't it?

Environmentally Harmful Fabrics

The thing that makes a material or clothing potentially harmful to the environment is its most basic part - the fibre.

According to a report by the company Textiles Intelligence, the biggest threat to the environment emerges at the stage of manufacture of fibres.

Report summary

Wool
The problem starts at the stage of sheep farming. Manure fumes, for example, have had a significant impact on the increase of greenhouse gases in the atmosphere over the past centuries. In addition, feces contribute to pollution of surface water in areas where sheep have been grazing.

Cotton
In the case of cotton, the problem is associated with water usage. It is estimated that approx. 8,500 litres of water are needed to grow the cotton that is used to produce one t-shirt and a pair of jeans. Another problem is the

use of pesticides, chemical fertilisers and other chemicals on crops, which can be harmful to the environment. Moreover, pesticides can be a source of considerable harm to human health.

If cotton is produced in such large quantities in the nearest future, we will see a growing need to find improved and sustainable methods of growing it. A number of such initiatives have already emerged, including such projects as the Better Cotton Initiative (BCI) and Cotton made in Africa (CmiA), among others.

Synthetic fabrics

In the manufacture of synthetic fibres, raw materials are less environmentally friendly than in the production of cellulose fibres. This is because most of it is derived from the petrochemical industry, especially from non-renewable sources.

There are research initiatives to counter the dangers linked to the production of synthetic fabrics. One among these is Ingeo, a synthetic fibre made from agricultural crops. However, critics of this method argue that the land used for cultivation of these crops takes up the space for potential food crops.

The textile industry has indeed a long way to go. Despite the efforts to reduce environmental pollution, eco-friendly fibres account for only a small proportion of the 89 million tonnes of fibres produced globally.

FESPA 2017

CONNECTING PRINT COMMUNITY

Exhibitors endorse annual show cycle with 80% of FESPA 2018 Berlin space reserved.

FESPA 2017 (Messe Hamburg, 8-12 May 2017) brought together a buoyant speciality printing community, with many exhibitors reporting record sales, and an audience of senior decision-makers coming with an immediate intention to invest.

The event's 'global print expo' strapline was reflected in its diverse international visitor profile, with printers and signmakers coming to Hamburg from 139 countries, making it the most international FESPA ever. The largest visitor groups were from Germany, the UK, Italy, the Netherlands, Spain, Denmark and Poland, the latter two reflecting the accessibility of the host city for visitors from these countries. Following the success of FESPA Asia in Bangkok in February 2017, the Hamburg event also saw growth in visitors from Asia, representing 10% of total attendance.

Of the 20456 unique visitors who came to FESPA 2017 and its co-located events, the majority opted to stay at the event for two days. This brought total attendance to 39224, demonstrating the breadth of FESPA as a product showcase. With almost 100 first-time exhibitors on the show floor, visitors had access to a comprehensive line-up of suppliers of technology, materials for printing and sign-making, consumables and accessories.

During the show, FESPA took reservations for almost 80% of the available floor space at FESPA 2018 in Berlin (15-18 May 2018), requiring the team to book two further halls at Messe Berlin to meet exhibitor demand. This response underlines the success of the FESPA expo as a forum for meeting customers and prospects face-to-face, making concrete sales and developing business pipelines.

FESPA Divisional Director Roz Guarnori comments: "Following on from the success of the last week in Hamburg, we're thrilled by the enthusiastic commitment to our next event in Berlin in 2018 from digital, screen and textile vendors alike. This endorses our decision to move the FESPA global print expo to an annual cycle and make every event a comprehensive showcase of all processes and products."

The profile of FESPA as the leading European exhibition for textile printing continues to increase, with significant announcements of new textile printing solutions from many vendors in Hamburg, and developments in soft

BUOYANT BUSINESS AT FESPA 2017 INVIGORATES GLOBAL SPECIALITY PRINT COMMUNITY

signage a dominant topic of discussion with visitors. Printed interior décor applications were also prevalent throughout the event.

Roz Guarnori concludes: “Judging by the energetic mood and buzz from exhibitors and visitors, FESPA is an event that invigorates and stimulates a whole community, giving guidance on new technologies and solutions, supporting visitors to build profitable businesses, and fuelling success for exhibiting brands.”

FESPA 2018 incorporating European Sign Expo will take place at Messe Berlin, Germany from 15th to 18th May 2018.

About FESPA
Founded in 1962, FESPA is a global federation of 37 member associations for the screen printing, digital printing and textile printing community. FESPA’s dual aim is to promote screen printing and digital imaging and to share knowledge about screen and digital printing with its members across the world, helping them to grow their businesses and learn about the latest developments in their fast growing industries.

FESPA Profit for Purpose
Our shareholders are the industry. FESPA has invested millions of Euros into the global printing community over the last seven years, supporting the growth of the market. For more information visit www.fespa.com

FESPA Census
The FESPA Print Census is a global research project to understand the wide format, screen and digital print community. It is the largest data gathering project of its kind. The survey is published in several languages and can be completed online: www.fespa.com/completemycensus.

Forthcoming FESPA events include:

- FESPA Africa, 13 - 15 September 2017, Gallagher Convention Centre, Johannesburg, South Africa
- FESPA Mexico, 21 – 23 September 2017, Centro Banamex Mexico City, Mexico
- FESPA Eurasia, 7 – 10 December 2017, CNR Expo, Istanbul, Turkey
- FESPA Asia, 22 – 24 February 2018, BITEC, Bangkok, Thailand
- FESPA 2018, 15 - 18 May 2018, Messe Berlin, Germany

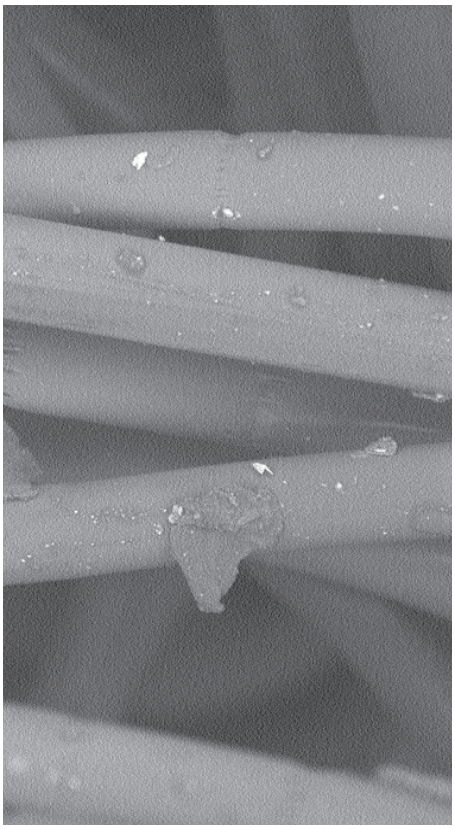
Issued on behalf of FESPA by AD Communications.

Article and photos courtesy of FESPA

Written by:
Grigory Kovalenko, Elena Bokova, Maria Pawłowa

DEVELOPMENT OF SYNTHETIC MEMBRANES FOR CLOTHES AND SHOES

MOSCOW STATE UNIVERSITY OF DESIGN AND TECHNOLOGY



INTRODUCTION

Membranes are high technology products of inter-branch application, without which the breakthrough development of basic and high-tech sectors of the economy, science, as well as effective solution of the important tasks of social and environmental problemsis impossible. [1].

The largest producers of membrane materials, varying in their properties, in the last five years are such companies as W. L. Gore, Dermizax (Spyder, Descente), AWT (Killy), DIAPLEX (Phenix), Venture (Schoffel), Helly Tex (Helly Hansen), Sensor Tex (Volkl), ATX (EVF).

A sufficiently large segment of the market is occupied by the membrane materials for apparel and shoes production. According to several manufacturers, such membranes represent a sufficiently large range of waterproof and breathable polymer materials designed for extreme and high-functional clothes and shoes. [2]

It is known from literature, that there are various methods for producing (forming) membranes, such as extrusion, laminating, sintering, electrospinning, phase separation, etc. The last two are the most common methods for receipt of apparel and footwearmaterials, as they provide the possibility of a wide variation of morphology and porosityand allow you to form the membrane with a gradient pore system.

Thus, using the method [3] ofthe phase separation of the polyurethane solution in dimethylformamide,the series of membranes for apparel and shoes productionhas been prepared and the effect of temperature of the phase separation on the porous structure, mechanical properties and gas permeabilityhave been studied.

During the process [4] the polyurethane membranes were prepared by electrospinning.The authors have investigated the performance of membrane sanitary properties; they have proved its high oxygen permeability and controlled water vapor permeability.

The authors [5] have obtained waterproof breathable membrane, which is a composite material consisting of a synthetic textile with a coating of a nonwoven fabric. Non-woven fabric was obtained from a solution of a polyesterurethane (PEU) in dimethylacetamideusing the electrospinning method. The composite material showed a high air permeability, vapor permeability and insulating properties, but had lower resistance to water (water resistance) in

comparison with a foil membranes prepared by phase separation.

Based on literature data analysis, it is obvious that the membrane material for clothing and footwear should have a number of special properties, such as steam and gas permeability, durability, water resistance, strength, etc. Such a set of operational characteristics can only be achieved by creating composite polymeric materials.

The purpose of the work is development of scientific bases and process solutions to produce PEU membrane materials such as “synthetic leather” on the basis of non-woven fibrous fabric, received by electrospinningmethod.

RESULTS

One of the main load-bearing elements of modern membrane materials such as “synthetic leather” are non-woven fibrous bases produced by the aerodynamic method of forming the canvas from a mixture of polyester and polypropylene (70:30) fibers, followed by needling and heat shrinkage. Such materials have a sufficiently large thickness of about 7 mm, so it necessary to skive it for 2-3 layers. The linear density of individual fibers in such fabrics ranges from 0.33 to 0.44 tex, surface density - 350-700 g/m^2, bulk - 150-220 kg/m3, the total porosity - 76-80%.

Currently, the multifibrillar fibers with linear density 0.1 - 0.01 tex and diameter of several micrometers are gaining increasing importancein the production of synthetic leather;they are obtained from bicomponent fibers “matrix” (e.g., high pressure polyethylene) - “fibril” (e.g. polyester) by extracting the “matrix” boiling organic solvent (e.g., xylene, toluene, etc.) in the already formed and treated with polymeric binder nonwoven base.

This technological process, pretty complicated from ecological safety viewpoint, is aimed at reducing the dimensional features of the fibers in the nonwoven fabric, changing the structure of nonwoven webs, increasing their total porosity (90-95%), geteroporosity, specific surface, vapor permeability without a change in hydrophilicity and sorption activity with respect to water vapor.

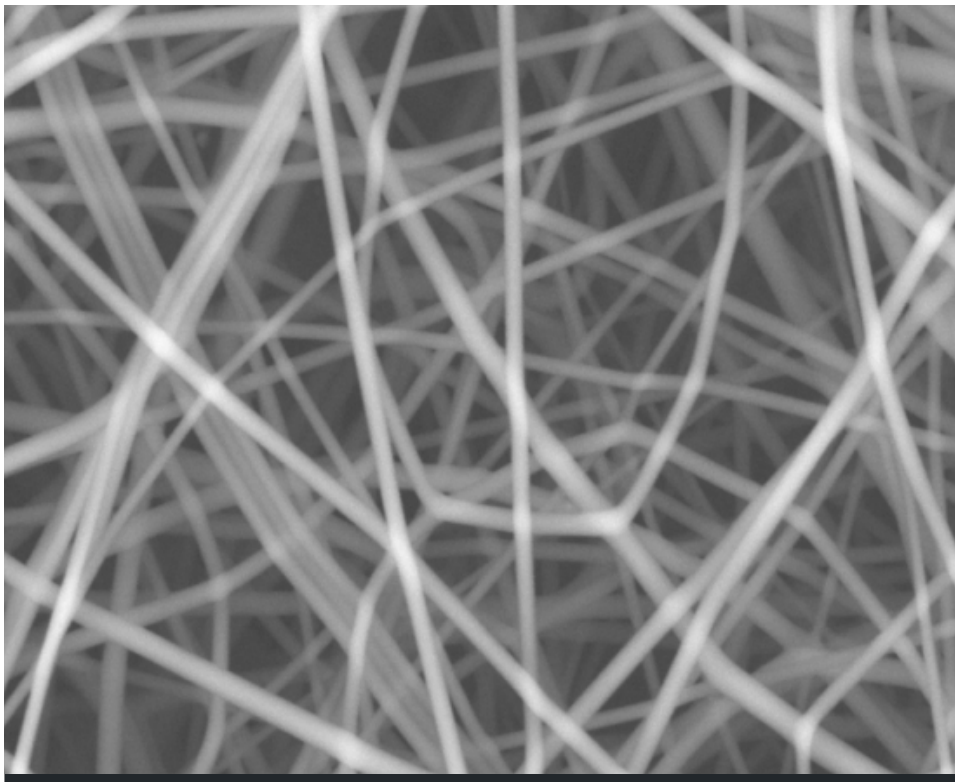


Fig. 1. Microphotograph of nonwovenmaterial from solution of PA 6/66. Image magnification 2500x.

To solve the similar problems the electrospinning method for nonwoven materials as one of possible waysto obtain highly porous structures of a wide range of polymers including those of hydrophilic nature has been used.

When choosing a spinning solution for electrospinning,the necessity ofinsolubility condition of nonwoven webs in dimethylformamide (DMFA) was a precondition, taking into account its subsequent impregnation with a solution of polyether urethane (PEU), as well as providing hydrophilic materials prepared for its comfortable operating in contact with the human.Polyamide solution PA 6/66 in a mixture of ethanol (70 wt.%) - water (30 wt.%) was chosen from the wide range of analyzed polymer solutions, used to prepare the materials by the electrospinning method, and satisfying these requirements.

Nonwoven fabricshave been obtained in the laboratory of aerosols of Karpov Scientific Research Institute of Physics and Chemistry (NIFKhI) with a help of NanospiderTM (Elmarco, Czech Republic) using the following parameters: concentration of the polyamide solution - 15%, the viscosity of the solution - 0.4 Pa•s, conductivity - 0.11 cm/m, the voltage - 30V, the volumetric flow rate of 30 ml/hour, the distance between the electrodes - 20 cm.

The structure of the formed fabric is shown in Fig. 1

The diameter of the fibers in such material ranges from 0.8 to 1.3 microns. Bulk density is 100-110 kg/m3, surface density - 25-30 g/m^2, which is about 25 times less than in the nonwoven webs obtained by needling technology.

Analysis of modern synthetic leathers demonstrates that the total contribution in the structure, properties and behavior in the operation are made by nonwoven base, the polymeric binder and the final morphology of the material formed as a result of impregnation, phase separation and subsequent washing and drying operations [6].

Indicators	Membrane material based on Vitur TM-1413-85	Membrane material based on Vitur TM-1413-90
Thickness, mm	1.3	1.5
Vapor permeabilty, mg/(cm^2·hour)	4.4	5.8
Hygroscopicity, %	10	8.6
Water-yielding capacity, %	9.8	7.4
Sorption capacity, g/g	0.2	0.25
Tensile strength, MPa	3.5	4.1
Tensile strain at break, %	210	240

Table 1. Indicators of performance properties of membrane materials such as “synthetic leather”

15% solutions PEU of Vitur TM-1413-85 and Vitur 0533-90-TM in DMFA were used for impregnating the nonwoven bases. 30% DMFA solution in water at 20 ± 5 °C was used as the coagulation bath. Washing was conducted with water at a T = 20 ± 5 °C, and the drying – in heat chamber at a temperature of 100 ± 10 °C. When selecting a temperature of the phase separation the undesired shrinkage of the hydrophilic nonwoven baseobserved at the stage of impregnation and phase separation was taken into account.

Fig. 2 shows microphotographs of the structure of membrane materials such as “synthetic leathers”.

Composition of the precipitation bath - 30% solution of DMFA in water. The temperature of phase separation – 20 °C, the drying temperature – 100 °C.

A distinctive feature of the membranes obtained during the process is the presence of a strongly marked fibrous structure in the microporous PEU matrix, as well as the absence of the expressed surface gradient layer in almost all the samples. This is due to both, the impregnation features of ultrathin nonwoven webs, and kinetic factors in the process of structure formation at the stage of phase separation of PEU solutions. Fast uniform impregnation, virtually simultaneous phase separation throughout the nonwoven webs consisting of a number of micro-fibers, results in materials of similar appearance and organoleptic to natural leather.

During the investigations, it was established that as the result of processing nonwoven base with a polymeric binder by the impregnationmethod followed by the phase separation in a non-solvent medium, the diameter of the fibers in the semi-finished product of synthetic leather after the drying process practically does not change and is about 1.3-1.5 microns.

However, the photographs clearly show the presence of additional microvoids between the microfibers and astabilizated polymeric binder, which is a consequence of detachment of the hydrophilic fibers from hydrophilic-hydrophobic polymer matrix during the drying process. Specific surface of membrane materials and pore sizes were measured by low-temperature nitrogen adsorption.For samples based on solutions PEU Vitur TM-1413-85, specific surface area is 24.1 m^2/g with a correlation 0.989, and for the samples based on PEU

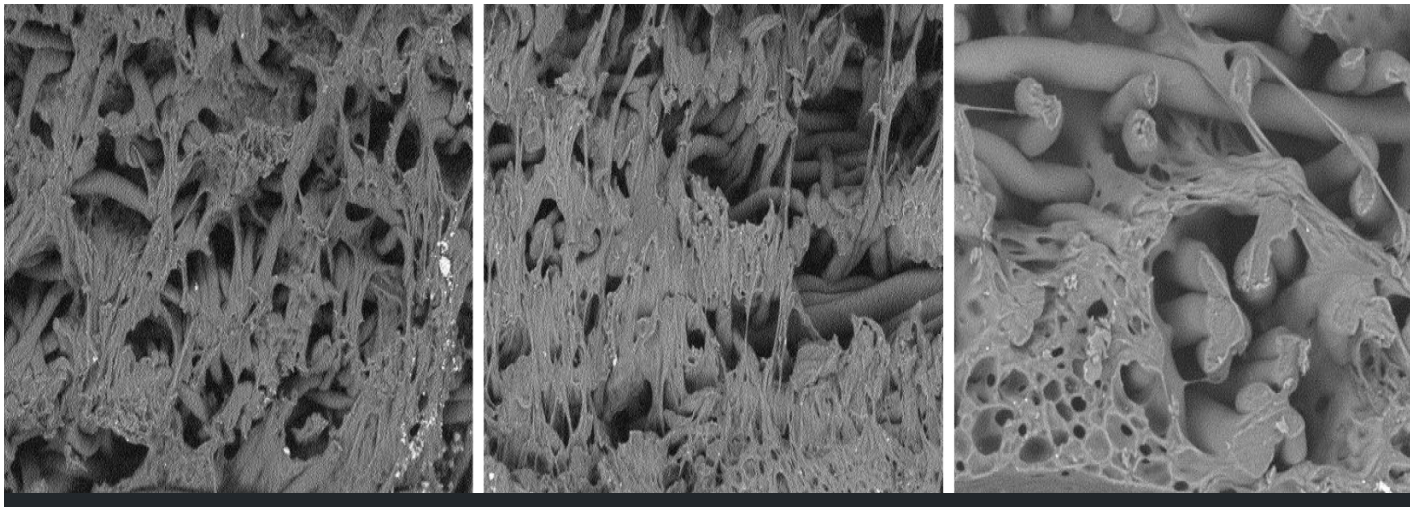


Fig. 2. The microphotographs of structure of membrane materials such as “synthetic leathers”: a - on the basis of PEU TM-0533-90 (image magnification 1500x) c, d - on the basis of PEU TM-1413-85 (image magnification 1500x, and 5000x, respectively).

Change model of the synthetic leather structure (SKM)

Synthetic leather manufacturing technology by solvent extraction (SKM)

Synthetic leather structure:

- Polyether urethane frame;
- Voids at the interface between the fiber and the frame;
- Micropores;
- Microfibrillar fibres from PET;
- Bicomponent fiber matrix from LDPE

TM-0533-90 – 23.9 m^2/g with a correlation 0.992. The presence of pores are determined in developed synthetic leathers with a diameter from 0.01 to 1.41 microns, which is the total contribution of pores to the structure of micro fibers formed as result of PEU solutions astabilization, as well as an additional system of micropores, which are formed during the drying process due to the multi-directional action of the forces of capillary contraction.

The Table 1 shows the indicators of performance properties of membrane materials such as “synthetic leather”.

High levels of vapor permeability, hygroscopicity, water-yielding capacity of synthetic membrane materials obtained in the work are related to the formation of a highly open-cell structure consisting of the hydrophilic polymer microfibers. High rates of tensile strength at low thickness of these materials are provided with the greater binder weight gain in experimental synthetic membrane materials, the presence of the reinforcing component in the form of a solid, as compared with polypropylene and polyester, polyamide fibers, a different mechanism of deformation and destruction of electroformed webs, compared with needle-punched fabrics.

In general, the availability of received materials together with heteroporous structure, developed system of micropores, hydrophilic fibrous skeleton, as well as high levels of hygienic properties, can be used to create high-performance “smart” materials, working closely with a human.

CONCLUSIONS

The systematic study and science-based approach were conducted to receipt membrane materials such as “synthetic leather” on the non-woven base, formed by the electrospinning method, and PEU solutions impregnated into the structure of the nonwoven fabric by phase separation in non-solvent medium.

The conditions of the preparation of membranes on the non-woven base from the polyamide solution 6/66 and new brands of PEU (Vitur TM-1413-85 and Vitur TM-0533-90) were also developed.

It was revealed that the porosity of the received membrane material (~ 96-98%) corresponds to the porosity of synthetic leather comprising microfibrillar fibers, and the specific surface area was 23-24 m^2/g, which is much higher than that of industrial analogue.
The modified production technology of membrane materialswas also proposed, allowing to expand the range of competitive synthetic leathers with geteroporous structure, leather-like organoleptic properties and high levels of operational properties, such as: vapor permeability – 4.4-5.8 mg/(cm^2 per hour), hygroscopicity – 8.6-10%, water yielding capacity - 98-99%, tensile strength - 6-6.4 MPa, and elongation - 210-240% withno extra cost and increase in environmental risks.

For experimental methods please check at www.research.tetex.com

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SYNTHESIS, APPLICATION OF A NOVEL AZO DYE AND ITS INCLUSION COMPLEX WITH BETA-CYCLODEXTRIN ONTO POLYESTER FABRIC

Original source: International Journal of Textile Science 2017, 6(3): 79-87

INTRODUCTION

Azo compounds are a type of chemical compounds that are continuously receiving attention in scientific research [1, 2]. They are usually strongly coloured compounds which can be intensely yellow, red, orange, blue or even green, depending on the exact structure of the molecule. As a result of their colour, azo compounds had great importance as dyes and also as pigments for a long time [3]. In fact, most of the dyes in industrial use today are azo dyes, which are mostly prepared from diazotization-coupling reaction [4, 5]. The structural features in organic compounds, that commonly produce colour [6] are > C = C <, –N = O, –N=N–, aromatic rings, > C = O and –NO2. Cyclodextrins are natural compounds which have distinct structures and ability to give inclusion complexes with different molecules through host–guest interaction [7]. Physical and chemical properties of guest molecules can be developed after forming the inclusion complex. On the other hand cyclodextrins have numerous uses in textile dyeing and washing methods as leveling agents [8] to reduce the non fixed absorbed materials from fiber by creating inclusion complex with these undesired substances. Also, cyclodextrins inclusion dye complexes can be used to remove unpleasant smells, and act as antimicrobial agent [9, 10] towards textile fibers, as a result cyclodextrins used in industrial medical textiles. Furthermore, using cyclodextrin inclusion dye complexes for dyeing purposes do not cause any environmental problems because their waste water is not toxic [11, 12]. Polyester fiber has a highly compact and crystalline structure, and is markedly hydrophobic. For this reason, its aqueous dyeing is carried out at high temperature and high pressure using hydrophobic dyes. Solvent-assisted and carrier dyeing has been widely studied as a mean of accelerating the dyeing rate, improving dye uptake and lowering dyeing temperature [13]. However, both solvents and carriers have serious problems, namely toxicity and unpleasant odor, poor light fastness, adverse effect on the physical and chemical properties of the fiber, high costs of waste water treatment and environmental contamination. Clearly, it seems sensible that efforts should be devoted towards the development of a new dyeing technique to accelerate dyeing rate, improve dye uptake and lower dyeing temperature in the areas of textiles. Comprehensive research efforts have been made in the area of cyclodextrins inclusion dye complexes that have been used for the dyeing of hydrophobic fabrics [14, 15] to modify and develop their surface functional properties.

The present paper reports on the synthesis of an azo dye 4-(2-(10-oxoanthracen-9(10H)-ylidene)hydrazinyl)-N-(pyrimidin-2-yl)benzenesulfonamide (dye1) and its inclusion complex with β- cyclodextrin (dye2). Spectral methods were applied to demonstrate the chemical structures of the synthesized azo dyes. The azo dyes were applied on polyester fabric and their batch dyeing behavior including dye exhaustion, dye fixation, dye quality%, diffusion coefficient and energy of diffusion at various temperatures were evaluated and compared.

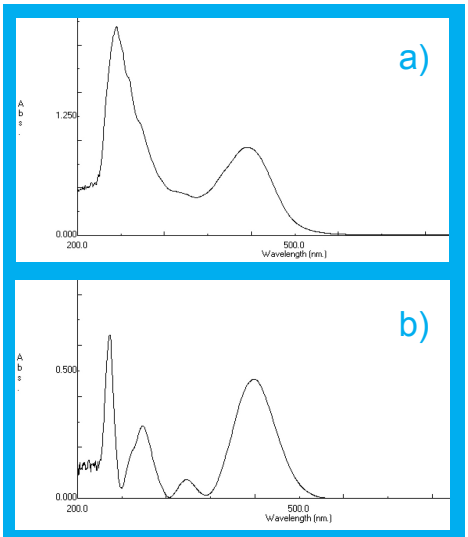

Figure 1. Diffusion coefficients and diffusion activation energy of Figure 1. Absorption spectra of a) dye 1 and b) dye2

EXPERIMENTAL

Materials

All reagents (Sigma Aldrich, 95%) and β-cyclodextrin (Acros Organics, 99%) were used as received without further purification. Scoured and bleached 100% polyester (0.22 dtex) fabric was supplied by El-Mahalla El-Kobra Company. The fabrics were further scoured in aqueous solution with a liquor ratio 1:50 containing 2 g/L nonionic detergent solution (Hostapal, Clariant) and 2 g/L Na2CO3 at 50°C for 30 min to remove waxes and impurities; they were then rinsed thoroughly in cold tap water, and dried at room temperature [16]. All other chemicals were purchased with high purity from Merck (Darmstadt, Germany).

Functional Group	Wavenumber (cm^{-1})		Changes
	β-Cyd	Inclusion - complex (dye2)	Δδ
ν[OH] symmetric	3389.28	3421.1	+31.82
ν[CH2]	2925.48	2930.22	+4.74
ν[C–O-C]	1158.55	1159.01	+0.46
ν[O–H] bending vibration	1027.87	1090.55	+62.68

Table 1. Elucidation of the intensity of β-Cyclodextrin and the inclusion dye complex (dye 2)

Functional Group	Wavenumber (cm^{-1})		Changes
	Azo dye (dye1)	Inclusion - complex(dye2)	Δδ
ν[OH]	3440.28	3397.96	-42.32
ν[N=N]	1455.03	1418.39	-36.64
ν[C=O]	1661.37	1660.41	-0.96

Table 2. Elucidation of the intensity of azo dye formed (dye1) and the inclusion dye complex (dye2)

Synthesis of Dyes

Synthesis of 4-(2-(10-oxoanthracen-9 (10H)-ylidene) hydrazinyl)-N-(pyrimidin-2-yl)benzenesulfonamide (dye 1)

Sulfadiazine (1.28 g, 5.12mmole) was dissolved in 20 ml HCl conc. and was cooled in an ice bath to -4°C. A cold solution of sodium nitrite (0.36 g) was slowly added with continuously stirring. After diazotization was completed, the diazo solution was added to anthrone (1 g, 5.15 mmole) in sodium acetate (2 g) and acetone (15 ml). The reaction mixture was stirred for 1hour; the formed precipitated was filtered, washed with water, and dried. Afterwards, it was recrystallized from ethanol to give yellow crystals in 90% yield; m.p. 282-284°C. FT-IR (KBr, cm-1) showed the presence of broad bands due to (vNH) at 3244.65 cm-1, (vC=O) at 1650.77cm-1and (vN=N) at 1441.53 cm-1; 1H-NMR (400MHz/DMSO) indicated at δ7.03-8.56 (m, 15H, arom. H); 11.22 (s, 1H, NH); 11.65 (s, 1H, NH); MS (m/z): 455, which corresponds to the molecular formula (C24H17N5O3S).

Synthesis of inclusion complex 4-(2-(10-oxoanthracen-9(10 H)-ylidene)hydrazinyl)-N-(pyrimidin-2-yl)benzenesulfonamide -β-cyclodextrin (dye2)

Amixture of 4-(2-(10-oxoanthracen-9(10H)-ylidene) hydrazinyl)-N-(pyrimidin-2-yl)benzenesulfonamide (0.5 g, 1.1mmole) and β- cyclodextrin (2g, 1.76 mmole) was stirred in DMF for 72 hours at 50°C. The reaction mixture was poured onto water; the solid formed was then filtered off, washed with water, and dried to give inclusion dye complex (dye2) (0.94 gm, 0.59 mmole) as orange crystals; m.p. 325°C. FT-IR (KBr, cm-1) showed the presence of bands due to (vOH's) at 3421 cm-1, (vC=O) at 1668 cm-1 and (vC-O-C) glucosydic at 1159 cm-1; 1H-NMR (400MHz/DMSO) indicated at δ2.13 (7H, H-4); 2.28 (7H, H-2); 2.74 (7H, H-5); 2.90 (7H, H-3); 3.66 (14H, H-6); 4.40 (broad s-OH,7H,7OH primary hydroxyl); 4.85 (7H, H-1); 5.56 (broad s -OH, 14H, OH secondary); 6.70-8.64 (m, 15H, arom. H); 11.34 (s, 1H, OH); MS (m/z): 1590, which corresponds to the molecular formula (C66H87N5O38S).

Compound	H-1	H-2	H-3	H-4	H-5	H-6
β-Cyclodextrin	5.06	3.63	3.96	3.58	3.66	3.96
Inclusion dye complex	4.85	2.28	2.90	2.13	2.74	3.66
Δδ	0.22	1.35	1.06	1.45	0.92	0.3

Table 3. Chemical shifts (ppm) for the protons of pure β-cyclodextrin and inclusion dye complex

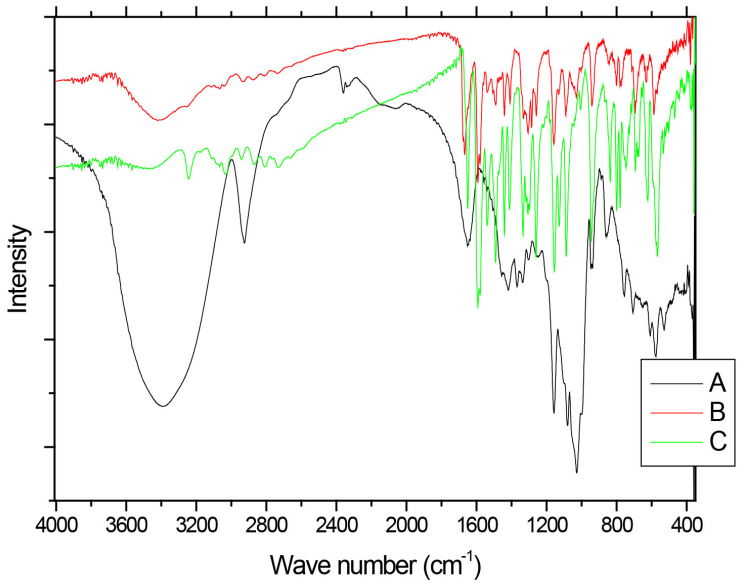

Figure 2. FTIR spectra of β-Cyclodextrin (A), inclusion dye complex (B) and azo dye (C)

Characterization of Synthesized Dyes

All melting points are measured on Griffin melting point apparatus. Chemical structure of the synthesized dyes was studied with Fourier transform infrared (FT-IR) spectroscopy. The FT-IR spectra (KBr) were recorded on a Shimadzu 408 spectrometer and carried out at the Central laboratory of South Valley University. Proton nuclear magnetic resonance (1HNMR) spectra were recorded using Bruker 400 MHz spectrometer. Chemical shifts are reported in ppm with TMS as an internal standard and are given in δ units. Mass spectroscopy (MS 5988 and AmD 402/3 mass spectrometers at ionization energy 70 Ev) was applied.

For dye application method please check at www.research.tetex.com

RESULTS AND DISCUSSIONS

The Fourier Transform-infrared (FTIR)

FT-IR spectra are important technique to prove the formation of inclusion dye complex as a result of the change in frequency of functional groups of azo dye (dye1) than that of the pure β-cyclodextrin after formation of inclusion dye complex (dye 2). Figure 2 shows the FT-IR spectra for pure β-cyclodextrin (A), inclusion dye complex (B) and azo dye (C).

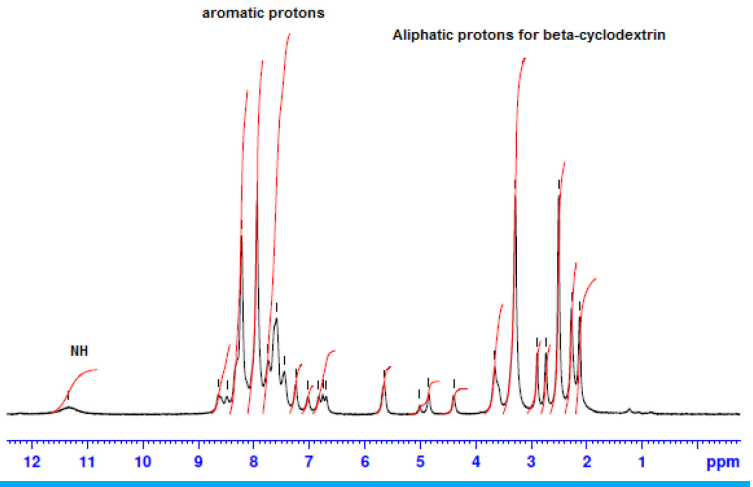

Figure 3. ^{1}H NMR spectra in DMSO of (dye1)

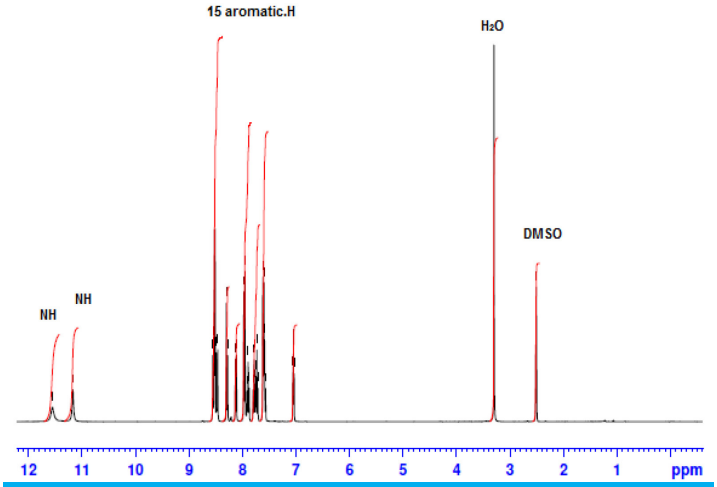

Figure 4. ^{1}H NMR spectra in DMSO of inclusion azo dye complex (dye2)

It's observed that the spectrum of the inclusion dye complex and the spectrum of pure β-cyclodextrin are different, and this is attributed to the formation of the inclusion complex. Also, the spectrum of inclusion dye complex indicates that hydroxyl groups appear narrower than the hydroxyl groups of pure β-cyclodextrin as a result of the formation of the inclusion dye complex.

Tables 1 and 2 show that there are slight increase and decrease in intensity changes Δδ. Enhancement of Δδ because of locating of the azo dye through the electron rich cavity of β-cyclodextrin which lead to increasing the frequency [7]. Also, the decreasing of intensity changes Δδ due to creation of van der Waals forces and hydrogen bonding during formation of the inclusion complex [21].

H-NMR Spectra

1H-NMR spectra for producing azo dye1 indicates the presence of aromatic protons at δ7.03-8.56 ppm and no peaks due to aliphatic protons, figure 3, also,1H-NMR spectrum of inclusion dye complex(dye2) show that appearance of β-Cyclodextrin protons in the region 2.13 to 5.56 ppm give good indication for forming of inclusion dye complex figure 4. Table 3 shows the chemical shifts observed for H-1, H-2, H-3, H-4, H-5 and H-6 for pure β-Cyclodextrin and its inclusion dye complex(dye2). Its observed that the values of chemical shift for protons of β-Cyclodextrin after formation of inclusion complex decreased and become more up field due to effect of shielding of aromatic rings for azo dye, this phenomena prove that formation of inclusion dye complex.

Dyeing Kinetic Characterization

The dyeing process is a solid/liquid phase process, which proceeds by the movement of the dye molecules from liquid phase to the solid surface of the fabric by virtue of their affinity, and then diffusion takes place inside the fabric. Therefore, the first process would be a fast adsorption controlled process where the dye molecules get into the fabric; the second slow process, which is diffusion-controlled, starts to take place. For the dye molecules to diffuse into the fabric, it is expected that the free volume could be formed within the fabric. This free volume is regarded as the void being temporarily formed within the fabric by the thermal movement of molecular chains and the dye molecules penetrate into this empty space [22]. Adsorption kinetics are important from the point of view that they control the efficiency of the process and correlate the adsorbate uptake rate with its bulk concentration. Therefore, the most practical parameters, i.e exhaustion %, fixation %, diffusion coefficient and activation energy of diffusion were determined for both types of dyes into polyester fabric.

Exhaustion %

Time-exhaustion isotherms of dyeing polyester -fabric using dye1 and dye2 at temperatures of 70, 80, 90, and 100°C over a 120 min interval are shown in Figure 5 for dye1 and figure 6 for dye2. The two figures show that the Exhaustion % (dye uptake) of polyester fabric using dye1 is generally high but not better in dyeing quality than that obtained using dye2. This is generally attributed to the fact that the β-cyclodextrin/ inclusion dye complex (dye2) with the increased molecular weight (1589 gm mol-1) does not diffuse rapidly within the fibre and has low substantivity for the textile substrate. This retarding mechanism is due to the formation of a dye/β-cyclodextrin inclusion complex (scheme 1). This complex would slow down the rapid uptake of the dye by the fibre. Agents having affinity to the dyes slow down the dyeing process by forming complexs with the dyes. The complex compound moves slower compared to the dye itself. Savarino with co-workers [23, 24]. On the other hand cyclodextrin inclusion dye complex showed a slight bathochromic shift of the absorption maxima of dye molecule. They are used as retarding agents during dyeing of the polyester fibers [25]. Higher temperature resulted in an increase in dye exhaustion onto fabric; hence, the dye adsorption is an endothermic process.

Fixation %

The percentage rate of fixation of the two dyes at equilibrium time of 120 min is given in table (4). The data clarify that dye2 records high Fixation % than dye1. This is due to the ability of cyclodextrins inclusion dye complex(dye2) to act as levelling agents achieving uniform dyeing by slowing down the dye exhaustion or by dispersing

the dye taken by the fibre in a uniform way [8], and thus cyclodextrin-dye solution showed an acceptable homogeneity in dyeing. Whereas with dye1 the coloration was heterogeneous although the higher recorded values of exhaustion % as seen from figure 5. The permanent fixation of cyclodextrin inclusion dye complex on polyester fabric surfaces as shown from the data in table 4 (fixation %) will result in textiles with new properties [26]. These properties enable cyclodextrins inclusion complexes to be used in food, pharmaceuticals, cosmetics, environment protection, bioconversion, packing and in the textile industry [27]. The ring structure of cyclodextrins allows them to act as hosts and form inclusion compounds with various small molecules as it occurs with dye2. This "molecular encapsulation" is already widely utilized in many industrial products, technologies, and analytical methods [28, 29]. Dyeing quality % was calculated and recorded in table 4 and the values of fixation % were significantly improved compared with exhaustion% leading to increase of dyeing quality % to 98.57% when β-cyclodextrin inclusion dye was used as a retarding reagent compared to dye1 at 100°C.

Diffusion Coefficient and Activation Energy of the Dyeing Process

The physical adsorption (physisorption) or chemical adsorption (chemisorption) mechanisms are often an important indicator to describe the type of interactions between dye molecules and polyester fabric. The increased diffusion coefficients of dyes with temperature rise Table (5) can be related to the polyester –dye interaction which increases the adsorption surface capacity. Lower values of diffusion Coefficient and consequently slower penetration and high dyeing quality of dye2 than dye1 were observed, which further confirm the possibilities of using cyclodextrins inclusion dye (dye2) as a dye complexing levelling agent in dyeing of polyester fabric. It also has effective influence for controlling dyeing uniformity. Furthermore, it is found that the arrangement of guest dye molecule within the cavity of the cyclodextrin host molecule gives the positive effects on the quality of polyester dyeing with dye2 than dye.

The activation energy describes the dependence of the diffusion coefficient on the dyeing temperature and also represents the energy barrier that a dye molecule should have to diffuse into the fabric polymer chain [30]. The low activation energies are characteristic for a physical adsorption (5-40 kJ mol-1), while higher activation energies (40-800 kJ mol-1) suggest chemical adsorption [31]. The activation energy of the diffusion of dye1 and dye2 was calculated by Eq. 4 from the linear relationship of log D against 1/T for both dyes, Fig. 7. The diffusion coefficient and activation energy results for dyeing of polyester -fabric using both dye1 and dye2 are demonstrated in Table 5. Considering these values are in the typical activation energy range for physisorption, one can conclude that dye1 and dye2 adsorbed mainly physically. Furthermore the activation energy of diffusion of dye 2 onto polyester - fabric (23.11 kJmol-1) is significantly higher than that of dye1 (19.48 kJmol-1) their positive values confirmed again the endothermic nature of the overall dyeing processes.

Dye	Temp. °C	D x 10^7 (cm^2 min^{-1})	E_D (k J mol^{-1})
Dye 1	70	0.69	19.48
	80	1.60	
	90	2.07	
	100	2.49	
Dye 2	70	0.46	23.11
	80	0.58	
	90	1.08	
	100	1.96	

Table 5. Diffusion coefficients and diffusion activation energy of dye1 and dye2 onto polyester- fabric at various temperatures

CONCLUSIONS

This paper describes:

- The synthesis of 4-(2-(10-oxoanthracen-9(10H)-ylidene) hydrazinyl)-N-(pyrimidin-2-yl)benzenesulfonamide (dye 1) and its inclusion complex with β-cyclodextrin (dye2). Their structures were confirmed by FT-IR, 1H-NMR and mass spectral studies.
- The two azo dyes prepared in this study are exhibited good (dye1) to excellent (dye2) dyeing properties on polyester fabric.
- The values of fixation % and dyeing quality % suggests that the formation of inclustion complex (dye2) via interaction of cyclodextrins host with dye guest should play a significant role in achieving uniform acceptable homogeneity dyeing by slowing down the dye exhaustion or by dispersing the dye taken by the fibre in a uniform way, whereas with dye1 the colouration was heterogeneous although the higher recorded values of exhaustion %.
- Diffusion coefficients increase with temperature rise and varied from 0.69-2.49x10-7 cm2min-1 for dye1 when the temperature increased from 70 to 100°C and from 0.46-1.96x10-7 cm2min-1 for dye2 at the same temperatures range. This can be related to the nature of dye polyester-fabric interaction.
- The activation energy of the diffusion of dye1 and dye2 was calculated and found to be in the typical range for physisorption. Furthermore the activation energy of diffusion of dye onto polyester -fabric (23.11 kJmol-1) is significantly higher than that of dye1 (19.48 kJmol-1), their positive values confirmed again the endothermic nature of the overall dyeing processes.

For full list of references and figure 5,6,7 please check at www.research.tetex.com

Written by:
H. M. Dardeer[1], El-sisi A. A.[2], Emam A. A.[2], Nora M. Hilal[2]

[1] Chemistry Department, Faculty of Science, South Valley University, Qena, Egypt
[2] Department of Chemistry, Faculty of Science, Al-Azhar University (Girls), Nasr City, Cairo, Egypt

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