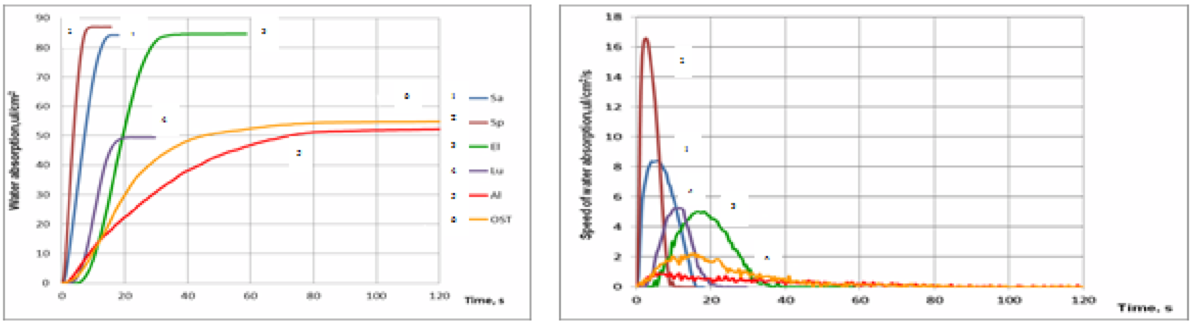

Figure 2. Dependence water absorption and speed of water absorption vs time

The received experimental data can be described by the known empirical equations of gases and a moisture transfer through thickness of textile materials vs time (Boltzmann, Wasburn, Navier-Stokes, etc.). We have defined unknown coefficients in the equation $u_z = u_{z\max}\left(1 - e^{-kt}\right)$ from experimental data for each individual textile material (u_z – concentration; u_{zmax} – max concentration; z – thickness of layer; t – time of sorption).

For the second layer and each subsequent layer we have received the differential equation of speed change and change of concentration in view of braking action of the first (and each subsequent) layer. Then, we have neglected presence of an air layer between two next layers. Integration allows predicting change of concentration and change of absorption speed for any two neighboring layers.

Thus calculation for a multilayered material which consists of textiles with various properties has been carried out. Calculation considers that movement of fluids in each subsequent layer of "sandwich" is broken by the previous layer (Fig.3).

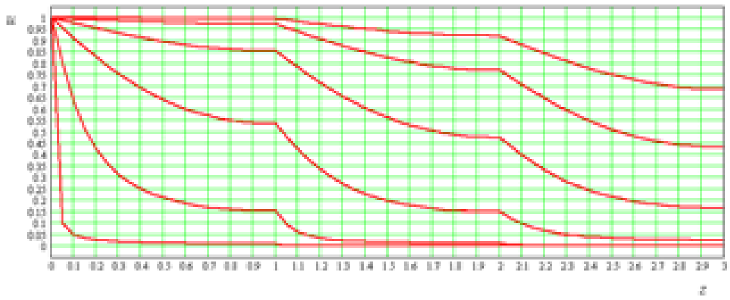

Figure 3. Moisture concentration change in thickness of textile materials vs time

Proposed method allows predicting water sorption and it's kinetic through layered textiles using the experimental data for each individual layer.

Key Words: Multilayered textiles; liquid sorption and transfer

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INTERFACE PHENOMENA OF PP/ GLASS BRAIDED STRUCTURES

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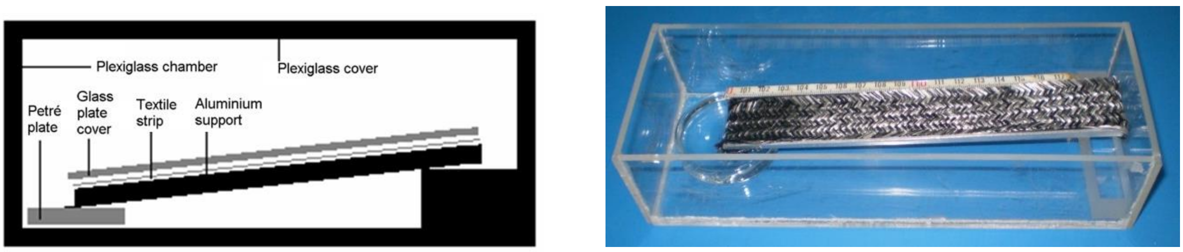
Textiles have important place in automotive and railway industry due to many advantages. In this paper, the interface phenomena of braided structures are researched through thin layer wicking method and contact angle. It occur at solid-liquid interface and depend to a large extend on the kind and magnitude of the solid surface free energy (SFE). Therefore, it is interesting to investigate the SFE of braids and related composites.

MATERIALS AND METHODS

Triaxial braids have been produced based on commingled PP/glass yarns suitable for thermo-compression in order to consolidate the fabric structure. Linear density of yarns is 640 tex, glass content is 71,6 % of the total mass and tensile strength is 20,78 cN/tex. The main difference between braids is in braiding angle. Reference BF_200 is manufactured by braiding angle of 45°, reference BF_300 by braiding angle of 35° and reference BF_400 by braiding angle of 25°. After manufacturing by using tubular braiding machine braids are cut and opened to make flat textile structures which are heated at T = 200°C and compressed with a constant pressure of P = 2MPa during 5 minutes. The consolidation is ended with a cooling step at 100°C in 2 minutes and the pressure is preserved during the last step. As result, thermoplastic composites are obtained. [1, 2]

Chibowski thin-layer method was used for SFE analysis of unconsolidated braided fabrics (Figure 1). The experiment was carried out in a closed plexiglass chamber. One set of the braided strips (250 x 20 mm) was conditioned in standard atmosphere, while the other was saturated in the vapour of the liquids applied (distilled water, formamide and n-heptane). [3, 4]



a) **b)**

Figure 1. Chibowski thin-layer wicking method: a) Plexiglass chamber for textile strip wicking, b) Measurement of the test liquid (formamide) penetration into braided fabric

Contact angle of consolidated braids, thermoplastic composites, are measured on DataPhysics OCA 20 Instrument using three different liquids – water, formamide and diiodomethane.

From the results of disperse Lifshitz-van der Waals (γ^{LW}) and polar acid-base (γ^{AB}) interactions, components of surface free energy (γ_L^{TOT}, γ_L^- and γ_L^+) are calculated according to Wu's, Owens-Wendt and Acid-Base theory.

RESULTS AND DISCUSSION

According to Chibowski thin-layer wicking method, components of surface free energy of braids have been calculated from liquid penetration rates into fabrics. The surface free energy (SFE) components and total SFE for unconsolidated braided fabrics are collected in Table 1. Based on penetration rate of n-heptane and pore radius, nonpolar Lifshitz-van der Waals interactions (γ^{LW}) are high. They are in range from 40,766 mJm^{-2} to 58,768 mJm^{-2} and calculated from bare (ΔG_b^h) fabric's strips. These values contribute to the total unconsolidated braids SFE. In accordance with Chibowski and Holysz results [4] obtained for glass by reaching the SFE polar component value of 80 mJm^{-2}, the high values of negative polar interaction belong to the glass fibre in braids. [4] The SFE of polypropylene is around 30 mJm^{-2}. [4] Results in Table 1 confirm that presence of PP in braids has influence on total SFE.

Table 1. Surface free energy components for unconsolidated braided fabrics according to Chibowski thin-layer method

Sample Label	R (cm)	ΔG_b^h (mJm^{-2})	γ_s^{LW} (mJm^{-2})	ΔG_p^W (mJm^{-2})	ΔG_b^W (mJm^{-2})	ΔG_p^f (mJm^{-2})	ΔG_b^f (mJm^{-2})	γ_s^+ (mJm^{-2})	γ_s^- (mJm^{-2})	γ_s^{total} (mJm^{-2})
BF_200_002	0,056	18,321	42,756	6,701	4,605	17,560	18,919	0,689	69,830	56,635
BF_200_003	0,046	18,585	43,139	8,347	7,444	20,395	16,075	0,018	85,609	45,642
BF_300_003	0,073	24,168	51,662	4,277	5,016	14,256	15,034	$4{,}2x10^{-7}$	80,008	51,674
BF_400_002	0,073	16,935	40,766	5,418	5,154	20,895	19,098	0,329	81,322	51,115
BF_400_003	0,086	20,539	46,035	5,499	4,068	13,145	10,349	0,010	81,062	47,853

CONCLUSION

Good adhesion of braided structures is important for improved properties and applications in automotive and related industries. The surface free energy components for braided fabrics can be minimized by modification of glass fibres. In the paper, the surface free energy of consolidated braided structures will be determined for deeper analysis.

ACKNOWLEDGEMENTS
The paper is a part of the results of the EU project "MAPICC 3D" within the call NMP-FP7- 2010-3.4-1, numbered with 263159 entitled: *One-shot Manufacturing on large scale of 3D up graded panels and stiffeners for lightweight thermoplastic textile composite structures.* The authors would like to thank the European Commission for the funding of the project.

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TEXTILE RECYCLING: AN ENVIRONMENTAL PERSPECTIVE

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With growing world population and enhanced affluence of the emerging countries, the fiber consumption has been increasing steadily over the past few decades. This has led to increased post industrial and post consumer waste. Even though Europe is at the forefront of recycling, with a textile consumption of 10 million tons, it is the largest consumer and second biggest producer of textile materials in the world. At the current rate of demographic and economic trends, European fiber and textile consumption per year will surpass 12 million tons by 2025.

Currently, 80% of steel is recycled, 65% of paper and 30% of plastics, recycling of textiles stands at an abysmal 15-20%. European Union consumers, in fact, discard 5.8 million tonnes of textiles per year. Only 1.5 million tonnes of the post-consumer textiles are recycled, mostly by charities and industrial enterprises. The remaining 4.3 million tonnes goes to landfill or is burnt in municipal waste incinerators, representing an enormous unused source of secondary raw materials and a negative footprint on the environment.

Besides textiles being near the bottom of all industries in terms of recycling, the problem is exacerbated with no coherent strategy for a sustainable future encompassing responsible care of the planet as demanded by society. This is not acceptable in the face of a shortage of raw materials and pressure on the environment due to land filling and burning. In addition, there is a strong grass root movement to leave behind a planet safer and better for future generations than we found it.

With both US & Europe as net importer of raw materials, in particular oil, urban mining offers an alternative strategy consistent and compatible with the concept of a circular economy. The talk focuses on an overview of fiber and textile recycling coupled with case studies. It includes general description of fibrous waste, statistics, material characteristics and sources. It outlines the environmental impact of recycling and the link between sustainability, recycling, energy and prosperity. Future development trends are discussed.

COATS COLOUR EXPRESS – THREAD COLOUR SAMPLE SERVICE COATS STOCKMATCH – EXCESS THREAD STOCK MANAGEMENT

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This study is presenting a service product for Fast Thread Colour Sampling Service which is designed in line with the global supply requirements of apparel industry and an adoption of the same model for Excess Thread Stock Management. In line with the targets of service innovation and to become the first choice of the customers, current service and product requirements in the sector has been determined with market research. A service model has been developed which makes acurate, easy and fast colour selection possible. After the initial lauch, the product has been developed to conduct the service of Management of Excess Thread Stocks as well.

Keywords: Sewing thread – colour sample – excess thread stocks

THE INFLUENCE OF HUMAN BODY DISPROPORTIONS ON GARMENT FITTING IN 3D CAD

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Abstract /Research problem

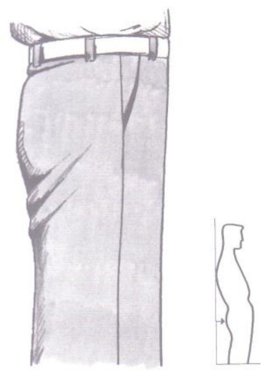
In this paper we studied the impact of chosen asymmetries of the human body on the 3D clothing pattern engineering in order to define the proper pattern shapes. In our study we designed the basic pattern of men's pants then adjusted them to the most common asymmetries of the man body using 3D software solutions. Moreover, this work contains the comparison between 3 different conception methods of basic men's pants leading to "the optimal pants look" for a given man's morphology. Then the new men's pants patterns, taking into account the particular human body asymmetries, were established. We were makes out the 3D simulations of these pants in order to check the pattern maker ability to identify the expected problems in the men's pants appearance. Finally we were trying to answer if it's possible to design the correct shapes of pants for no standard bodies, employing 3D software solution on the example of Modaris software.

Key Words: Clothing pattern engineering, asymmetries of the human body, 3D simulation

Literature Review

There can be quite a lot of explanations to have morphological body asymmetries and pattern making mistakes [1]. For the reason that the life styles, job areas, the types of the bones, aerosol capacity, energy sources,our genes, chromosomes, ages and hobbies all human bodies can have some morphological asymmetries and the key point is to find know how to deal with these effects in our lives [2], [3]. Besides these deformations, drawing the curves and the straight lines or taking the wrong measurement from the human body may occur some pattern making mistakes [4].

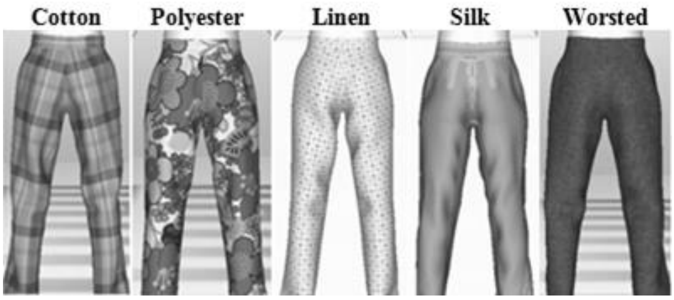
Some Results/Analysis



Flat hip asymmetry

Pattern making process represents a creation of "2D shapes", then patterns are transformed in "3D shapes" clothing by using sewing and glue techniques. In this paper we present our approach applying the men's pants pattern making method. In order to prepare the pants pattern different tools: 3D scanner, Modaris V7R1 are used. Measurement of the human body's circumferences influence and determine the clothing size. Taking into account our man mannequin measurements we select correct size corresponding to the chest, waist and hip measurements closed to mannequin's measurements. In order to make our pants we use Lectra CAD solution which offers all necessary to create 2D patterns and make out 3D simulations. Next, basic Swedish, Polish and French pants pattern have been drawn [4] [5] and simulated to show their appearance. We choose Polish method to create all our patterns that take into account the most common asymmetries of the man body.

The picture below presents an example of an asymmetry called “flat hip” which shapes in the back part of the pants. The main reasons is an incorrect posture of man, specific for the “springy person” where his hip is leaning forward. To solve the “flat hip” it is necessary to follow several steps. The key modifications focused on the back part in the crotch line which must to be shorten. Some modifications are also needed in the waist area on the front and back part. This project finally presents the dependence between the clothing problems appearances on the human body asymmetries and the mechanical characteristics of the fabrics as Kawabata parameters used in Modaris software . Five types fabrics simulated in Modaris are tested to distinguish the appearance differences.



Different appearances “Flat hip”

Discussions/Conclusions

Our studies show that the asymmetries of the human body impact strongly the conception of different pants pattern shapes, but also the characteristics of the fabric influence on the appearance of the pattern mistakes which can be a big challenge for pattern makers employing 3D software to recognize unambiguously the kind of mistake or human body asymmetry.

It seems to be interesting to check the influence of the another kinds of fabrics on the mistakes perception coming from the human body morphology and clothing pattern shapes.

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PLACEMENT OF FLAT GENERATOR IN GARMENTS

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INTRODUCTION

The integration of electronic systems into apparel is at present a very typical way of expanding the functionality of garments. The RTU carries out multi-industry research to make clothing serve not only for traditional purposes with the help of electronics. They are also meant to safeguard the safety and health of humans. Following examples can be mentioned: children's underwear microclimate control jacket, a bikers jacket with turn indicators and a stop signal, a vest with a cooling system.

BACKGROUND

All electronic systems integrated into a garment require a power supply. Most often batteries are used to supply power, which have to be replaced or charged periodically [1]. None of the two solutions can be considered as environmentally friendly, therefore motion converters into electric energy are being developed in the recent years. Usually there harvesters have a dimensional form as they consist of a coil with a moving magnet. Such power supply solutions are not suitable for the integration into clothing, as they deform its details.

RESULTS AND DISCUSSION

RTU has invented and developed a human mechanical motion energy converter with a flat structure working on the principle of electromagnetic induction. The electromagnetic energy harvester consists of a flat induction element (a coil) and a permanent magnet. The periodical movements of the magnet parallel to the coil create a periodic variable flow of the magnetic field crossing the coil and generating electric energy [2].

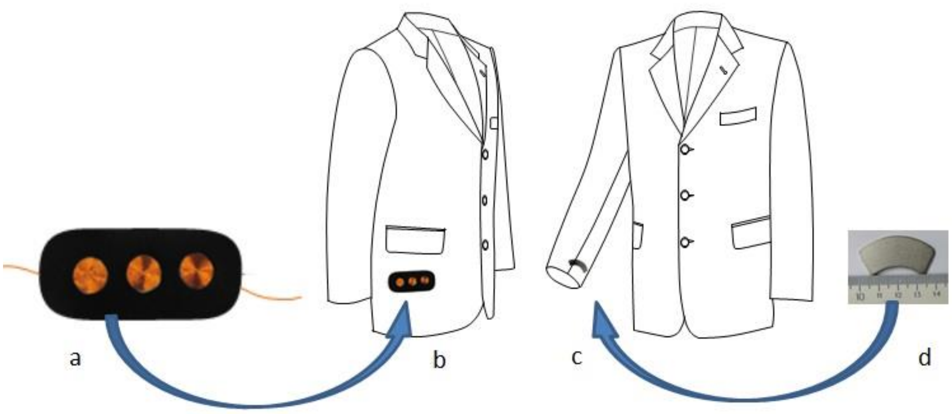

Figure 1. Elements of the electromagnetic inductor and their placement in a garment:
a – a spiral type inductive element, b – placement of the inductive element, c – placement of the magnet, d – a permanent magnet.

The energy harvester has been integrated into the apparel in a way for the magnet to move back and forth as close to the coil as possible while walking (Fig. 1). Voltage impulses were registered by attaching a digital oscilloscope – Piciscope 2205.

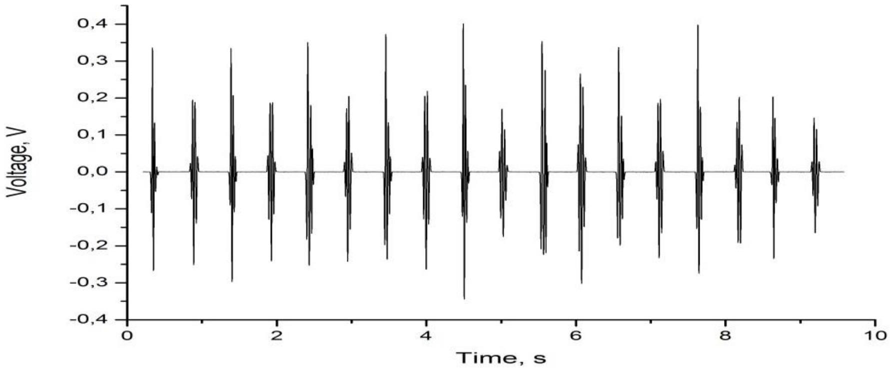

Figure 2. Generated voltage impulses

The generated output power depending on the number, placement and the geometrical shape of coils was researched to optimize the system. The influence of the marching speed and motion asymmetry on the parameters has also been studied. In the developed prototype (men's jacket) the energy harvesting structural elements were integrated into the side pockets and the sleeves on palm joint level between layers of fabric, maintaining the symmetry. The integration of the magnets and coils has been achieved without deforming the basic layers of the jacket. The average developed power for one energy harvester is up to 0,2mW, which is enough to provide the functionality of different health monitoring and other sensors. During the energy harvester placement studies it has been detected that in the case of average stature figures the most effective way of placing the coils is in the side parts of the apparel 6 - 8 cm under the waistline (on the level of the facet of the ilium), and the magnets accordingly on the inner lower part of the sleeves. Under these circumstances an experiment showed that the output power can be 502µW and 261µW at 6 km/h and 4.4 km/h. Good results have also been achieved by placing the system even lower - on the level of the hip and the fist-line of the sleeve. A stable shape garment like an insulated jacket is advisable to provide uniform and close movements of the magnets along the coils [3]. The integration of the system into beams of trousers is bothered by different leg shape of the wearers as well as the motions of the beams in case of wide trousers. Better results have been achieved by placing the coil and the magnets in the inner seams on knee level.

CONCLUSIONS

It is possible to integrate a flat structure electromagnetic energy harvester into apparel. The developed power can reach 0,5mW at a 6 km/h marching speed. The amount of energy is sufficient to power different wireless sensors and send information to remote receivers.

Key Words: Wearable human power harvester, functional smart garment

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SOME APPLICATIONS TO IMPROVE EFFICIENCY IN WEDDING GOWN PRODUCTION

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Wedding gown industry that clustered around İzmir has penetrated world markets with their own brand and designs. This feature enables to provide more added value than mass producing ready to wear companies which are only performing as subcontractors. Wedding gown companies that serve customized products are targeting to enter international markets with their own designs. Nevertheless the actual high added value and higher profits of this product causes less concentration on efficiency and waste in product development and production processes.

In Turkey wedding gown is usually evaluated as a craft product. It was never considered to be an "Industrial Product" and it has been produced with traditional tailoring methods. In wedding gown industry it is hard to name a process which is an equivalent of technical product development that we see in automotive, domestic appliance industries. However the most important input for production planning is obtained in the end of product development process. This lack of a professional product development process is also preventing the development of an efficiency vision. Additional result of traditional production style of wedding gown causes oblivion of higher profile designers and engineers donned with technical skills and information. For this reason complicated technology and operations which require more information and education are not applied in this industry. Supporting the modular product development project with new technologies for the development process that starts with customer's demand and taking each demand as totally another product, will make it possible to increase efficiency.

Even companies of this industry with higher capacities like 5000-15000 pieces per year are not exactly applying industrial technology and methods for increasing efficiency and controlling costs. On the other hand there are global competitors from Spain, China, USA that are able to produce and sell millions of ready to wear wedding gowns each year. Some of these companies (Pronovias, Vera Wang) have a serious competitive advantage.

Today we know that only organizing or investing for mass production technologies does not solve the efficiency problems. Apparel companies that used to mass produce garment products about until 10 years ago are now struggling with the problems such as smaller orders, increasing design variability. Some mass apparel production companies could foresee the need to change organization structures for maintaining flexibility in receiving orders in small amounts and in a high variety and reduce costs by eliminating waste in production processes by applying "lean production" techniques. However their processes do not include product development as they are producing as subcontractors. The lean principle concentrates on processes or steps which do not add value to the product names them as waste and eliminating these waste.

In this project to provide a flow of value Kanban and Modular Product Development methods will be adopted in order to increase capacity. Additionally for eliminating delays and non-value added steps, patterns will be constructed clearly so that no regulations on product will be required during production processes.

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APRIL 04, 2014

2BFUNTEX SESSION

BOOSTING COLLABORATION BETWEEN RESEARCH CENTRES AND INDUSTRY TO ENHANCE RAPID INDUSTRIAL UPTAKE OF INNOVATIVE FUNCTIONAL TEXTILE STRUCTURES AND TEXTILE RELATED MATERIALS IN A MONDIAL MARKET

2BFUNTEX is a 4 year project funded by the EC 7th Framework Programme NMP – commenced on the 1st of January 2012.

The 2BFUNTEX consortium includes 26 partners from 16 European countries.

The interactive website **www.2bfuntex.eu** was recently launched as a place for both companies - to detect new technologies and business opportunities as well as express their needs – and research institutions to present their current and future actions in research and education, and their available technologies.

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- **INOTEX (Czech Republic)**
- **Future in Textiles Association (Romania)**
- **UP-tex (France)**
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- **North West Textiles Network Limited (United Kingdom)**
- **Danish Technological Institute (Denmark)**
- **TechniTex Faraday Limited (United Kingdom)**
- **Ecoplus. Niederosterreichs Wirtschaftsagentur (Austria)**

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*IITAS 2014 2BFUNTEX Session was organised by Ege University team

2BFUNTEX: TRANSFER OF INNOVATIONS IN FUNCTIONAL TEXTILES TOWARDS INDUSTRY

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Abstract

2BFUNTEX is a European Coordination Action and stands for "Boosting collaboration between research centres and industry to enhance rapid industrial uptake of Innovative Functional Textile Structures and Textile related Materials in a Mondial Market". The objective is to bring together all innovation actors in the field to exploit the untapped potential in functional textile materials by fostering a multidisciplinary approach between academia and industry. The 2BFUNTEX team aims to identify technological gaps and eliminate barriers resulting in a faster industrial uptake of functional materials with new functionalities and improved performance. Technological needs are mapped, new joint international research disciplines are identified and multidisciplinary teams are created. As an industry-oriented approach is envisaged, industry is involved at all stages which should also contribute to a rapid uptake of innovations by SMEs.

Training materials for research and industry purposes will be elaborated and implemented, allowing a common language regarding functional textiles, and increasing the number of well-trained people in this field. Through the development of an interactive website with an extensive database, collaboration will be boosted and rapid industrial uptake catalysed and enhanced. Multidisciplinary teams that collaborate along a specific research topic will play a key role.

The website www.2bfuntex.eu is the place for both companies to detect new technologies and business opportunities as well as to express their needs, and for research institutions to present their current and future actions in research and education, and their available technologies. Based on the information gathered in the project inventory, researchers and industrials will be invited to participate in new joint research projects aiming to exploit the untapped protential and leading to the development of new industrial products.

The 2BFUNTEX consortium includes 26 partners from 16 European countries comprising all important sectors – fundamental research and education on textiles and related materials (universities and research institutes), economic, policy, foresight and complexity management (research institutes and SMEs), associations of SMEs, and a governmental chamber of commerce and industry. Further, an Industrial Advisory Board, representing both large companies and SMEs at different levels in the value chain, is set up to validate the strategy and progress of the project and give information on the industrial needs in the field of functional textiles and textile related materials.

More information : info@2bfuntex.eu, http://www.2BFUNTEX.eu

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DEVELOPMENT OF COMPOSITE TEXTILE STRUCTURES FOR WOUND DRESSING APPLICATIONS

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ABSTRACT

The paper discusses the development of novel and responsive nonwoven composite structures containing gelling materials for wound management. The study mainly focused on the development of novel 'all-in-one' collagen-booster therapeutic nonwoven wound dressings that also provide essential functional properties such as high absorption, vertical and lateral wicking, antibacterial and acidic pH properties. The developed composite wound dressing consists of carboxymethylcellulose (CMC) fibre and also it was reinforced with polylactic acid (PLA) fibre. The composite structures were engineered and produced by making use of the needlepunching technique. The machine settings were optimised during nonwoven production in order to obtain a simulated 3D fabric structure. The simulated 3D fabric structure is expected to have an increased surface area for higher absorption. The produced composite wound dressings were treated with two different collagen boosters at 4% (w/v) by using the spray method. The details of the collagen boosters have not been disclosed in this paper due to the Intellectual Property Rights (IPR) issues. The selection of collagen boosters have been based on previous studies. They were selected after screening the collagen enhancing property of the various individual chemicals in the literature. It is evident from the literature that the selected collagen boosters are essential for collagen synthesis. Another important benefit of using collagen booster treatment is that it allows the maintenance of an acidic pH environment at the wound area. It is well known that acidic pH reduces the wound healing time and enhances the wound healing process. Furthermore, one of the collagen boosters promotes not only the proliferation of the epithelial cells in wounds but also can provide antibacterial action.

The results demonstrate that the PLA fibre reinforced CMC composite dressing has enhanced wicking properties which help to minimise the pooling of exudate on the wound bed and as a result maceration is prevented. The PLA fibre reinforcement also enhances the integrity of the dressing and minimises the contamination of the wounds due to loose fibres and provides enough mechanical strength for painless dressing removal. The results also demonstrate that collagen boosters treated dressings maintain the wound bed in an acidic pH condition which also improves the wound healing process. In addition to the above stated properties, the collagen booster treatment imparts antimicrobial activity against Gram-positive and Gram-negative bacteria, thus resulting in the reduction in the propensity for wound infection. Ultimately, the research has proved that the 4% collagen booster treatment enhances the antimicrobial activity and the acidic pH characteristics of the developed CMC/PLA composite wound dressings.

FLEXURAL PROPERTIES OF WOVEN E-GLASS/POLYESTER NANO SILICA COMPOSITES

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The aim of this study was to understand the warp and weft directional bending properties of the developed two dimensional multistitched multilayer E-glass/polyester woven nano composites.

It was found that the specific bending properties of all developed structures were proportional to their warp and weft directional bending properties. There was a slight difference between warp and weft directional specific bending properties. Generally, the warp directional specific bending strength and modulus of the composite structures were higher than those of the weft. The warp and weft directional specific bending strengths and modulus of unstitched/nano composite structures were higher than those of the unstitched structures. When the nano silica material in the unstitched E-glass/polyester composite structure increased, the warp and weft directional specific bending strength and the modulus of the unstitched/nano structures increased. In addition, the warp and weft directional specific bending strengths and modulus of unstitched structures were higher than those of the multistitched and multistitched/nano structures due to stitching caused minor filament breakages. It was found that the warp and weft directional bending strengths and modulus of densely stitched structures were higher than those of the lightly stitched structures. When the stitching direction increased, the warp and weft directional bending strengths and modulus of hand and machine stitched structures decreased. The warp directional specific bending strain of unstitched/nano composite structures was lower than those of the unstitched structures, whereas the warp and weft directional specific bending strains of unstitched structures were higher than those of the multistitched/nano structures due to stitching. It was found that the warp and weft directional bending strains of densely stitched structures were almost the same compared to the lightly stitched structures. In addition, there was no significant differences were found between warp and weft directional bending strains by the increase of stitching direction. These results indicated that stitching yarn type, stitching directions, stitching density and amount of nano materials generally influenced the warp and weft directional bending properties of multistitched E-glass/polyester woven composites.

It was found that the warp and weft directional specific damaged areas of unstitched structure were lower than those of the unstitched/nano structures but, higher than those of the hand and machine stitched and stitched/nano structures. Also, the warp and weft directional specific damaged areas of machine stitched structure were slightly higher than those of the machine stitched/nano structure. It could be concluded that the addition of nano silica in the stitched structures improved their damage resistance slightly. In addition, when the stitching direction increased, the warp and weft directional damaged areas of low (stitching yarn Nylon 6.6) and high modulus (stitching yarn Kevlar® 129) lightly and densely stitched structures decreased. It was generally found that when the stitching direction and stitching density in structures increased, the damaged areas of the structures decreased. Also, it was found that there was a

slight difference between the warp and weft directional specific damaged areas in all structures.

The failure of warp and weft directional 2D unstitched and unstitched/nano woven E-glass/polyester composite structures was matrix breakages, and partial fiber breakages in their front and back surfaces. They had a complete delamination in their cross-sections. On the other hand, the failure of warp and weft directional 2D multistitched and multistitched/nano woven E-glass/polyester composite structures was matrix breakages, and partial and complete filaments and yarn (tow) breakages in their front and back surfaces. They had a local delamination in their cross-sections and the delamination did not propagate to the large areas due to multiple stitching. The failure was confined at a narrow area due to multistitching and resulted as the catastrophic fiber breakages. In addition, it was found that the warp and weft directional specific damaged areas of multistitched and multistitched/nano structures were lower than those of the unstitched and unstitched/nano structures. This was considered that the damage tolerance performances of the multistitched and multistitched/nano structures were enhanced due to stitching in particular at four directional stitching.

Key Words: Multistitched woven preform, stitched composite structure, warp-weft bending strength, bending failure, nano composite

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MEASUREMENT OF ELECTRICAL POWER PRODUCED BY PIEZOELECTRIC FIBRES

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The piezoelectric effect is a widely studied phenomenon that consists in the production of electric charge in some materials when they are subjected to mechanical loading. Materials displaying piezoelectricity can be either crystals (i.e. Quartz, Lead zirconate titanate (PZT), e.t.c.) or polymers (i.e. Polyvinylodifloride (PVDF), Polypropylene (PP), e.t.c.). The piezoelectric effect in polymers was observed in 1969, firstly on PVDF, by Kawai [1]. The piezoelectric mechanism in ceramics involves the whole crystal structure while in polymers the effect is correlated to the intertwined long-chain molecules that attract and repel each other when an electric field is applied [2] and it was observed to be stronger than the one observed in crystals.

Since now, piezoelectric materials have been used in many applications. Especially the piezoelectric polymers have penetrated the world of smart textiles, since, unlike ceramic piezoelectric materials, can turn into flexible fibres. Also, being sensitive to deformation, they can be useful in a number of sensor applications. The flexibility and small size of the fibres makes it possible to include them as miniature-sensors in structures or garment without affecting their shape or comfort [3]. Additionally, energy harvesting devices have been constructed with the use of thin films made out of polymeric materials with piezoelectric properties [4]. Combining textiles and energy harvesting devices intelligent clothing with flexible piezoelectric materials in films or fibres can be integrated into fabrics making the latter capable of harvesting a part of the mechanical energy associated with daily activities.

Although the significance of polymeric piezoelectric materials is proven by the fact that they can be exploited in many areas of interest, their piezoelectric characterization, especially when they are in the form of fibres, is still an issue. For the characterization of the piezoelectric fibres methods such as voltage response testing have been used. This method consists of the test of the piezoelectric fibres for their voltage response by placing several fibres in between two copper plates that act as electrodes and collect the charge from the fibres. This structure was placed in an impact test rig and the voltage response from the structure can be recorded using a digital oscilloscope [5]. Another way to perform a piezoelectric characterization is to clamp one end of the fibre and stimulate periodically its free end, recording the peak to peak produced voltage on the clamped end of the fibre [6]. Piezoelectric characterization, haw also been performed by subjecting the fibre to a dynamic strain in the axial fibre direction using a servo-hydraulic tensile testing machine. The piezoelectric output voltage from the fibers has been recorded at 4 Hz [7]. Finally another way to test piezoelectric materials is to mount them to a vibrating structure undergoing base excitation and measure its voltage output [8].

In the present paper, the measurement of the power of the piezoelectric material is proposed for its piezoelectric characterization. In more details a novel experimental setup capable of measuring the power of an oscillating piezoelectric fibre is described. Utilizing the fibre clamping facilities that this mechanical set-up has, the produced power is measured during the stimulation of different polymeric piezoelectric fibres (PP and PVDF) under periodic bending loading. The mechanical part is followed by a specially designed electronic circuit for the capture of the voltage and current signals produced by the piezoelectric fibres. The weak signals are filtered and amplified before their digitization for the further processing stages.

The results of the measurement and their numerical processing are presented in this work and simultaneously they support the thorough understanding of the piezoelectric effect on the textile fibres' level. The experimental set up solves the complex technical problem of the capture and the handling of the generated signals in parallel with the standardization of the mechanical stimulation of the fibers, serving though the comparison of the results obtained.

Key Words: Piezoelectirc fibre, PVDF, Experimental setup, Power measurement

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USE OF IONIC LIQUIDS FOR PREPARATION OF PET FIBRES WITH COTTON-LIKE SURFACES

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Polyester as well as cotton fabrics have certain properties that make them the most popular fibre materials regarding the world production of fibres. Polyester is comparably hydrophobic and chemically inert. It exhibits excellent mechanical properties and form stability. Moreover, the polymer absorbs very low amounts of water and does not show swelling. Thus, textiles made of PET dry very fast and the polymer is not sensitive to vermins. On the other hand, cotton is a hydrophilic material. It absorbs high amounts of water, has a lot of functional groups and is, therefore, comparably reactive. In addition, it shows only a low tendency for an electrostatic charging. Since it produces a comfortable micro climate close to human skin it is widely accepted for manufacturing of apparel. Drawbacks of cotton might be in the fact that the fibres tend to swell in water, drying takes comparably long time, tensile strength is low and the fibres are sensitive to vermins. The idea of an ongoing research project is to finish conventional PET fibres with cellulose to generate a new fibre material combining positive properties of both materials.

In the last few years ionic liquids have been of great interest for several reasons since they offer a lot of interesting properties. For instance, they show excellent dissolving properties for various materials that are normally difficult to dissolve or even known as insoluble. In general, ionic liquids are salts that show melting points below 100 °C. There are various ionic liquids that dissolve cellulosic materials at high concentrations without the necessity of a derivatisation of the polymer. We report of an ongoing project investigating the deposition of cellulosic materials onto PET fibres from ionic liquid solutions. To guarantee high amounts of cellulose covalently and, therefore, permanently bound to the surface we investigate different approaches employing linkers and cross-linkers. The general approach allows the deposition of various amounts of cellulose covering the polyester fibre. The resulting fibres exhibit highly hydrophilic surfaces as known from cotton while the strength of the polyester fibre is not affected. Furthermore, the modified PET fibres are suitable for a reactive dyeing with dyestuffs typically used for the colouring of cotton. In addition, they yield excellent adhesion values when used for preparation of composites. The PET fibre with a "cotton-surface" is of interest not only for apparel, since it promises the "cotton feeling" but also on technical textiles, since it exhibits a functional or reactive surface.

TUFTING PROCESS FOR PREFORM FIXATION ON FOAMS FOR SAFE HANDLING OPERATIONS

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INTRODUCTION

Because of the excellent lightweight-properties, the demand on Fiber Composites is crossing continuously in different departments [1]. Actually, there exist many different methods for the production of Fiber Composite parts [2]. One suitable method for the serial production of Fiber Composites parts (20.000 – 30.000 pieces/year) is the impregnation with resin [3]. This method is separated in a preforming part and a resin infusion application. At the moment, the preforming process is mainly accomplished by manual labour. Because of that, the costs of the production of 3D-textile-preforms are increasing. Together with the high material costs of the carbon fibers, the total production costs of Fiber Composite parts are very high [4].

One possibility for lower production costs of Fiber Composite parts is the manufacturing of 3D-textile-preforms in low-wage countries with know-how concerning textile applications. In this case, Turkey is a suitable location for the low-cost production of 3D-textile-preforms. Therefore, storage and transport applications for the export of 3D-textile-preforms have to be designed.

The aim is to ensure safe storage and transport of 3D-textile-preforms (Preforming logistics) without its displacement. The approach to provide such a preform logistic is to store and transport the preforms on expanded, foamed polystyrene cellular plastics (EPS-foam). Due to their low density, EPS-foams allow easy handling of 3D-texile-preforms. During transportation the fiber orientations are ensured by fixing the textile layers using tufting technology. In experimental studies, it has to be investigated how the density of the foam, the insertion depth, the number of textile layers as well as the tufting yarn have an influence on seam strength of the tufting seam and shear strength of fixation of the textile in the foam.

METHOD

Investigations on the influences of the listed parameters on the seam strength are made by the Design of Experiments (DoE) on EPS-foams [5]. After that, the steam strength is identified by tests in the textile-laboratory of ITA. Therefore, two different experiments, shown in Fig. 1, are applied. One experiment is the determination of the tuft withdrawal force in accordance to ISO 4919 [6]. The other one is the determination of the shear strength on the tension testing machine in the laboratory.

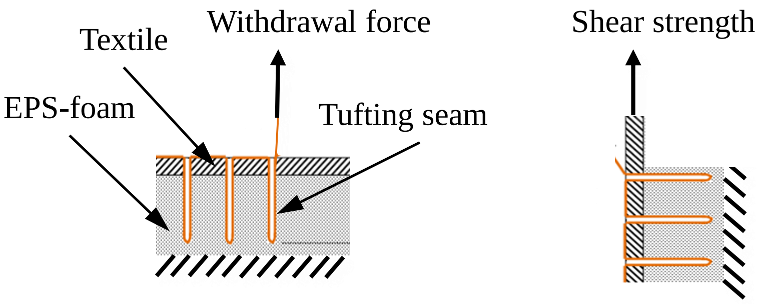

Figure 1. Design of the experiments to identify the seam strength by investigations of the tuft withdrawal force (left) and the shear strength (right)

RESULTS

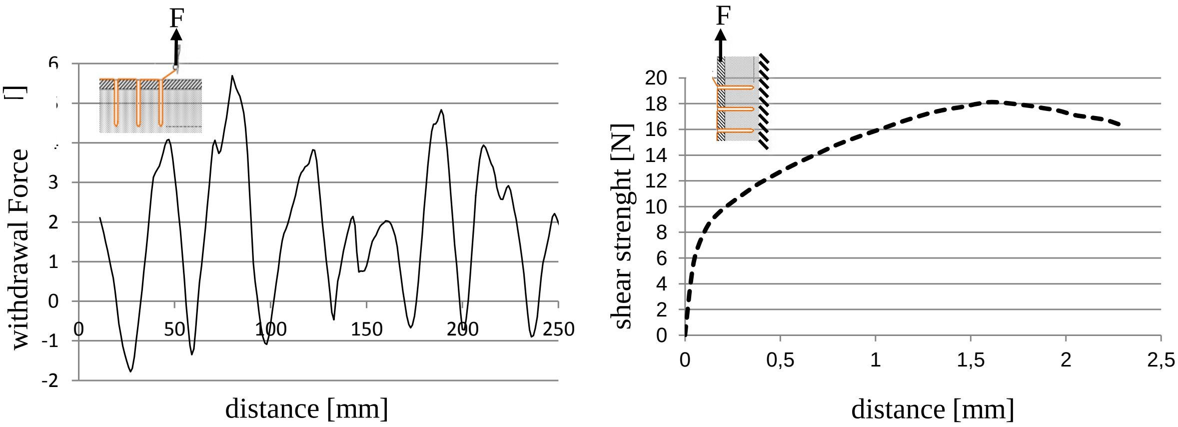

Figure 2. Exemplary graphic of the tuft withdrawal force (left) and the shear strength (right)

The left graphic in Fig. 2 shows the peaks and valleys from the withdrawal force while the tufting yarn is pulled out of the seam. On the right graphic the curve of the shear strength is shown until the compound between the textile and the EPS-foam is separated.

DISCUSSION

Comparing the occurring forces in these two experiments, the implementation of the tuft withdrawal force has no influence on the seam strength. The results from the shear strength are more significant in regards to the seam strength, which ensures a safe transportation for 3D-textile-preforms. The main parameters for good shear strength are the density of the foam and the insertion depth. The higher the density of the foam and the deeper the insertion depth, the better the fixation between the textile and the EPS-foam.

CONCLUSION

EPS-foams are suitable as a fixation and transport support for 3D-textile-preforms (Preforming logistics). This is the result of the experiments done in the textile laboratory of ITA which shows sufficient seam strength for the transport of 3D-textile-preforms.
For the transport/export of 3D-textile-preforms a suitable packaging-technology has to be developed.

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SILVER COATING ON MALEIC ACID TREATED COTTON FABRIC

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INTRODUCTION

Maleic acid (MA) is a bi-functional carboxylic acid which react to cotton fabrics in the presence of NaH_2PO_2 .The polycarboxylic acids are durable press finishing agents for using the cross linking on cotton fibers[1].The treated cotton fabric with Maleic acid and sodium hypophosphite involves two reactions. Esterification of MA forms single esterlinkage with cellulose. As the temperature increases to 160 °C, the cotton fabric treated with MA and NaH_2PO_2 show significantly increased wrinkle resistance, indicating cellulose cross-linking [1].

There are several methods for stabilizing of materials on cotton fabric. These processes consist of functionalizing, drying, and curing. Surface modification of textiles with silver particles is not permanent and this antibacterial effect reduces against repeated laundering. [2, 3, 4, and 5].In this research, the cotton fabric was treated by Maleic acid in five concentrations. Then silver nitrate was coated on untreated and treated cotton fabrics. All of samples were divided to two parts; and one part of the samples was washed for laundering test in 5 cycles. Before silver nitrate coating of treated fabrics, the cotton fabrics were dyed by methylene blue dye for determination of carboxylic acid groups' content on cotton fabric. The weight change and Crease Recovery Angle (CRA) were determined for this purpose. The Atomic Absorption (AA) analysis was used for the determination of silver ions, the Silver coated fabrics were placed in furnace at temperature of 600 for one hour, then dissolved and diluted in nitric acid and distilled water. The antibacterial performance and FTIR spectroscopy were done to demonstrate chemical bonding and bacterial effects.

METHODS

The cotton fabrics were treated with Maleic acid at 5 concentration of 1,2,4,5 and 6 % (owf%). The fabrics were coated with maleic acid and sodium hypophosphite, then dried and cured at temperature of 180 for 2 minutes. . All of samples were divided to two parts; and one part of the samples was washed for laundering test in 5 cycles. The maleic acid treated fabrics were dyed by methylene blue dye for determination of carboxylic acid groups of cotton fabric. The fabrics were dyed at ambient temperature for 5 minutes and the colorimetric parameters were measured using spectrophotometer. The weights of fabrics were measured before and after the maleic acid treatment according to the standard test method and the difference were calculated. The crease recovery angle was measured due to the AATCC test method 66. The untreated and maleic acid treated cotton fabrics were coated with silver nitrate (2%).

For investigation of chemical bonding infrared spectra were collected using a Bruker-Equinox 55 system FTIR⁄ATR (Attenuated Total Reflectance) spectrometer. All data were recorded by means of a ZnSe Internal Reflective Element. Spectra were collected at a resolution of 4 cm^{-1}

and 32 scans. The antibacterial effect was determined by the standard test method AATCC-100 with two bacteria (Escherichia Coli and staphylococcus aureus) and Atomic absorption analysis was used for determination of Ag ions which was the Varian Spectra AA 1000 (Australia). The fabrics were weighted and placed at temperature of 600 $^{\circ}$C. Then samples diluted in nitric acid and distilled water to the certain volume.

RESULTS

The FTIR analysis of untreated cotton, Maleic acid treated cotton and silver loading on maleic acid treated cotton showed the peak belongs to the –C=O groups of acid carboxylic acid. The peak clearly shows the increase of carboxylic acid groups on cotton fabric which is produced by treating Maleic acid on cotton fabric. The colorimetric parameters of methylene blue dyed samples showed the slightly increase in color yield and decrease in lightness. This might be because of absorption of cationic dye on cotton fabric which increases by maleic acid treatment.

The maleic acid treatment of the cotton fabric showed the increase in fabric weight, as the maleic acid concentration increased the weight increased. The crease recovery angles of untreated and treated cotton fabrics demonstrated the increase in angles, therefore the increase in wrinkle resistant of cotton fabric. The wrinkle resistance increased by increase of the Maleic acid concentration.

The results of antibacterial test indicate that the untreated cotton absorbed the Ag ions so that showed reduction of E coli bacteria. The treated cotton with maleic acid increased the reduction of bacteria and the increase in concentration of maleic acid increased the bacteria reduction too.

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COMPRESSIBILITY OF FOLDABLE WEFT KNITTED STRUCTURES WITH AUXETIC POTENTIAL

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3D foldable weft knitted structures with auxetic potential exhibit extreme versatility and multi-functionality. They offer new, aesthetically intriguing relief surfaces, appropriate for the use for packaging and shock absorbing materials. The folding and auxetic potential enable good fit to the content and adequate protection of the goods from external damages. Auxetic effect of foldable structures is based on the structural disequilibrium of face and reverse loops, which causes the fabric to crease, contract, and form into 3-dimensional structure after the production process. Foldable structures shrink in both course and wale directions. Under applied strain in horizontal or vertical direction, 3-dimensional foldable structures smooth into flat fabric, creases unfold and the structure expands in both directions. Liu et al. determined that the fabric with more folded and more closed zigzag form also exhibits more significant auxetic effect. This behaviour influences the thickness of the fabric, which increases with folding process. Higher thickness of the fabric means the more closely folded structure.

Compression is one of the important properties of fabric, in addition to friction, bending, tension and shear. The compressive force applied allows the yarn to undergo deformation non-linearly, resulting in a change in thickness of the fabric. The compressibility behaviour plays a significant role in the fabric structural stability. It is affected by different knitting parameters such as density, fabric thickness, texture, etc. The pressure-thickness relationship describes the compressional characteristic of the fabric. The pressure-thickness curve of textile fabrics in lateral compression is highly nonlinear.

The objective of research was to evaluate the compressibility of links-links weft knitted fabrics with zigzag structure which could potentially be used as packaging and mechanical damage protection material. The influence of yarn material composition, structural parameters of the foldable structures such as repeat size and width/height ratio on the compression properties of foldable links-links knitted structures were examined in order to evaluate their adequacy for shock absorbing and compression resistant materials.

A study of the influence of the unit cell size as well as the zigzag rib width of knitted structures on their compression properties was performed. First series of the zigzag knitted structures was produced in various unit cell sizes with the same number of courses and wales in a zigzag form from the biggest 24×24 to the smallest 4×4 repeat size, while the second series was produced with various widths of a zigzag line in a unit cell with a constant number of courses from the widest 24×24 to the narrowest 2×24 repeat size. The compression test was performed on the dynamometer INSTRON 5567. The compression load was read when the distance between the movable pressure foot and the fixed flatten reached 1 mm.
Zigzag folded knitted structures with the square repeat comprising the same number of courses and wales (1st series of samples) fully fold in both course and wale direction. Full

folding emerges for all the repeat sizes and for structures produced from both yarns. The structures designed with various widths of zigzag ribs (2nd series of samples) exhibit substantial deterioration for the smaller repeats; the structures with rib widths less than 7 loops are very poorly folded; their thickness is significantly decreased.

The maximum compression load of the CV/PA foldable knitted structures exceeds the maximum compression load of the Wo/PAN structures with comparable repeats although knitted structures made from Wo/PAN yarn are thicker than comparable knitted structures made from CV/PA yarn. The maximum compression load and fabric thickness decrease with the repeat reduction. For all the analyzed repeats and materials, the maximum compression load at the compressed thickness of the knitted structure t_{compr} = 1mm exceeds 100N.

The decrease of the compressive stress with the knitted structure repeat reduction is not linear. The compressive stress decreases similarly for the structures with the repeat widths from 24 loops to 18 loops. For the foldable knitted structures with the repeat widths smaller than 18 loops, the compressive stress differs substantially; structures with the square repeat exhibit gradual compressive stress decrease while for the structures designed with various widths of zigzag ribs instant drop of the compressive stress is evident.

Foldable knitted structures are compressible. They can be appropriate for the use in clothing sector, interior design, seat covers for the automotive industry, mattresses, and for packaging and mechanical damage protection material.

Key Words: Compressibility, foldable structures, auxetic potential, knitted fabric, knitting

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ELECTROSPINNING OF NANOFIBRES ON TEXTILE MATERIALS BY LARGE-SCALE PILOT PLANT

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Electrospinning is recognised as the main method and the most versatile way to produce polymer-based nanofibres. In electrospinning process, nanofibres are produced by repulsive electrostatic forces acting on a polymer fluid (e.g. polymer solution). The most simple electrospinning setup consists of a pump that pushes the polymer solution to a capillary, a collector on which nanofibres are deposited and an electric power supply that generates the electrostatic field between the capillary and the collector. Academic and industrial interest for electrospinning raised from the 1990s. Nanofibre-coated fabrics have potential uses in filters and protective clothing, but at least three issues have to be solved in order to fulfil industrial requirements: up-scaling of electrospinning plants, enhancement of the process stability and improvement of the adhesion between nanofibres and textile substrates.

Large-scale electrospinning systems are required to increase productivity and to allow continuous nanofibre production and deposition. One approach is the development of multi-nozzle electrospinning plant. In this work, several multi-nozzle electrospinning configurations (from 6 to 9 nozzles) were studied in order to minimize jet-jet interactions (electrostatic repulsion, alteration of whipping motion). A modular electrospinning pilot plant equipped with 62 nozzles per module was designed and developed. Tests were carried out electrospinning nanofibres continuously deposited on a micro-fibre non-woven substrate moved close to the collector by a roll-to-roll system. The shifting speed of the substrate influenced thickness, porosity and density of the deposited nanofibre layer (Figure 1). Air permeability decreased from 3000 l/(m^{2}s) of the uncoated substrate to 1260 l/(m^{2}s) obtained at 7 m/h, down to 650 l/(m^{2}s) at 4 m/h. At the same speed, with two steps of nanofibre deposition, air permeability decreased of one order of magnitude, and the uniformity of the nanofibre layer was enhanced, too.

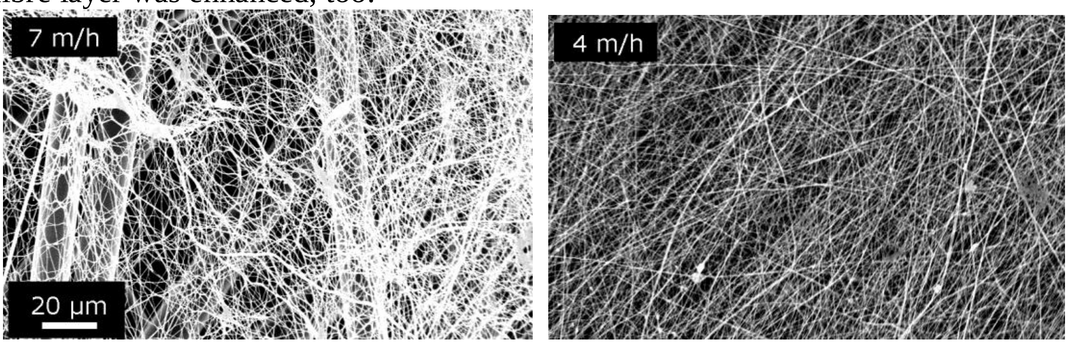

Figure 1. SEM pictures of electrospun nanofibre layers on micro-fibre non-woven produced at different speeds.

For filtration, clothing and protective textiles, electrospun nanofibres need to be deposited on a supporting substrate (usually textile materials such as woven fabrics or non-wovens) because of their limited mechanical properties. Textile materials are electrical insulator by nature. In this work, different process perturbations (i.e. stability of the jets, distribution of the deposition zones and nanofibre morphology) were observed when a non-conducting textile substrate (e.g. polypropylene non-woven) was used as nanofibre collector in multi-nozzle electrospinning. In fact, the presence of a non-conducting substrate on the collector alters the fibre-forming process and increases Coulomb repulsive force between the jets (Figure 2). At the same working conditions, the intensity of the perturbations increases with increasing the weight of the substrate resulting in defects on the nanofibrous mat (i.e. beaded nanofibres), production of thick fibres or failure of the spinning process (e.g. film, droplet). To minimize perturbations, adjustments in the process conditions were studied.

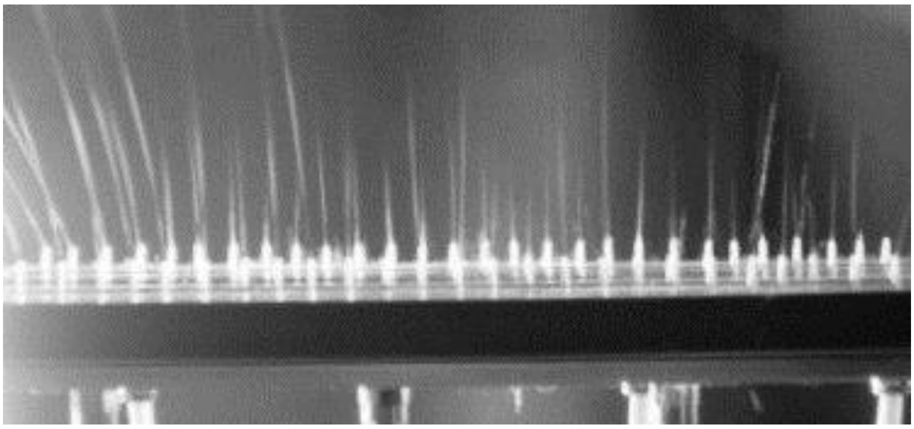

Figure 2. Picture of the 62-nozzle electrospinning head during tests.

The last challenge is to guarantee adhesion of nanofibres to textiles achieving satisfactory durability for practical uses. Adhesion of nanofibres to textile substrates was characterized by means of peeling tests. Investigations were carried out also for the comprehension of the factors that limit the adhesion. Textile processes, including plasma treatments, were proposed in order to enhance adhesion by pre-treating the textile substrates. In particular, after oxygen low-temperature plasma treatments, a polypropylene non-woven showed significant changes in hydrophobicity and wettability (i.e. water contact angle decreased to 97° immediately after the treatment from 133° of untreated fabric). The treatments results to increase adhesion energy and force of peeling tests. Adhesion between nanofibres and substrate were about 5-15 times higher for PEO nanofibre when deposited on a plasma treated PP non-woven, and about 2-5 times higher when PA6 nanofibres were used.

The adhesion is low when a fabric composed of staple fibres is used as substrate. Even if treatments could improve the adhesion, optical microscopy observations on both nanofibre layer and fabric after peeling tests suggested that on staple fabrics the electrospun nanofibres were actually linked to few anchor points (i.e. protruding fibre) on the fabric surface. Therefore, surface hairiness of fabrics seems to be a critical limit for considerably improving adhesion, even if improvements can be promoted by the treatments. Hence, it seems that not all textile materials are suitable substrates for coating with electrospun nanofibres. Therefore, further works shall be focused to assess adhesive behaviour of fabrics with low hairiness using, for instance, fabrics composed of continuous filaments or monofilaments.

Key Words: Electrospinning, nanofibre-coated textiles, adhesion, air permeability.

NANOSCALE ANTIMICROBIAL COATINGS FOR THE DEVELOPMENT OF FUNCTIONAL TEXTILE FIBERS

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In the last decades, there is an increasing demand for antimicrobial materials in broad area applications such as medical devices, health care, hygienic application, water purification systems, and textiles due to the pathogenic effects of microorganisms. There are several chemical and physical treatments for the production of antimicrobial textile fabrics. Especially the application of chemical agents during the finishing stage extends protection against microorganisms. Quaternary ammonium compounds are very effective since their target is directly to the microbial membrane and they accumulate in the cell driven by the membrane potential [2, 3]. The adhesion of the chemicals and the extension of antimicrobial protection carry significant important to produce functional properties of textile fibers after the treatment of chemical finishes on the fiber surfaces.

In the present work, quarternary ammonium compounds were functionalized by alkyl alkoxy silane groups in order to increase the adhesion of antimicrobial agent on surface. These functionalized quarternary ammonium compounds were applied on the surface of fibers by sol-gel polymerization. During polymerization, the surface of fibers was positively charged that created an "electromagnetic" attraction between the negative charged microorganisms. This patented compound, Antimic®, in the market is colorless, odourless and non-toxic material that forms nanolayers on the surfaces and its long-term conservation on surfaces inhibits the growth of microorganisms [4]. This antimicrobial agent was applied on different type of cloths such as shirt, trousers, and socks to compare its effectives on different surfaces. Figure 1 represented Scanning Electron Microscope (SEM) image of woven polyester fiber coated with silane functionalized quaternary ammonium compounds by sol-gel technique. In this SEM image, bright shadows showed silane containing materials. The results showed that nanoparticles were still on the surface after washing process. Even after 30 washings, antimicrobial activity was about 91%. This material also reduced the formation of unpleasant odours in textiles and prevented the mold formation and provided a physical barrier between the skin and cloth.

The activity of Antimic® compound on bacteria, fungus, yeast, and viruses was carried out in accordance with ASTM, AATCC and ATTC methods on various materials and in various environments. Antimic® provides the highest level of antimicrobial protection and offers new solutions by reducing the risks to human health and the environment.

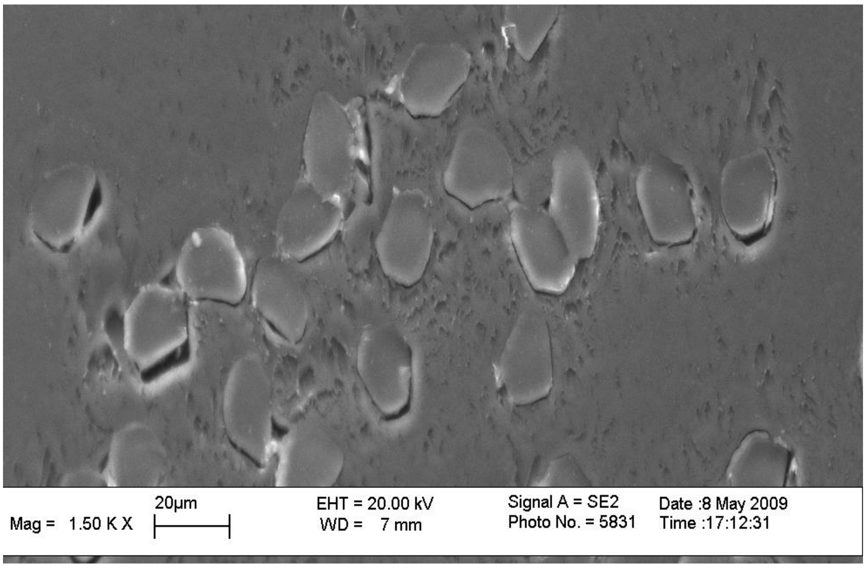

Figure 1. SEM image of woven polyester fiber coated with silane functionalized quaternary ammonium compounds

Key Words: Sol-gel, antimicrobial, nano-coating, finishing textiles

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CHITOSAN COATED COTTON TEXTILES FOR COPPER AND CHROMIUM IONS ADSORPTION

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The increasing contamination of water by chemical wastes has became an important and popular issue due to the discharge of industrial wastewaters coming from metallurgy, microelectronics, tannery, chemical manufacturing, mining operations and pharmaceutical industry.

In particular, heavy metals accumulation in the environment is hazardous to animals, plants, microorganisms and human beings, mainly because they are non-degradable, persistent and therefore they can accumulate in the body. In order to remove metals from industrial wastewater, numerous techniques are currently available such as chemical precipitation and filtration, electrochemical treatments, ion exchange, reverse osmosis, adsorption and biosorption. Adsorption is considered an effective and economical method to remove heavy metals from wastewater, also for the variety of adsorbent materials available to use and the high efficiency at a very low cost [1].

Among these materials, there is chitosan, a natural polymer abundant on earth, resulting from the deacetylation of chitin, which is the major component of crustaceans shell. Chitosan chains are characterized by the presence of many hydroxyl and amino groups that function as coordination sites for different metals [2,3]. This biopolymer was widely investigated for adsorption of heavy metal ions like copper and chromium also because of its possible application in chemical and biochemical fields due to its biodegradable property. However, the chitosan degradability and loss in acidic environment limit its applications. A method to improve the chitosan stability is crosslinking process [4], even if the crosslinking reduces the density of the functional groups on the modified material. Moreover, chitosan attached to polymers like cellulose showed good adsorption properties towards heavy metal ions [5].

In this work we studied the adsorption efficiency for Cu (II) and Cr (VI) of a cotton gauze coated with chitosan (Fig 1) at three content percentages (10 – 20 – 30 %).

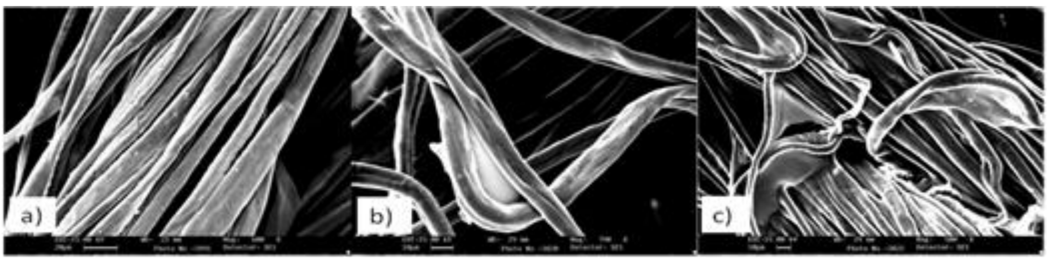

Figure 1. Cotton fibres: a) untreated; b) chitosan treated 10% weight on; c) chitosan treated after metal adsorption.

Chitosan, in acetic acid solution, was applied on the gauze by padding, and grafted by ultraviolet radiation, in consequence of radical reactions promoted by a photoinitiator. In UV curing, radical species are generated by the interaction of UV light with a suitable photoinitiator, which induces grafting reactions of reactive chemical groups at low temperature and quickly, with lower environmental impact and lower process cost than conventional thermal curing process [6].

Adsorption of copper and chromium onto the gauze was tested in batch process at different experimental conditions. The effect of the initial metal ion concentration, contact time, pH and temperature were investigated. The pseudo-first and pseudo-second order models were used to describe the adsorption process and the adsorbent characterization before and after the adsorption process was carried out by Fourier Transform Infrared Spectroscopy (FT-IR), Scanning Electron Microscopy (SEM), EDX, Elementary Analysis and XPS.

According to the results, the copper adsorption capacity increased with increasing the contact time and reached a constant value after 2 h. The kinetic parameters obtained indicate that the adsorption of Cu(II) follows the pseudo-second order rate. The maximum adsorption capacity (14.4 mg/g) was reached at pH 5 and the data obtained fitted better the Freundlich isotherm model. The equilibrium time of Cr(VI) adsorption was reached already after 10 minutes and the kinetic studies demonstrated that the Cr(VI) adsorption is better represented by the pseudo-second order kinetic model. The maximum adsorption capacity (13.6 mg/g) was reached at pH 3 and the Langmuir isotherm model described better the Cr(VI) adsorption process. For both the metal ions studied, the adsorption capacities increased and the removal efficiencies decreased with increasing metal ions concentration (Fig. 2) and the temperature doesn't affect the metal ions adsorption process.

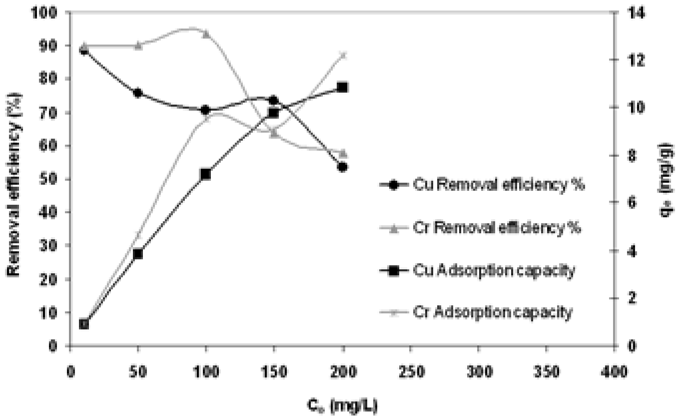

Figure 2. Effect of the initial metal ions concentration on the adsorption capacity and removal efficiency of Cu(II) and Cr(VI) on the chitosan coated gauze.

In both cases, the value of R_L calculated for the 10 mg/L initial concentration indicated a favourable adsorption on the chitosan coated gauze.

Thus, the chitosan coated cotton gauze studied can be considered as a good adsorbent substrate for application in treatment of water solutions containing heavy metal ions, like copper and chromium.

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FIBRE PRODUCTION WITH BACTERIA AND FUNGI –NEW TEXTILE MATERIALS BY BIOTECHNOLOGY

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Sustainability has become an increasingly important topic for the players along the textile chain. Against the background of resource scarcity, we have to wonder how to handle resources and who – beside nature – generates raw materials for fibre production. The vision of producing sustainable raw materials equipped with new functionalities is already within reach. With the advent of genetic engineering, technology has reached a stage where sustainable biomaterials can be synthesised by the use of genetically modified microorganisms rather than by use of plant resources or oil. So, in the post-fossil world of tomorrow textiles will probably be made biotechnologically using bacteria or fungi. Current research projects conducted by the Hohenstein Institute are focussed on wet-spun biopolymer fibres made of alginate and chitosan from biotechnological production. By variation of fermentation conditions, nutrition media and biopolymer isolation protocols, the characteristics of the raw materials can be adjusted with direct impact on properties of fibres made from those biopolymers. In addition, modern biotechnology allows modifying microorganisms genetically (genetic engineering) and thus influencing polymer output and characteristics from the very beginning.

Alginate:
In the course of a current research project, which is conducted by Hohenstein together with different industry partners, first alginate fibres made of biotechnologically produced alginate have been developed and characterised. The microbe *Azotobacter vinelandii* is able to synthesize alginate in order to protect the cell and its sensitive enzymes from oxygen [1]. Alginate is a biopolymer consisting of β-D-mannuronic acid (M) and α-L-guluronic acid (G) monomers [2] with the M/G-ratio determining the material characteristics. We were able to show that depending on the *A. vinelandii* strain and culture conditions, the monomer constitution of the alginate polymer could be modified in order to achieve stable wet-spun fibres with tremendous water absorption capacities. Compared to common alginate made of algae, the biotech-alginate was of constant quality (e.g. controlled monomer sequence, no heavy metals, no endotoxins), non-allergenic and non-toxic. Due to the controlled production conditions and the adjustable characteristics, biotech-alginate could be used for various applications in the future, e.g. in the medical field (wound dressings).

Chitosan:
Another high-potential biopolymer is chitosan, which is usually made of deacetylated chitin by treating shrimps and other crustacean shells with sodium hydroxide. Chitosan is used for various applications and chitosan fibres are already on the textile market. They are promoted to have an intrinsic antimicrobial activity and good adsorption properties [3]. However, the use of the natural source (chitin crustacean shells) presents some major drawbacks, such as fluctuating material properties and quality, an laborious isolation/deacetylation procedure mostly with incomplete deacetylation and the risk of heavy metal and protein residues, which

are potentially allergenic for susceptible people. We here present first results of Hohenstein research on chitosan from microbiological sources, e.g. fungi. Those organisms can be grown in a sustainable way on waste products from food production and directly produce a high chitosan – not chitin (!) – content in their cell walls. Moreover, the resulting biopolymer is free of heavy metals or endotoxins, biocompatible and non-allergenic.

Biotechnology and textiles imply the use of microorganisms to synthesise fibres and yarns as well as the use of enzymes to influence processing or properties of fibres, yarns and fabrics with the aim to improve economy of the overall textile industry. Using biotechnology it will be possible in future to produce natural fibres having characteristics of synthetic fibres without planting and harvesting. This technology is a powerful biological tool, which already enables us today to produce a variety of materials with the help of microorganisms, which can then be processed to sustainable man-made fibres. With this technique, we strike in a new direction for the sustainable textile industry of tomorrow: From the microbe via the fibre up to textile end use.

Key Words: Alginate, chitosan, wound dressing, medical, biopolymer

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APRIL 05, 2014

SESSION I

COMPLEX CHARACTERIZATION OF FABRIC TOTAL APPEARANCE BY COMPUTATIONAL TOOLS

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Apparel and household goods are often discarded for no other reason than that the fabrics lose aesthetic appeal. Fabric appearance is normally evaluated from the traditional appearance attributes such as wrinkling, staining, creasing, texture, pilling, drape, color and many other parameters. Most of these attributes are measured using subjective methods, which lack reproducibility and often cause controversy due to large variation in perception and skill of the evaluator. Moreover, there is no method available which can combine all aesthetic attributes to express the fabric quality from appearance point of view. In this work a computer vision system is proposed to measure and integrate most important aesthetic attributes of an apparel fabric such as pilling, drape, texture and wrinkle so as to develop an index called fabric appearance index. However, the system is flexible and can be modified to include other parameters as necessary.

The appearance of a fabric mainly depends on the fabric design and characteristics of raw material used for it. The design of a fabric could be an artistic design and/or engineering design. The artistic design includes weave structure, pattern and color of the material, whereas the engineering design is mainly concerned with constructional details. The weave design is also an integral part of the engineering design. However, the color selection for a given end use mainly depends on the user's choice. The weave design, pattern and fabric sett combined together attribute to texture of the cloth. Material characteristics along with engineering design specification determine fabric mechanical properties. The properties that linked to the aesthetic appearance in a major way are therefore drape (mechanical properties), texture (constructional parameters), wrinkle (irregular surface deformations) and pilling (surface abrasion). Each of these four parameters is quantified based on scientific principles using digital image processing and integrated together to estimate a parameter called degree of satisfaction (DS) as follows:

$$DS = \exp\left(\sum_{i=1}^{n} W_i \ \log(u_i)\right) \quad (1)$$

where, n is the total number of properties, ui is nonlinear transformation of the grade A_i of the i^{th} property obtained by digital image processing and
W_i is the fractional contribution of the i^{th} property.
The nonlinear transformation from grade scale to partial degree of satisfaction follows one side bounded characteristics.

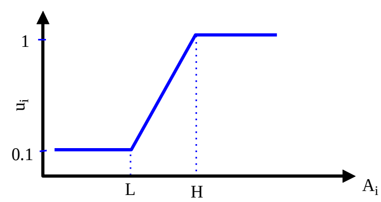

Figure 1. One side bounded characteristic of Degree of satisfaction

The lowest level L = 1 and the highest level H = 4 were here selected. The DS varies from 0 to 1. Higher the value of DS, better is the appearance.

In order to determine the fractional contribution of each attribute, an expert panel was constituted and a survey was conducted to decide the contribution of each element to fabric appearance.

A very good correlation between DS and subjective grades given by experts can be seen from Fig. 7.

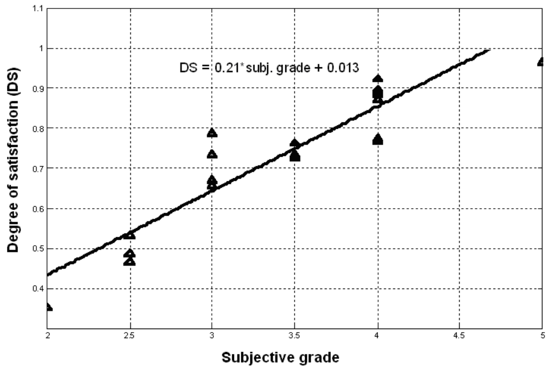

Figure 2. The DS vs subjective grades TAV

CONCLUSION

Drape, wrinkle, pilling and texture are objectively evaluated by suitable image processing software and summed up at a suitable proportion suggested by a team of experienced fabric technologists to derive total appearance of fabrics. The newly evaluated total appearance characteristics called degree of satisfaction gives a very strong correlation with overall appearance (TAV) of the fabric subjectively assessed by the experts. The system is flexible and can be modified to include other parameters as necessary. A bootstrap type simulation is suitable for statistical characterization of DS.

Key Words: Total appearance value, degree of satisfaction, appearance attributes, computation

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DESIGN OF TEXTILE COMPOSITES WITH STABILE STRUCTURE

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As is well-known, the structure of textile materials must be stable during exploitations. In some cases with the use of textile material packages or composite materials (which consist of several individual textiles), it is desirable to obtain an isotropy of the mechanical properties of a system in all directions. The formation of certain positive characteristics of multilayer composites depends on the mechanical (visco-elastic) properties of each component, their position in the system, and the type of bonding materials.

The visco-elastic characteristics of individual textiles and textile composites under dynamic conditions were investigated by the method of longitudinal resonance vibrations (UDM 1 instrument). A scheme of the device is shown in Figure 1.

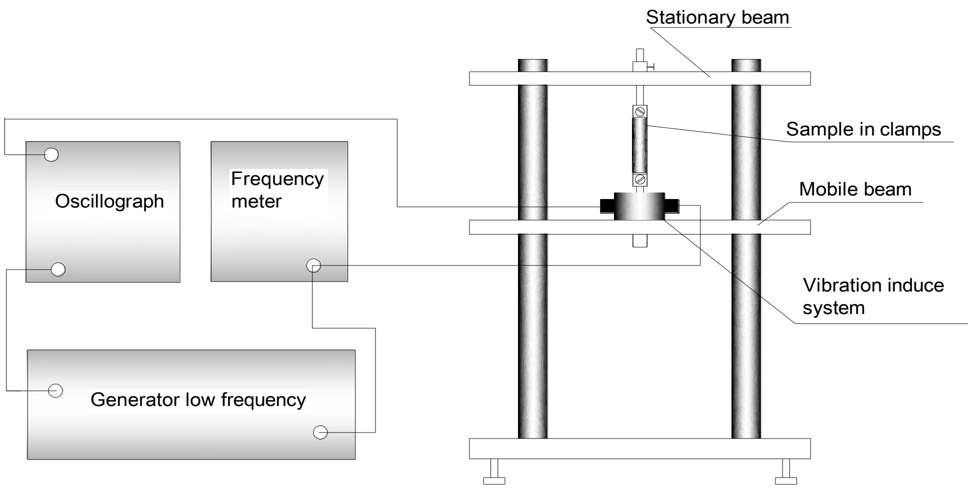


Figure 1. Operating principle of UDM 1 instrument

The following visco-elastic characteristics one can determine during the investigation: dynamic module of elasticity (E_d, MPa); logarithmic decrement of attenuation (δ); dynamic rigidity (D, $\mu N \cdot m^2$).

Single layer sample “B” – polyester tight woven fabric and three types of two-layer composites (to obtain by thermo-glue method) were investigated.

Three types of two-layer composites were received for investigation of the effect of the mutual position of the initial textile on their visco-elastic properties:

1. The first type of composite (warp - warp) – the textile layers are located along their longitudinal direction relative to each other;

2. The second type of composite (warp - 45° angle) – the second textile layer is located under an angle 45^0 relative to the first textile layer;
3. The third type of composite (warp - weft) – the second textile layer is located under an angle 90^0 relative to first textile layer.

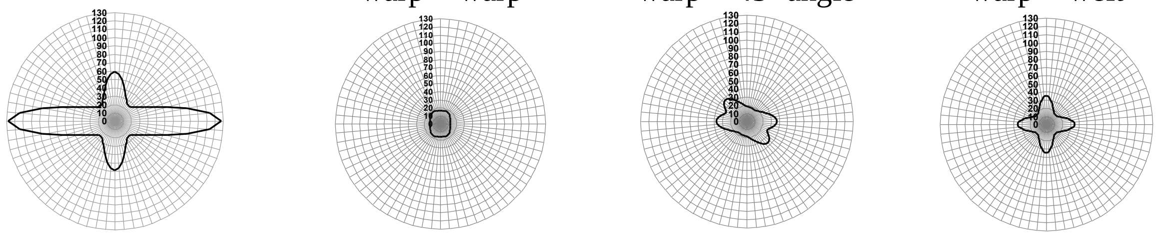
It is interesting to note that the value of the dynamic rigidity of all the composite materials increase 1,5 - 4 times in comparison with this parameter for a “B” fabric – the composite materials became more rigid (Table 1).

Table 1. Visco-elastic characteristics of the individual textile and composites

Sample code	Direction of measurement	Dynamic module of elasticity, E_d, MPa	Dynamic rigidity, D, μN·m^2
“B” Single layer	warp	58,47	3,95
	45° angle	24,82	1,68
	weft	127,36	8,60
“B+B” Two layers (warp + warp)	warp	16,33	5,11
	45° angle	15,91	4,97
	weft	12,43	3,88
“B+B” Two layers (warp + 45°angle)	warp	17,96	5,61
	45° angle	17,96	5,61
	weft	37,03	11,57
“B+B” Two layers (warp + weft)	warp	35,12	10,98
	45° angle	15,91	4,97
	weft	35,12	10,98

«B» «B» + «B» bonded in different directions

warp + warp warp + 45^0 angle warp + weft



a. b. c. d.

Figure 2. Dynamic module of elasticity, MPa

The analysis of the dynamic module of elasticity distribution diagrams of the composite materials has shown that the composite with an arrangement of layers “warp – warp“ (Fig. 2, b) is characterized by the highest degree of isotropy with regard to the “dynamic module of elasticity“ parameter and “dynamic rigidity“.

The analysis of the experimental data concerning the second type of composite (Fig. 2, c) shows that this sample has a diagonally dominant character. This may be explained by the mutual position of the second layer relative to the first layer (warp - 45° angle).

As the diagrams show, the third type of composite “B+B” (Fig.2 d) is characterized by a cross-similar character. This is due to the mutual position of both layers (warp - weft). The initial fabric “B” has the largest value of the module of elasticity in a warp and weft directions (Fig.2 a).
The experimental data shows that the visco-elastic properties of two-layer textiles depend on the initial materials’ characteristics and their mutual position.
The results of the investigations also show that the application of the thermo-glue method for obtaining multilayer textile allows obtaining the planar textile composites with high stability structure and control of the anisotropy of their visco-elastic properties.

Key Words: Visco-elastic characteristics, composite materials, high stability structure

PROBLEM OF DISTANCE AND COMPLEX QUALITY OF TEXTILES

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For computer aided design purposes is essential to calculate the distance between target (designed) fabric and various variants evaluated experimentally, calculated virtually or selected from database system. Let the target fabric is characterized by set of G_i values for m utility properties and *j* th variant fabrics is characterized by the set of R_{ij} properties for the same utility properties. Let the each property has importance characterized by some weighting factors β_i, standardized to have sum equal to one. The distance d_j between target fabric and *j*-h variant fabric is in majority cases calculated from selected metric (usually general *Minkowski distance* with proper power factor). Unfortunately, these distances are not invariant to changes in scale and the results can change appreciably by simply changing the units of measurement.

The main shortcoming of all these distances is assumption of symmetry i.e. distance from target value is the same if properties are increased or decreased. For the case of calculation distance for computer aided textile design it is in fact distance characterizing loss of quality. It means that target fabric has prescribed quality and aim is to construct variant fabrics with similar "or better" quality. Higher distance then should correspond to smaller quality only.

The textiles quality is generally characterized by several properties expressing their ability to fulfil functions it was designed for. The degree of quality (complex criterion) is often expressed as utility value $U \in <0, 1>$ (see e.g. [1]). General quality of textiles is characterized by various utility properties X_i (i = 1,...m). These are such properties that make it possible for the product to fulfil its function. For complex evaluation, the ***R*** (n x m) matrix is available containing for individual V_1,.........V_n variants (***R*** matrix rows) the values of selected R_1,.......R_m characteristics (***R*** matrix columns) The R_{ij} element of the matrix thus expresses the value of the *j* - th characteristic of X_j for the *i* –th variant of V_i. A special technique for *U* calculation is the so called "base variant method". When applying the method of base variant for expressing of textiles quality, the following problems have to be solved:

- Selection of X_i characteristics corresponding to utility properties,
- Determination of preferential functions $u_{ij} = u(R_{ij})$ expressing "partial quality" for chosen utility property,
- Assessment of the importance β_i of individual utility properties,
- Proper aggregation, i.e., determination of the *U* function.

The weighted geometrical average *U* is calculated by the relation

$$U = exp\left(\sum_{i=1}^{m} \beta_i \, ln(u_i) \right) \qquad (1)$$

The *U* value can be used alone as complex quality criterion for each variant and target fabric as well. In this case the *U* values for some variants can be better than for target fabric. Second possibility is to calculate some pseudo-distances as

$$d_{Pj} = K \left(1 - U_j\right) \qquad (2)$$

where K is constant with meaning of maximum possible distance when quality is equal to zero. The simplest is to choose K = 1, and pseudo- distance is then in the interval *<0, 1>*. In the case of pseudo-distance computation the target properties are usually used instead of properties for an absolutely satisfactory product.

When forming the aggregating function U from experimentally determined values of individual utility properties, the statistical character of the R_j quantities should be considered and the corresponding variance *D(U)* should be also determined besides the *U*. One procedure for estimating of *E(U)* and *D(U)* based on Taylor series expansion is given in the paper [2].

In program COMPLEX written in MATLAB the technique described in [3] has been applied. It is based on the assumption that for each utility property X_j the mean value R_j and variance s^2_j are determined by statistical treatment of the measured data or based on previous knowledge.

The procedures of complex criterion evaluation and pseudo-distance calculation were used for determination of the effect of catalysts on the quality of crease resistant finishing. The target fabric D_i was selected according to the requirements of minimizing the influence of finishing on the loss of mechanical properties and surface abrasion on the one hand and improves the recovery angles on the other hand. This fabric is in fact ideal one because the (at least small) drop of mechanical properties due to this type of finishing is obvious. The V_0 variant is an untreated fabric, the V_1 is a fabric with crease resistant finish treated with the Catalyst AC (Monsanto) and the V_3 is a fabric with resistant finish treated with the Catalyst CR (Cassela).

The seven R_i characteristics (tensile strength, break elongation, tearing strength, dry recovery angle wet recovery angle and surface abrasion) were measured by means of standard testing procedures. Mean values R_{Mj} of individual properties and values corresponding to just unsatisfactory S_j and satisfactory D_j (target fabric) base variants wer specified. The relative errors of measurements were in all cases of below 5%. By using of the above described program COMPLEX in MATLAB the mean E(U), variance D(U), and pseudo-distance d_P values for all three variants have been estimated. Results are summarized in Table 1. (for simplicity, constant weights β_j = 1/7 and K = 10 were chosen).

Table 1. Statistical characteristics of utility values

Type	E(U)	D(U)	d_P	Euclidian distance
V_0	1.24E-6	1.59E-11	0.99	169
V_1	0.352	1.54E-3	0.648	8530
V_2	0.354	1.31E-3	0.646	9486

Apparently, based on E(U) the V_2 variant is slightly better that the V_1 one. From statistical point of view the mean utility values for V_1 and V_2 variant are not significantly different. The pseudo-distances show the relative big difference due to relatively high loss of surface abrasion and tearing strengths.

Key Words: Distance calculation, complex quality evaluation, utility value, program COMPLEX

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QUALITY FUNCTION DEPLOYMENT (QFD): ADVANCED APPLICATION IN TEXTILE BASED R&D

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INTRODUCTION

The Quality Function Deployment (QFD) methodology provides a systematic approach for developing and evaluating customer oriented development strategies. QFD considers in particular customer requirements and presents a comprehensive tool which offers to benchmark the strategy. In addition it helps reorganize the development strategy. Furthermore, QFD figures out which departments of the company should communicate and work in team to meet customer requirements and promotes team work within different departments. It provides a methodology to establish an effective and efficient development strategy with the highest possible performance/productivity.

The experience of large companies employing QFD has demonstrated its effectiveness in providing quality, customer satisfaction, and competitiveness. QFD holds great potential for technical as well as marketing staff to determine customer needs; and develop programs to meet those needs better than their competitors can [1].

DISCUSSION

The presentation will show how QFD could be applied for developing marketing strategies [2], simulation tools [3] and production technologies [4] to meet customer requirements in textile industry. An example for advanced application of QFD in textile machinery is shown in figure 1. A very flexible and innovative high performance drafting system was developed at ITA (Institut für Textiltechnik of RWTH Aachen University, Aachen) using QFD. To fulfil sufficiently overall requirements, QFD was used to detect technical descriptors fulfilling some requirements just barely. Therefore the QFD matrix was simplified to relevant technical descriptors. Afterwards these technical descriptors were modified to fulfil the requirements better hence to improve the performance of the drafting system.

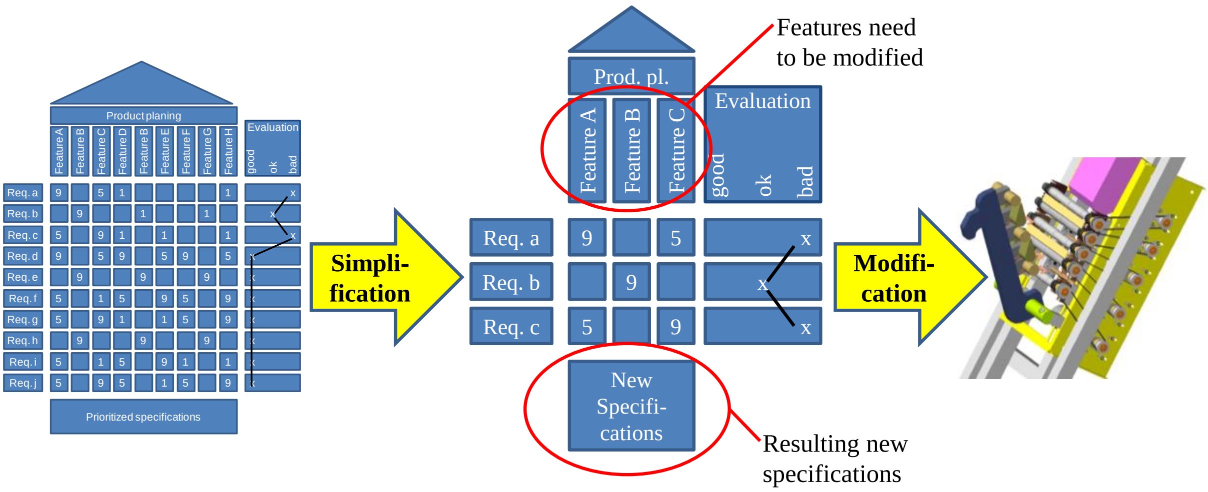

Figure 1. QFD advanced application in textile machinery

Another application is depicted in figure 2. A further advanced QFD application carried out at ITA is utilisation of QFD as a tool for development of market and industry oriented Research and Development Strategy.

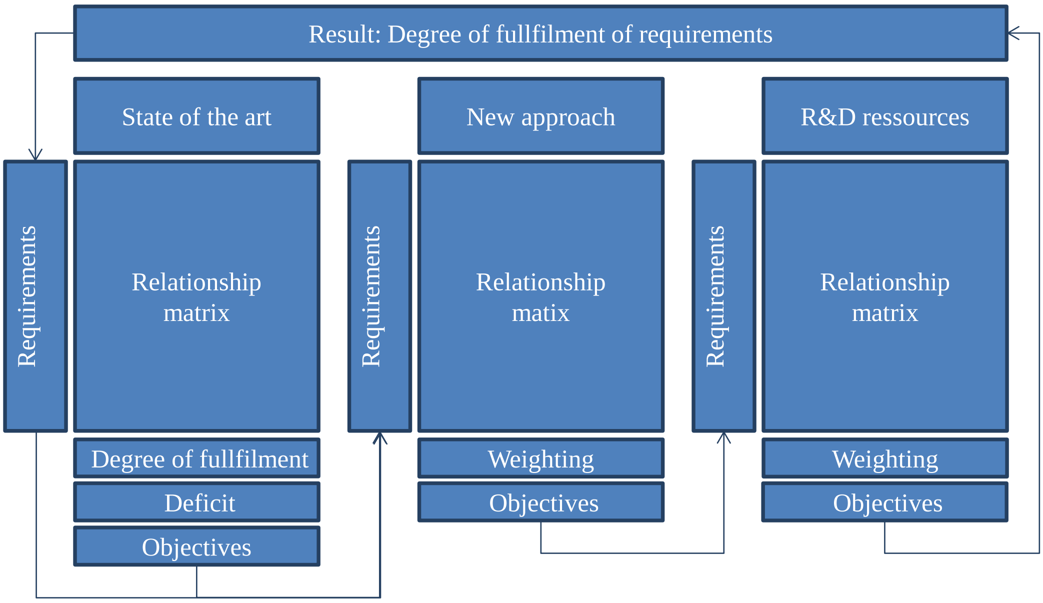

Figure 2. QFD a tool for market and industry oriented and Research and Development

CONCLUSION

Various applications of QFD in textile based research and development is successfully carried out at ITA. Beginning with marketing, throughout production technologies up to market and industry oriented research and development strategy. The QFD methodology holds great potential for further advanced application in textile and apparel industry and guarantee satisfied customers and successful textile and apparel industry.

Key Words: QFD, Research and Development, Marketing, Production Technology, Textile technology

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THE EFFECT OF INTERMINGLING PROCESS ON THE SYNTHETIC YARN STABILITY AND UNIFORMITY

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Intermingling is one of the best alternative methods to make the filament yarns more resistant against high volume stress. This technique has started to replace conventional methods such as sizing and twisting in terms of gaining strength. The intermingling process mixes multifilament yarns along with entanglement points and open parts by turns throughout the length of the yarns. This process makes tensile value of multifilament yarns entirely different from the component of separate filaments. This study tries to define the effect of commingling on the filament yarn strength. Two matters are generally mentioned to describe the intermingling quality in a multifilament yarn. These are entanglement point numbers in a meter of the yarn and knot stability. Yarn speed in an intermingling process is one of the most influential factors on knot numbers and knot quality. This study also describes yarn speed effect to the intermingling uniformity with various synthetic filament yarn samples.

LITERATURE

Kravaev *et al.* (2013) presented a new method to analyze the blending quality along the length of commingled yarns. It is claimed that this new method can be applied for the manufacturing process of thermoplastic composites.

Özkan and Baykal (2012) performed a study on intermingling parameters and filament properties effect to the stability of knots. They found that a positive linear correlation exists between air pressure and knot stability.

Webb *et al.* (2009) performed a work about relationship between splicing performance and yarn count. This study concluded that when yarn counts increase sufficiently, it is needed to enhance three variables to acquire optimum splicing. These three variables are cross section of the splicing chamber, airflow, and the knife separation.

Boubaker *et al.* (2009) studied on a descriptive model for the longitudinal structure of wet pneumatic spliced yarn. It is found that elastic spliced yarns stand two more asymmetrical twisted zones in microscopic analysis although classical spliced yarns contain a symmetrical twisting zone.

RESULTS

Our experimental observations and statistical results revealed that strong relationships exist between the variables of yarn type and machine speed with final yarn strength and knot numbers. It is also known that knot number directly affects the yarn strength in a positive way.

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APRIL 05, 2014

SESSION II

THE NEW SMART ELEMENTS OF MILITARY CAMOUFLAGE DESIGN IN VIS AND NIR SPECTRUM

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Camouflage technique implies targeted material designing in which the chosen shapes and the chosen colours produce the perfect harmony with the natural surrounding. Current camouflage design follows two different trends: one trend is towards “universal” designs which perform well in a wide range of environments and another is towards more specialized designs and patterns with definite requirements for colour characteristics. In this paper, two experimental parts are presented: experimental camouflage pattern designing and camouflage uniforms design with smart element - installed specifically engineered infrared message which is seen isolated at 1000 nm. In first part two original designs were created using stylized shapes of animals that are symbols of natural heritage of Republic Croatia: “marten” and “griffon vulture”, which are composed with other macro and micro elements of design into a pattern with concealing ability (Figures 1 and 2). The patterns were developed as an individual design for woodland environments with proposed requirements for colour characteristics: spectral reflectance values over VIS and NIR spectral range, CIE tristimulus values, colour values – L*(lightness), C*(chroma), h*(hue), a* and b* (multicoloured shade) and allowed colour difference – ΔE , that correspond to Croatian army technical requirements for woodland outdoor uniforms.

Figure 1. Camouflage design with marten shapes

Figure 2. Camouflage design with griffon vulture shapes

As it is shown on Figure 1, each presented design was made in two variations of colour scheme and elements. In compare to its original, the variations have one more colour added – light green and one more design element added – stylized shape of an oak tree leaf (also characteristic for the Croatian natural heritage). The colours of specified spectral reflectance values were defined in accordance to natural colour scheme characteristic for Croatian woodland environment. In the experimental part of the research the detailed study of performance of presented samples is performed. First, the evaluation of camouflage effectiveness according to the spectrophotometrical measurements of reflectance properties is performed in order to predict the camouflage pattern characteristics. Also, the computer based photo modeling method of pictures’ loading of camouflage samples into the photograph of appropriate background was performed in order to evaluate the camouflage effectiveness in VIS and NIR spectral range. The aim was to determine optimum spectral reflectance values in the VIS and NIR spectral range for each colour, to ensure required concealing ability in this range and to determine optimum partition relationship between chosen colours, in order to achieve satisfactory balance for the particular environment as one of the key parameters of camouflage effectiveness. In the second part of the experimental work the camouflage uniform design with installed specifically engineered infrared message is presented. Graphics designed for the infrared spectrum should be planned in the accordance with the environment, because plants (leaves and flowers) in the infrared spectrum have no response, and the objects of mineral origin are responsive.In the selected camouflage motifs of adapted environment in augmented reality of visible and near infrared spectrum from 400 to 1000 nm , the specifically engineered infrared message which is seen isolated at 1000 nm, is installed (Figure 3)

a)  b) 

Figure 3. The design of camouflage uniforms for a) visible and b) near infrared spectrum Z 1000nm

Infrared message is delivered in the same technological process without adding a new working phase. Infrared feature is in the interaction with graphics in the visual spectrum and for such a unique design the calculations for the colour twins should be done. The twins are both visible in the visual spectrum (V) with a delta E less than 3, and one of them has a response in the infrared spectrum at 1000 nm (Z). V and Z dyes twins allow the management process of hiding and showing information. Hidden infrared message can not be detected by the naked eye. For infrared detection we need the required interactive technologies such as infrared goggles, helmet with an infrared camera, software tools for reading two-dimensional codes hidden in the infrared part of the spectrum and ZRGB camera. Designed graphics can represent state symbols , the elements of nature , protected plant and animal species, and individualized information on each person or unit. We are witnesses of the counterfeiting of products which surround us, especially textile products and in this particular case the stealing of camouflage uniforms for identity takeover. By using Infraredesign planning and protection the counterfeiting of uniforms is prevented. Incorporation of the codes on the inner part of the military uniform enables the individualization of data and identification of individuals. In this paper we present a method of camouflage designs for different natural environment with management in the visual and infrared spectrum. Camouflage uniform in Near Infrared Spectrum can carry various hidden data: text, image, coat of arm and codes. Cleverly planned visual and infrared graphics enables and achieves new communication level in augmented reality, which is imperative in the case of military uniforms, and it possesses the added value in protecting against counterfeiting.

Key Words: Camouflage, colour parameters, infra red, smart technology

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DISINFECTION OF CELLULOSIC MATERIAL CONTAMINATED WITH S. AUREUS AND *K. PNEUMONIAE*

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For medical applications, textiles and clothes have to be disinfected before use. Conventionally, this process is carried out by a treatment of the textiles with water steam or diverse cleaning agents. So, it causes a considerable consumption of our water resources and leads to water charges. Water is becoming an increasingly scarce resource so that there is an urgent need to reduce the amount of water and energy used for washing clothes. A new environmental friendly way to disinfect textile materials under the UV-C light irradiation is presented and discussed. As contaminated material, S. aureus and K. pneumoniae on cotton fabrics is used. Five different cotton fabrics (untreated cotton fabric, carboxymethylated cotton fabric with/without ultrasound, cotton fabric treated with NaOH with/without ultrasound) were used during the experiments. For this purpose, an UV-C lamb was combined with finishing equipment in the laboratory. And sterilization of cellulosic material was performed in this cabin. The effect of distance between UV lamp and fabric, and treatment time on to the fabric properties (water retention, iodine sorption, hydrophility and chemical damage) and disinfection property was investigated. Two different distances (7 cm and 30 cm) and three different times (20-60-100 minutes) were chosen as variables. The results showed that the nearest distance to the UV lamp (7 cm) and the shortest treatment time (20 min.) improved iodine sorption values, the water retention and hydrophility properties of fabrics. Fehling test, Harrison silver test, and Methylene blue absorption test were performed to determine the occurred damage on the fabrics. Photo-chemical damage occurred after the UV treatment. The amount of damage is related to the treatment conditions (the distance between UV lamp and fabric and treatment time). On the other hand, the disinfection test results showed that UV-C light irradiation of untreated and treated cellulosic materials has a potentially to destroy S. aureus and K. pneumonia. This new process does not need drying process, water and chemical consumption so; it reduces energy-chemical-water costs, process time and does not lead water charge.

Key Words: Ultraviolet irradiation, disinfection, textile, S.aureus, K. pneumonıae

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SYNTHESIS OF NOVEL HYDROGEL/SILVER NANOCOMPOSITE AND INVESTIGATION OF ANTIBACTERIAL ACTIVITY

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In recent years, nanocomposites have been received considerable attention because of their excellent properties and broad applications. Among of all nanocomposites, antimicrobial polymer–metallic nanocomposites have excellent antimicrobial properties and potential applications in public health care and biomedical field and they can be prepared by several methods. [1-2]. Utilization of metallic nanoparticles in various biotechnological and medical applications represents one of the most extensively investigated areas of the current materials science [3-4]. Among silver, gold and copper nanoparticles, silver nanoparticles displayed acceptable antimicrobial properties [1].

Silver nanoparticles have an extremely large relative surface area, thus increasing their contact with bacteria or fungi, and vastly improving their bactericidal and fungicidal effectiveness [3-5]. Silver nanoparticles show antimicrobial activity by binding both to microbial DNA, preventing bacterial replication, and to the sulfhydryl groups of the metabolic enzymes of the bacterial electron transport chain causing their inactivation. Therefore, silver nanoparticles have been applied to a wide range of healthcare products such as burn dressings, scaffold, skin donor and recipient sites, water purification systems, and medical devices [5]. Also, silver nanoparticles proved to be non-toxic and eco-friendly antibacterial agents [1-3].

Because of metallic nanoparticles physical and chemical instability generally they agglomerate, to stabilize and control the nanoparticles structures various natural and synthetic polymers, surfactants, dendrimers, biological templates, latex particles, and biomacromolecules were used. Among the recognized novel approaches, hydrogels have proven to be the most promising templates and nanoreactors for in situ synthesis of nanoparticles that brought a concept for newer composite/hybrid materials. [1-3-6-7].

Hydrogels are three-dimensional cross-linked polymeric structures which are able to swell in aqueous environments, but remain insoluble due to chemical or physical crosslinks between individual polymeric chains [1-2]. Over the past 3 decades, a number of hydrogels differing in structure, composition, and properties have been developed [3].

The available free-network spaces between hydrogel networks reserve to grew and stabilize the nanoparticles. The formed nanoparticles in their network effectively inhibit the aggregation for longer periods. Moreover, these nanocomposite systems are highly suitable for bio-medical applications because of their good bio-compatibility over biological molecules, cells, tissues, etc, permeability and physical characteristics [2-5-6]. Another advantage of this method is that overall size and morphology of the nanoparticles can be controlled by changing its functionality and cross-linking points [6-7]. Application of hydrogel/silver nanocomposite would be a good alternative and consequently, they can open up a new opportunity for anti-microbial and multi-functional modification of textiles.

In this work, synthesizing nanocomposite materials consisting of silver nanoparticles embedded in natural polymer based hydrogel which can be used for textile modification was described. The antibacterial performance of the nanocomposite was investigated by disc diffusion test and Scanning Electron Microscopy (SEM) observations were done to investigate the morphology of the nanocomposite. According to the results, the samples showed antibacterial activity against both gram positive and negative bacteria.

Key Words: Nanosilver, hydrogel, antibacterial

DEVELOPMENT OF WATER REPELLANT FABRICS FOR SPORTSWEAR COMBINING WITH CHEMICAL AND MEMBRANE

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In recent years, several technologies have been developed for high functional fabrics. Since these fabrics support active sportswear with importance placed on high functions as well as comfort [1]. On the purpose of developing high performance property to the fabrics, producers apply different chemicals or surface treatments such as water repellent, water proof, UV protection, flame retardant, anti-static, anti-bacteria etc. In this project, high performance weft knitted fabrics will be developed by combining water repellent and water proof applications.

A waterproof fabric is one in which the pores, the open spaces between the warp and filling yarns and between the fibers, are filled with appropriate substances, resulting in a fabric having a continuous surface and a very low air permeability. A water-repellent fabric is one in which the fibers are usually coated with a "hydrophobic" type of compound, and the pores are not filled in the course of the treatment [2].

Table 1. Compression of Water Repellent and Waterproof Treatments

	Waterproof	Water-repellent
Pores	Filled	Unfilled
Water-vapor permeability	Very small	Small or large
Air permeability	Small	Usually large
Chief characteristic	Extremely resistant to passage of water even under a hydrostatic head.	Resistant to wetting by rain drops and to the spreading of water over the textile surface, but permits the passage of water under a hydrostatic head.

Ozen at al. (2012), in their project they tried to develop water proof breathable fabric. For this purpose, plain and 2/2 twill fabrics were woven by using cotton and polyester yarns with the same yarn count. Then the water repellent chemical was applied to these fabrics. Also lamination was subjected them for the process. As a result of this project, it was revealed that alone water repellent finished fabrics and alone microporous breathable films couldn't provide waterproofness [3].

The purpose of this project is to develop breathable, comfortable, water repellent sportswear garment combined with weft knitted fabric and membrane.

These products' performance will be determined according to the different standards for the rain tests.

Table 2. Rain Test Results

SPRAY TEST*	Water Repellent Study 1	Water Repellent Study 2	Membrane 1	Membrane 2
Test rating	5	5	1	1

*AATCC 22, Distilled water temperature: 20±2°C or 27±2°C

BUNDESMANN RAIN TEST*	Water Repellent Study 1	Water Repellent Study 2	Membrane 1	Membrane 2
Water repellent level (after 1 min)	4	4	1	1
Water repellent level (after 5 min)	2	2	1	1
Absorption of water (showering for 10 min)	32.30%	45.60%	140.10%	123.80%
Amount of water (ml)	360 ml	500 ml	0 ml	0.6 ml

*: TS EN 29865:1996, Bundesmann test water temperature: 25.9°C, hardness of water 8.5 dH, pH 7.9, centrifuge period: 15 sec

RAIN TEST*	Water Repellent Study 1	Water Repellent Study 2	Membrane 1	Membrane 2
Weight of blotting paper	5.25 g	5.9 g	0.15 g	2.6 g

*: AATCC 35:2006, water level: 4 inch, spray period: 5 min

When the performance of water repellent fabrics and membrane have examined, test results show us these two fabrics can be used together for developing product having the desired properties.

Key Words: Water repellent, membrane, sportswear garment

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DETERMINING THE PROTEASE ENZYME HAVING THE MOST SUITABLE ACTIVE SITE FOR DEGUMMING OF SERICIN RESIDUES ON SILK

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Fibers reeled from cocoons produced by Bombyx Mori silkworms, are called as “silk” [1]. The advent of synthetic fibers such as nylon and polyester, which are stronger than silk and lower in price, but do not possess the same hand, or quality, has caused a tremendous reduction in silk production and consumption. In many countries silk is still used for clothing, including light weight suits, coats and slacks, jackets, shirts and neckties, robes, loungewear, underwear, hosiery, and gloves. Silk is also used in lace, napery, draperies, linings, narrow fabrics, and handbags. [2]. Overall production of silk fibers accounts for 0.175% of world’s fiber production [3].

Filament silk yarn is so expensive due to the silk yarn process to be long and the amount of silk fiber produced annually to be limited. Nowadays price of degummed un-dyed silk yarn is approximately 100 $/kg. For that reason silk is a value-added and precious fiber. The most important cost increasing step is the finishing process. Some unlevelness problems may occur during the finishing processes, especially in dyeing process, of silk fibers. The major portions of unlevelness problem are skittery (which seems as age rings of tree on fabric surface) and streaky dyeings. Each fault dyeing not only causes increase in dyeing cost but also causes decrease in production and leads delay in supply time. Especially when the subject is a high added value fiber such as silk, the cost of faulty dyeing is also very high for the company.

Silk fiber, that have a different structure from other protein fibers, comprise of fibroin (%75) and sericin (%25) [4]. Silk fiber is formed by wrapping sericin outside silk fibroins, and so sericin also covers the bright and unique appearance of fibroin so it has to be removed prior to dyeing [5]. However, sometimes sericin cannot be properly removed and due to the different dye uptake characteristics of sericin and fibroin, unlevel dyeing problem occurs.

Therefore, absence of sericin residues on product plays an important role. The most conventional method of degumming process is boiling with Marseille soap [6]. However, in recent years, there are some studies on enzymatic degumming process with protease enzymes in the literature. Although there are many studies for removal of sericin with enzymatic degumming process, there isn’t any study that compares performances of protease enzymes according to their active sites.

In this study, it was found that the reason of unlevel dyeing problems of silk yarns at YÜNSA Inc. was sericin residues. So it was studied to determine the protease enzyme having the most suitable active site for degumming of sericin residues on silk fibers in order to create ecological alternative for conventional soup boiling method.

At first Marseille soap boiling process has been studied in the experiments. According to the treatments carried out in three different Marseille soap concentrations (20-30-40%) and three different periods (30-45-60 min.), optimum concentration and period was found to be 20% and 60 min. respectively. After pretreatment carried out at these conditions, approximately 6% weight loss occurs in fabric. Afterwards it was tried to determine the enzyme type that gives the best results in terms of degumming performance by making experiments with protease enzymes having four different active sites. As a result of experiments, it was observed that the order of enzymes giving the best results to the worst was as follows; Savinase (serine type protease) > papain (cysteine type protease) > Neutrase (metallo protease) > pepsin (aspartic acid type protease). According to these results, it can be said that the best results could be obtained with Savinase (serine type protease). The optimum conditions for Savinase enzyme are 2% concentration and 45 min. treatment time. After enzymatic pretreatment weight loss occurs in fabrics was determined to be 6%. From these results, it can be said that degumming performance of enzymatic method is similar compared to the conventional method. In addition to sericine tests carried out according to the weight loss, it was also applied staining test by dyeing with CI. Direct Red 80 and results were verified. Furthermore, in order to determine the effect of enzymatic treatment on the fabric strength, tear strength test was applied to the silk fabric that was treated with savinase enzyme at optimum conditions, and results were compared with untreated control sample. It was found that the tear strength of enzymatic treated silk fabric was slightly decreased in both warp and weft direction but it was determined that the decrease was in the acceptable.

The present study clearly indicates that there are 2 two alternatives for degumming of sericin residues on silk fabrics which are treatment with Marseille soap at 20 %w/w concentration at 95ºC for 60 minutes and treatment with Savinase enzyme at 2% w/w concentration at 50ºC for 30 minutes. According to these results, it can be said that treatment with a protease enzyme having serine active site could be used as an ecologically friendly alternative to soap boiling. Although enzymes are more expensive, concentration, time and temperature of enzymatic treatment is considerably lower than the Marseille soap treatment. So when the two processes are compared in terms of cost, it will be understood that there are no significant difference between two methods. It is thought that the use of enzymatic processes will gain even greater importance and are expected to spread especially in the future when the environmental measures will increase the legislations much more.

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ANTIBACTERIAL PROPERTIES OF BIODEGRADABLE FIBRES

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The expected properties of textile materials are far more then needs of covering or dressing up. In recent years, with emerging technology, demand for advanced comfort products with high-performance and protection is increasing day by day.

Methods which will not harm ecological system during production process and materials which are natural and recyclable, plays an active role in consumer demands.

With the development of environmental awareness, content of high value-added products has become an important criterion.

Anti-bacterial products are leading textile products through protection of health, personal hygiene and comfort. Antibacterial products and features prevent growth of bacteria and fungi, provide hygiene, avoid odor and pollution generated by micro-organisms on the product and also prevent discoloration and stain formation.

The added values of these textile products are; being producted from renewable resources and can be degraded in nature after completing their times of use .These products are used widely in many areas such as work-wear, hospital garments, military clothing, home textiles, baby clothing, sportswear, underwears and socks.

Within this study, as using Polylacticacit (PLA) derived from natural polymers and Chitosan fibers & with fibers such as Cotton & Lyocell of different proportions derived from different mixtures; biodegradable, anti-bacterial knitted fabrics will be developed.

Fabrics were tested for their antibacterial properties to determine which structure and mixture of fabric has the optimum effect .According to results of the tests, percentage of Chitosan and Lyocell fibers in the blend of yarn is the most important parameters.

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Key Words: Antibacterial,PLA fiber,biodegradable fibers,chitosan

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OZONATION: A NEW METHOD WHICH CAN TAKE PLACE OF ENZYMATIC DESIZING

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Technologies for development of economically and ecologically well-tolerated textile finishing are gaining increasing public interest. Although, desizing of cotton fabric can be accomplished by physical, chemical or combination of physical and chemical mechanism, namely rot steeping, acid steeping, treatment with enzyme and oxidizing agents, enzymatic desizing has gained more importance because of ecological and economical concerns. However, in general, changes in pH and temperature alter both the activity and stability of enzymes greatly. On the other hand, heavy metal ions such as copper, iron, etc. inhibit the activity too. Following the digestion period, a hot water wash, with or without subsequent alkaline scour, is required for complete removal for the size that has been solubilised by the enzymes. Also, it is quite common that the enzyme fails to remove all of the sizing. The desizing process is not finished until the size breakdown products have been removed from the fabric. This is best obtained by a subsequent detergent wash (with NaOH) at the highest possible temperature. Generally, about 10 to 30% of sizing remains on the garments because enzyme desizing is not sufficient to cause complete removal. The aim of this study is to develop a new ecological and economical process which can take place of enzymatic desizing. For this purpose, trials about ozonation and desizing with amylase enzyme were performed. Consequently, effects of both processes on to the desizing degree, weight of removed size, whiteness degree, water contact angle, and wetting time were compared. Also, the significance of aftertreatment processes on to the desizing efficiency has been highlighted again. At the end of the experiments, it was noticed that ozonation process can take place of enzymatic desizing of greige cotton fabrics. When the washing is applied as an aftertreatment process, treatment with ozone gas provides higher amount of removed size, better water contact angle, better wettability, and higher whiteness degree than the treatment with amylase. Moreover, ozonation of greige cotton fabrics concerns savings of "heating energy, water, chemicals, and waste management". It looks like that ozone offers bright prospects for the textile industry because of being ecological in certain labor conditions and saving production costs when compared with conventional processes.

Key Words: Ozonation, desizing, textile, environmental friendly

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SESSION III

EXAMINATION OF FABRIC SPREADING PROCESS IN ORDER TO CREATE A MODEL FOR DETERMINING STANDARD UNIT TIME

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In apparel industry, it is difficult to determine the efficiency of a production unit in a specific time period due to complexity of processes, variety and large quantity of operators. Thus, certain techniques have been developed in order to measure efficiency. Time study is one of these techniques and the most accurate way of determining performance standards.
In this study, in order to determine the standard unit time of tasks, time study method was performed. In the time study application, a digital stopwatch an REFA time measurement form was used basically. Before starting the time study process, the necessary information was given to operators; the objectives and importance of time study were explained to department supervisors; the suitable time period for measurement process was determined with the approval of management, respectively.
Time study was complete in ten main stages [1];

1. Selecting the job,
2. Obtaining and recording all the information available about the job, the operative and the surrounding conditions, which is likely to affect the carrying out of the work,
3. Recording a complete description of the method, breaking down the task into "elements",
4. Determining the work flow sequences,
5. Measuring with a timing device (usually a stop-watch) and recording the time taken by the operative to perform each "element" of the task,
6. Calculating the required number of observations;

The required number of observations was calculated by using "Formula 1" for 95% confidence interval. 15 observations were made for all tasks by using REFA time measurement form. If the required number of observations was calculated higher than 15, the missing observations were completed by additional observations. (N = required number of observations, n = the number of observations, x = observation value).

$$N = \left[\frac{40\sqrt{n * \sum x^2 - (\sum x)^2}}{\sum x} \right]^2 \qquad (1)$$

7. Evaluating the rating value of operator's performance depending on observer's "normal operating speed".
8. Calculating the normal time by using Formula 2 [2];
   Normal time = (Observed time * rating value) / 100 (2)
9. Determining the tolerances;
   Firstly, the type of allowances should be determined for tolerances. Standard values for personal needs are 5% and %7 of normal time for men and women, respectively. The accepted basic fatigue allowances are 4% both for men and women. In order to calculate fixed and variable allowances, various tables in literature were used [3].
10. Calculating the standard time: By adding necessary tolerances to normal time, standard time was calculated for each task.

In this study, workflow was created for fabric spreading process in a company which produces women's clothing by knitted fabric. Standard unit time of fabric spreading process was determined by time study application. During the study, standard unit times of 17 different type of fabric were examined for 24 different orders in three months period. A model was tried to create in order to forecast fabric spreading time for different fabric types by using;

-Standard unit times,

-Factors which are affecting the operations' elements

-Correlation of factors with elements.

Detailed results were explained for fabric spreading process as considering time and motion study standards (Table 1).

Table 1: Standard unit times of operations' elements according to fabric types

<table>
<tr><th rowspan="2">Fabric Type</th><th colspan="11">Standard Unit Times Of Operations' Elements (seconds)</th></tr>
<tr><th>1</th><th>2</th><th>3</th><th colspan="2">4</th><th>5</th><th>6</th><th>7</th><th>8</th><th>9</th><th>10</th></tr>
<tr><td>FT1</td><td>32,26</td><td>26,97</td><td>48,08</td><td>1,41</td><td rowspan="17">* spreading length (m)</td><td rowspan="17">2,03* spreading length (m)</td><td rowspan="17">Binding tape exist 74,13
Binding tape does not exist 55,11</td><td rowspan="17">65,02</td><td rowspan="17">96,76</td><td rowspan="17">125,78</td><td rowspan="17">31,61</td></tr>
<tr><td>FT2</td><td>47,78</td><td>26,97</td><td>89,21</td><td>1,54</td></tr>
<tr><td>FT3</td><td>18,14</td><td>26,97</td><td>124,99</td><td>2,37</td></tr>
<tr><td>FT4</td><td>30,24</td><td>26,97</td><td>125,80</td><td>1,38</td></tr>
<tr><td>FT5</td><td></td><td>26,97</td><td>60,78</td><td>2,25</td></tr>
<tr><td>FT6</td><td>32,26</td><td>26,97</td><td>100,90</td><td>3,36</td></tr>
<tr><td>FT7</td><td></td><td>26,97</td><td>55,64</td><td>2,10</td></tr>
<tr><td>FT8</td><td>25,20</td><td>26,97</td><td>48,99</td><td>1,88</td></tr>
<tr><td>FT9</td><td>18,14</td><td>26,97</td><td>69,55</td><td>2,24</td></tr>
<tr><td>FT10</td><td>27,32</td><td>26,97</td><td>53,67</td><td>2,42</td></tr>
<tr><td>FT11</td><td>27,22</td><td>26,97</td><td>95,56</td><td>1,69</td></tr>
<tr><td>FT12</td><td>30,24</td><td>26,97</td><td>103,02</td><td>2,61</td></tr>
<tr><td>FT13</td><td>32,66</td><td>26,97</td><td>38,00</td><td>2,43</td></tr>
<tr><td>FT14</td><td>45,36</td><td>26,97</td><td>49,80</td><td>1,55</td></tr>
<tr><td>FT15</td><td>28,93</td><td>26,97</td><td>42,13</td><td>2,04</td></tr>
<tr><td>FT16</td><td></td><td>26,97</td><td>34,68</td><td>1,75</td></tr>
<tr><td>FT17</td><td>45,36</td><td>26,97</td><td>42,74</td><td>1,14</td></tr>
</table>

Key Words: Fabric spreading, cutting department, efficiency, standard unit time

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VARIATIONS OF THE AIR PERMEABILITY OF SELECTED WOVEN FABRICS DUE TO CHANGES OF THE AIR TEMPERATURE AND HUMIDITY

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Air permeability is one of the fundamental textile properties influencing the wearing comfort of clothing, particularly clothing protecting against wind, like moto-bike and ski sport overals etc, where low air permeability is required. On the other hand, summer clothes should be enough air permeable, to enhance the heat transfer by ventilation. Air permeability depends mainly on the fabric porosity and thickness, and on the pores spatial geometry. In woven fabrics, the main role then plays fabrics thickness and structure, where the latter depends on the type of weave, type of yarns, yarns linear density, warp/weft density, finishing and other factors. Due to the importancy of the presented fabrics property, many studies were published in recent years, in which the effect of all the mentioned parameters on the fabrics air permeability was theoretically and experimentally analyzed [1- 3]. However, most of the studies refers to the fabric permeability at the standard laboratory conditions, but in the real life, fabrics are also used at diferent climatic conditions, see e. g. in [4, 5].

The purpose of our study was to investigate the effect of air temperature and humidity on the air permeability (air flow) of 6 fabric made of cotton, polyester and polypropylen. 4 samples were lain weaves with square mass about 160 g/m^2, with warp and weft densities 108 /cm, one denim fabric with 400 g/m^2, and PES single jersey knit with 180 g/m^2. The yarns had the same linear density 45 tex in warp and weft directions. Air permeability measurements were performed with the Air Permeability tester FX 3300 I (Textest Instruments) at the pressure 100 Pa. The sucking orifice of the Tester was connected by means of large flexible tube with the climatic chamber Voetsch (see the Fig. 1), which served as a source of pressurized air with variable air temperature and humidity. In order to eliminate the effect of temperature and humidity changes during the air passage from the chamber to the tester, a precise air temperature and humidity sensor was placed in the sucking orifice od the FX 3300 tester. The results then were statistically treated and linear regression lines were presented in diagrams.

Figure 1. Measuring setup consiting of the source of hot and humid air VOETSCH, air permeability tester FX 3300 and the air temperature and humidity measuring system AHLBORN

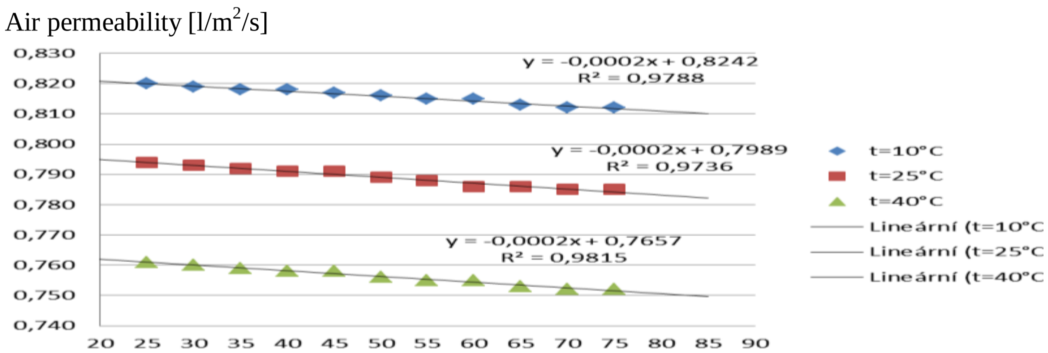

Figure 2. The effect of air temperature and humidity (in %, on horizontal axis) on the air permeability of POP woven fabric

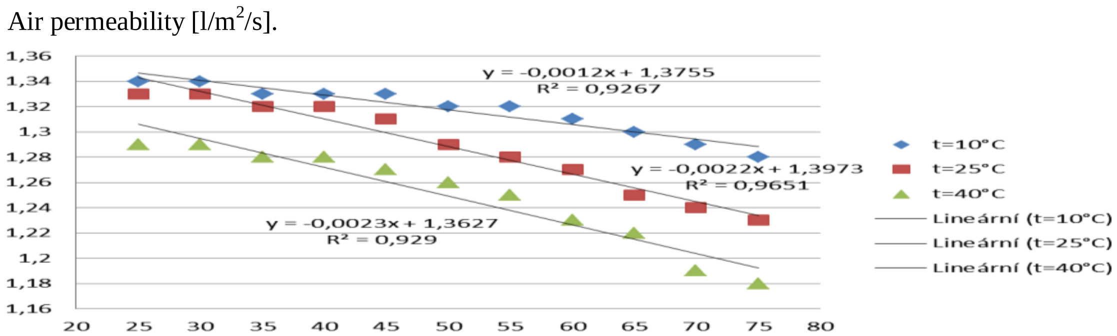

Figure 3. The effect of air temperature and humidity (in %, on horizontal axis) on the air permeability of the cotton woven fabric

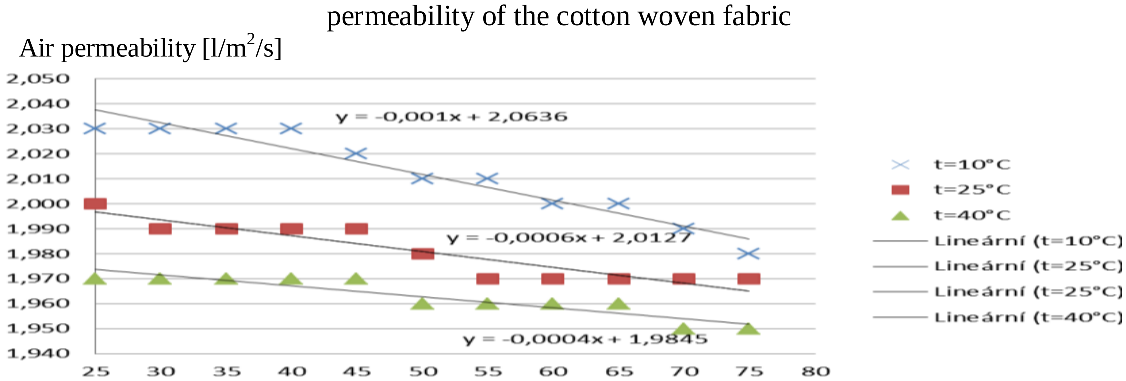

Figure 4. The effect of air temperature and humidity (in %, on horizontal axis) on the air permeability of PES woven fabric

The experiments revealed that in all cases, the air permeability decreased with the increasing air humidity and temperature. The observed effect of humidity was the lowest at the hydrophobic POP fabric. This can be explained by the lowest swelling of this fabric, contrary to the highest swelling of the hydrophilic cotton fabrics.

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IMPACT OF CORPORATE SOCIAL RESPONSIBILITY PROJECTS ON CUSTOMER LOYALTY IN CLOTHING SECTOR

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ABSTRACT

Companies are in interaction with the society that they are involved in both materially and also morally. Changes derived from the globalization introduced the fact that enterprises have a social mission within their economical contributions to the society. Today, people expect social benefits from companies which make profit and ensure their continuity. In today's competitive environment, factors such as quality, price and service quality are no longer differentiating companies from each other; hence corporate image has come into prominence as a distinctive value. Moreover, strong and a long term image can be achieved through demonstrating the social values of the companies to the society.

Contributing to society in terms of its economic, social and cultural structure will both prosper the living conditions and also reflect credit on some vital criterions for the companies such as increased sales by effecting the perception and reliance of customers. Therefore corporate social responsibility (CSR) projects take an active role in creating customer loyalty. This argument is confirmed according to the study of Pirsch et al. (2007) that demonstrated the relationship between CSR and repeat patronage intentions. Maden et al. (2012) showed that CSR has a strong positive effect on corporate reputation and also it has a strong positive effect on the behaviours of customers, employees, and also investors. At the same time, CSR projects are of prime importance in satisfying and appealing to shareholders (Maignan and Ferrell 2004; Salmones et al. 2005).

This paper aims to examine the given importance to CSR projects from the point of view of customers who reside in the city of Izmir and also comprehend customer perception about LCW –a Turkish clothing company- CSR Projects. Company of LCW has the highest turnover among other Turkish apparel retailing companies. Moreover, the company has been elected as the "lovemark" of ready-made clothing sector for 4 years consecutively including the year of 2013. The company also has made an impression with its CSR projects. A survey was conducted within the scope of this paper to be able to evaluate these projects from the view of customers. The survey was carried out with 340 consumers who live in Izmir and participated voluntarily via face-to-face interviews. The data obtained from the volunteers were evaluated with SPSS 16.0. The reliability coefficient of the survey was determined as $\alpha = 0{,}82$ which demonstrates that the survey is highly reliable.

In accordance with the study, the perception of customers toward overall CSR projects and also the ones conducted by LCW was assessed. Consequently, this paper tries to emphasize the importance of social responsibility projects about gaining the loyalty of customers and strengthening the corporate image for apparel retailing companies and also companies from other sectors.

Key Words: Social responsibility, customer loyalty, clothing sector

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AGILE MANUFACTURING FOR AN APPAREL PRODUCT

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ABSTRACT

In a globalized world without any commercial borders, it became too tough to be on the winner side in a fierce competitive environment against other companies with existing production processes. Therefore, the new production processes, methods or ideas need to be developed. Agile manufacturing has come into stage to fulfill those requirements.
Agile manufacturing is an ability to be successful in continuously changing surroundings. In other words, it is also an ability to act quickly and effectively in terms of technological, physical and administrative organizations in the markets where consumers have variable and fluxional products and services. Agile manufacturing is strategy which is composed of the lean manufacturing methods in conditions of 21th century in order to be successful. Agile manufacturing system is a composition which comprises the methods of TQM (Total Quality Management), JIT (Just in Time) and lean manufacturing practices. The difference is, agile manufacturing focuses on personalized products and less lot size compared to lean manufacturing. The specifications of agile manufacturing are suggested in Figure 1.

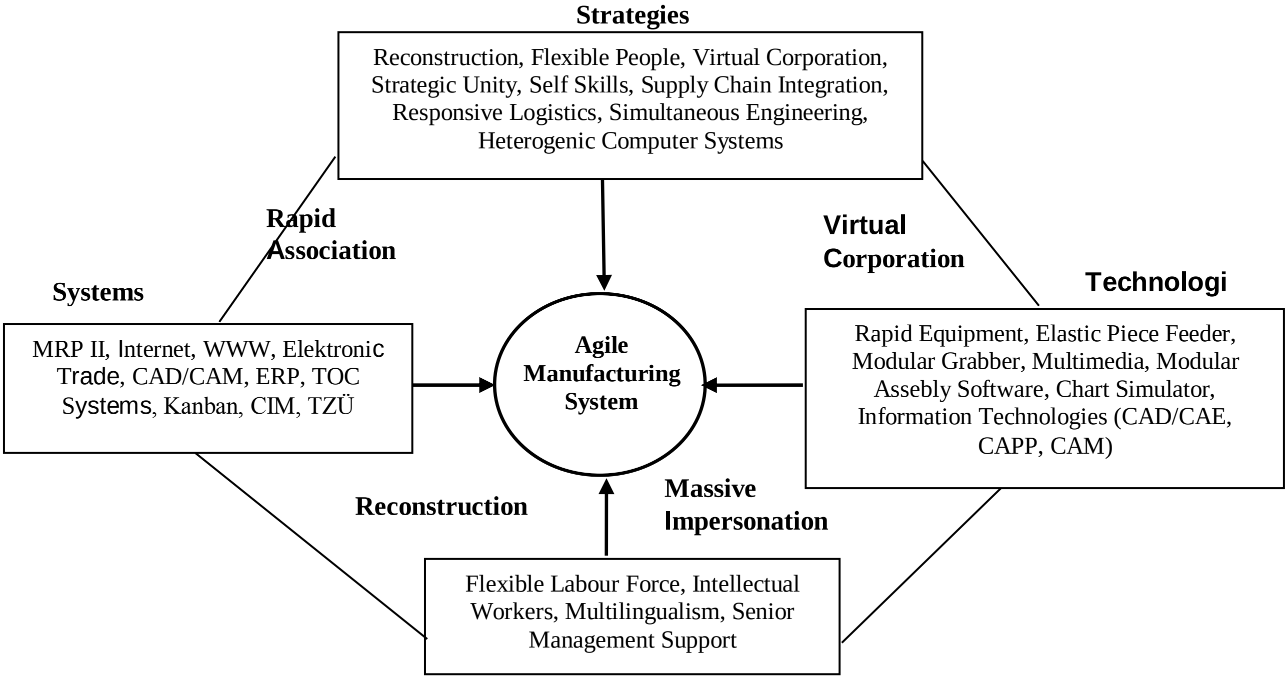

Figure 1. The specifications of agile manufacturing

From the recent past to today's world, the most important differences between agile and lean manufacturing that textile and apparel companies strive to concentrate on are as the followings (Figure 2);

- Whilst lean manufacturing aims to minimize losses and surpluses, agile manufacturing aims to solve the difficulties and chaos environment against continuous changes.

- Lean manufacturing concentrate on using the resources influentially but agility is a common strategy implemented in unpredictable environments.
- Whereas agility necessitates a prudential vision, lean manufacturing is that name of practices that existed in the past. So the vision difference exists between lean and agile manufacturing.

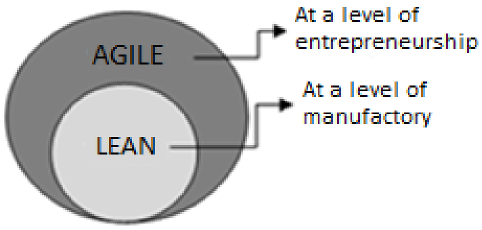

Figure 2. Levels of Agile Manufacturing, Lean Manufacturing

In this study, the production process of the company which has lean manufacturing system was observed and the following network was prepared via CPM-Critical Path Method (Figure 3). Accordingly, the network of another company which has agile manufacturing system will be examined compared with the former company. By this way, using the method of CPM, the differences of lean manufacturing and agile manufacturing are utilized and the importance of agile manufacturing is emphasized through numerical datas.

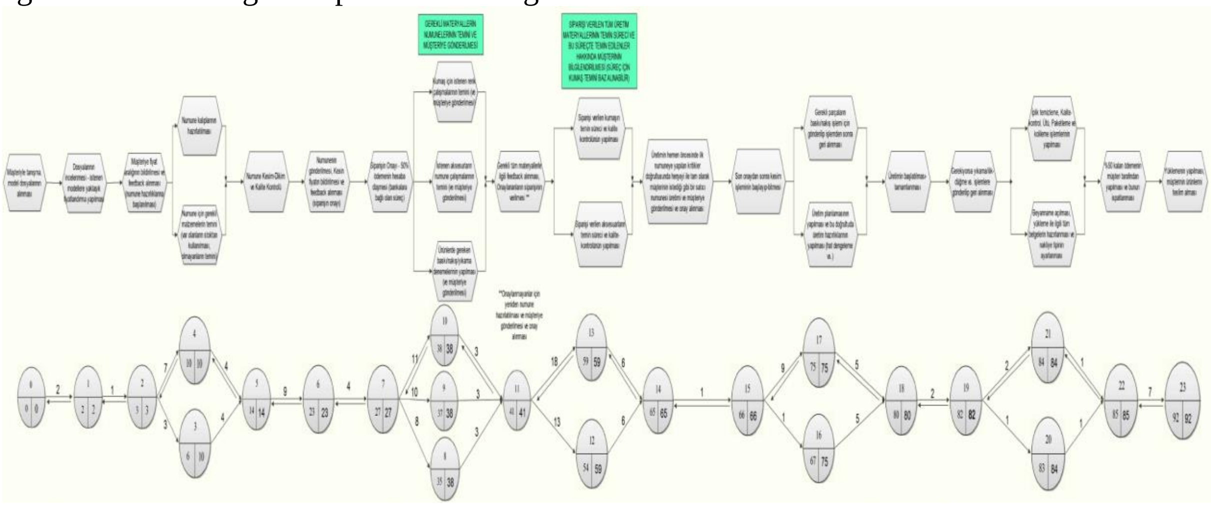

Figure 3. The network (CPM-Critical Path Method) of a company that has Lean Manufacturing

Key Words: Textile and apparel sector, agile manufacturing, lean manufacturing, CPM

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DETERMINATION OF KEY CUSTOMER BY USING TOPSIS MULTIPLE CRITERIA DECISION MAKING METHOD IN A CLOTHING COMPANY

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ABSTRACT

Big competition created by the condition of economy, social and technology has forced the firms choose new strategies in the matter of choosing of new customer. It is important to choose the right and the most suitable customer in respect of the criteria firms determined for keeping up the increasing competition. In this sense, this study evaluates a decision matrix composed of 5 selection criteria and 4 customers by taking necessary data from an apparel firm. TOPSIS (Technique for Order Preference by Similarity to Ideal Solution) method was applied to solve the key customer selection problem. Customer A1 is found out the best candidate.

Keywords: Multiple criteria decision making, Customer selection, TOPSIS Method, Ranking.

INTRODUCTION

Companies have to force to make the best decision because of the challenging and changing life circumstances. This selection process contains more than one alternative, for this reason applying scientific methods instead of intuitive interpretation is a necessity in order to achieve the best results. There are a number of multiple criteria decision making method to this end. TOPSIS is one of the multiple criteria decision making method that all the alternative are evaluated together. In this study, literature review which is related to problem solving with TOPSIS method in different areas of the sector will be given, after explaining the method and materials, in the implementation part, ranking of the alternative customers of the company will be determined by using TOPSIS method.

In the literature, TOPSIS method is applied to evaluate alternatives in many sectors. By using obtained information after making interview with the decision makers of a food company, in this fuzzy environment, considering the supplier criteria convenient for businesses, supplier selection which is about to be made among alternatives has been made by the fuzzy TOPSIS method which is one of the fuzzy multiple criteria decision making methods (Özçakar et al., 2011). Facility location selection problem has been taken into considerations in another study. Decision support model is offered in order to help a bank selecting the most suitable city for opening a branch among five alternatives in the South Eastern of Turkey. (Çınar, 2010). Traffic accidents are categorized according to the results in three groups as; accidents that cause death, that cause injury and that cause tangible damages. The relation between reasons and consequences of the traffic accidents was mathematically calculated and analysed by TOPSIS and AHP methods (Alp et al., 2011).

OBJECTIVE

The objective of the study is the ranking customers by using TOPSIS method and key customer selection according to the criteria which is determined after taking data from an apparel firm.

MATERIAL

In this study a textile company located in İzmir has been chosen as a material. Company manufactures and exports pants. After meeting with the decision makers of the company, current customers which they do business most and the criteria to evaluate them has been found.

METHOD

TOPSIS method was introduced for the first time by Yoon and Hwang (1981). This method is used to obtain the solution which is closest distance from the positive ideal solution and farthest from the negative ideal solution. Process steps can be summarized in 6 steps. After building initial decision matrix (Figure 1.) by listing alternative horizontally and criteria vertically, vector normalization technique is used to obtain the normalized decision matrix. Associated weights are multiplied by related column of the normalized decision matrix to construct the weighted normalized decision matrix. For the positive ideal solution, the largest values of each column and for the negative ideal solution the smallest values of the each column are determined. The separation of each alternative from the positive ideal and negative ideal are calculated with the help of Euclidean distances approach. The relative closeness to the ideal solution (Ci*) which is the final step of the process is found by calculating the ratio of separation of alternative from the negative ideal in total.

$$D_{ij} = \begin{bmatrix} x_{11} & x_{12} & . & x_{1n} \\ x_{21} & x_{22} & . & x_{2n} \\ . & . & . & . \\ x_{m1} & x_{m2} & . & x_{mn} \end{bmatrix}$$

Figure 1. Initial decision matrix

The calculation of the relative closeness to the ideal solution (Ci*) is shown in equation (1).

$$C_i^* = \frac{S_i^-}{S_i^- + S_i^*} \quad (1)$$

The value of Ci* is between $0 \le Ci^* \le 1$ and $Ci^* = 1$ shows the absolute closeness of the corresponding alternative to the ideal solution, in the same sense $Ci^* = 0$ shows the absolute closeness of the corresponding alternative to the negative ideal solution.

IMPLEMENTATION

Initial decision matrix which is composed of alternative customers and criterion to evaluate them has been obtained by three decision makers in the company. Customers are graded over

100 points and average value has been found by taking arithmetic average of the numbers. Associated weights of each criteria are also determined by the same people based on their experience. At the end of the application the values of positive and negative separation measures and relative closeness to the ideal solution for each alternative are shown in the Table 1.

Table 1. Si+, Si- and Ci

CUSTOMER	Si*	Si-	Ci*	Ranking
A1	0,016	0,049	0,75	1
A2	0,036	0,033	0,47	2
A3	0,047	0,021	0,30	4
A4	0,039	0,023	0,37	3

CONCLUSION

Companies are obliged to make a choice on many issues such as businesses of location, suppliers, machine, material and technology selection, evaluation of investment alternatives or strategies. TOPSIS method is one of the multi criteria decision making methods to be able to choose among the alternatives. In this study the problem composed of 4 alternative customer and 5 decision criteria has been solved by using TOPSIS method and it is shown that this method is the applicable for decision making. The results obtained after applying this model, that customer A1 fits best to the company's criteria and customer A3 shows the lowest performance are found.

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DRAPING IN TEXTILE AND FASHION DESIGN EDUCATION

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Covering is one of the first basic and physiological necessity from the beginning for people by the time the more esthetic to be dressed up to take the place of covering. Clothing serve a need variety of physiological and psychological. Clothing is so important physical and psychological for all people for social interaction. Therefore, clothing designs needed to become different , original and respond to people's wishes and desire.

Clothing sector in terms of clothing design aesthetic, artistic value, intense, visually, as a priority, and has a wide range of product types. Design and mold making is very important in production of clothing. Draping technique is the most commonly used technique to preapare mold design and cloth design. The other name of the draping is 3-dimensional mold preparation technique and that has an important place in the clothing education. Draping is apply, shaping by the fabric on a model. This technique recognizes to the designer for brings high levels cause to get chance to work one to one with fabric .That is applied directly on the body suit would be perfect harmony with the body.

The purpose of the study is to examine the levels of the draping technique knowledge and implementation , draped in different themes applied technique is to contribute to education in fashion design by creating clothing designs.

In this study; includes the importance of draping in the education of fashion design and the application processes. To benefit from the current literature and periodicals on the subject and contains information about draping. Draping the application, visually presented with the application of the stages. In addition, the technique draped designed with different themes applied to clothing designs and visually presented. The data obtained and tried to reach the conclusion in the light of the clothing designs.

Key Words: design, clothing, fashion, draping.

TOPOGRAPHIC CHARACTERIZATION OF WATER FILM LAY ON COTTON FABRICS DURING EVAPORATION BY USING CLSM

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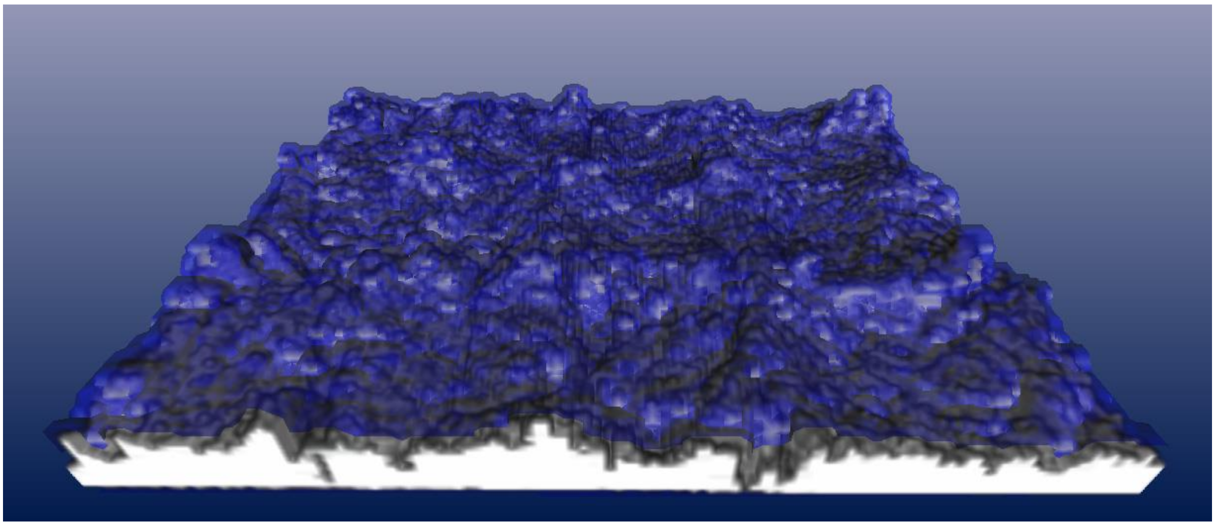
Solid and liquid surfaces can be characterized by theirs chemical composition, geometry and roughness. The way on how liquids interact with textile fabrics may involve one or several physical phenomena such as fiber wettability, depending on the intermolecular interaction between the liquid and fiber surface, their surface geometry, the capillary geometry of the fibrous assembly [1], the amount and chemical nature of the liquid as well as on external forces. A rough textile surface possesses pores, crevices, capillaries or other typical structures with their own characteristic wetting and penetration properties. As a consequence, the apparent contact angle on these surfaces will be affected by thermodynamics and kinetics associated with such intrinsic structures; that indicate the high difficulty degree of understand how a certain amount of liquid distributes on tissue.

Texture of fabric change the porosity value and strongly influences the textile characteristics such as mass, thickness, draping ability, or air permeability [2-4]. However, there are very few systematic investigations of quantitative relations between construction parameters, topography of fabrics and their wettability.



A confocal laser scanning microscope (CLSM) is an imaging instrument in which a specimen, such as the cornea, is illuminated with a focused light spot. A light beam passes through a light source aperture and then is focused by an objective lens into a small focal volume within a specimen. A mixture of emitted as well as reflected light from the illuminated spot is then recollected by the objective lens. A beam splitter separates the light mixture and reflecting the light into the detection apparatus. After passing a pinhole, the light is detected by a photodetection device, transforming the light signal into an electrical one that is recorded. The detector aperture obstructs the light that is not coming from the focal point, resulting in sharper images than those from conventional light microscopy techniques. Background information on the general field of CLSM is presented in detail in several sources [5-8]. To summarize, a confocal arrangement isolates information from volume elements without the necessity of physical sectioning.

Real time microscopy characterization of water film lays on a surface is an open challenge. The system is even more complicate if the solid substrate is a porous media, e.g. cotton fabrics. A non-invasive procedure were developed to observe the water layer on a cotton fabric by confocal laser scanning microscopy (CLSM). This methodology allows to examine and reconstruct the three-dimensional structure of liquid and solid surfaces with a depth of several hundred microns. Due to the natural emission of the material examined (cotton cells have an emissions band that overlay the laser wavelength) a specific dye in low concentration (0.01%wt), in order to not modify the liquid thermodynamical properties, was used to highlight the liquid film.

Furthermore, evaporation process has a relative short characteristic time in high magnifications, because of the laser that increase locally the temperature gradient.

Key Words: Cotton, CLSM, porous media, wetting, evaporation

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APRIL 5, 2014

2BFUNTEX SESSION

PROFILE OF SIDE EMITTING OPTICAL FIBER ILLUMINATION INTENSITY

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Side-emitting optical fibers illuminate part of the rays through surface. These fibers incorporated into textile structures may be used as the active visibility textiles in conditions of reduced visibility [2]. When transmitting rays are leading through light optical fibre, attenuation occurs [3 - 6]. It mainly depends on its wavelength, fibre type, fibre structure (i.e. crystallinity and orientation), impurities and accompanying substances (dopants), the distance from the source, and also on the outer geometric shape (micro-bends, macro-bends, surface damage). For side-emitting optical fibres is necessary to establish mean attenuation rate, which should ideally be constant.

Prototype for evaluation of side emitting optical fibre illumination intensity was developed and tested. The system of data treatment and evaluation of result was proposed and checked. Parameters characterizing of optical fibre quality, i.e. mean attenuation rate and maximum illuminated optical fibre length were proposed. The mean attenuation rate is ideally constant [6], but generally may be a nonlinear function of the length *L*. Experimental values of illumination intensity for optical fibre „Grace-standard“ having diameter 0,25 mm are shown in Fig.1. Standard power function derived from assumption of constant rate of attenuation is here shown as grey curve [1]. This curve is described by equation

$$P = P_0 \, 10^{-\alpha_L/10} \tag{1}$$

where P is illumination intensity, P_0 is illumination intensity on the fiber input and α_L is mean attenuation rate. Black piecewise solid line is so called LLF2 model. This model is based on the assumption that in short distances from light source there are some no uniformities in side emission due to accommodation to aperture and critical angle. In second phase the illumination intensity is slowly decreasing with distance from source L (system is accommodated). Local slopes of LLF2 are in fact sensitivity coefficients a_1, a_2. LLF2 model is described by equation

$$LLF2 = P_0 + a_1 L + a_2 (L - L_c)_+ \tag{2}$$

where function $(x)_+$ = 0 if x is negative and if x is positive, function $(x)_+ = x$. L_c is distance of transition between first and second phase. [18] Parameters of LLF2 were found by using of stage wise linear regression. Residual sum of squares (RSC) as function of distance from light source is shown in Fig. 2. Parameters of smoothing curves of illumination intensity calculated by using of LLF2 are given in the tab. 1. By using of LLF2 is possible calculated distance of transition Lc between first and second phase. First phase represents no uniformity in side emission due to accommodation to aperture and critical angle. In the second phase is system accommodated and illumination intensity is slowly decreasing with distance from source L.

Slopes of straight lines of both phases characterize sensitivity of illumination intensity on the distance from source.

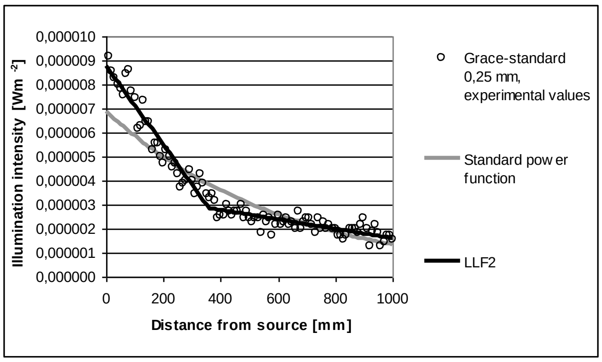

Figure 1. Illumination intensity as function of distance from source for optical fibre „Grace-standard" having diameter 0,25 mm

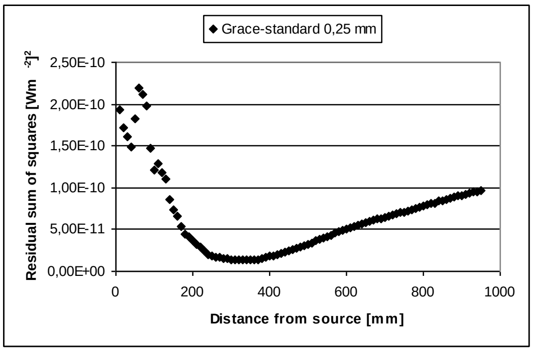

Figure 2. Residual sum of squares for illumination intensity - optical fiber „Grace-standard" with diameter 0,25 mm

Table 1. Parameters of LLF2smoothing curves of illumination intensity

Fiber type	„Grace-standard" 0,25 mm
Minimal residual sum of squares S [W m^{-2}]^2	1.372 10^{-11}
Corrected illumination intensity on the fiber input $P_{cor}(0)$ [W m^{-2}]	0.000009
Slope of first straight line a_1 [W m^{-2} mm^{-1}]	-1.64 10^{-8}
Slope of second straight line a_2 [W m^{-2} mm^{-1}]	-1.96 10^{-9}
Distance of transition between first and second phase L_c [mm]	359.9

It was found that mean attenuation rate α_L is not constant, but it is function of distance from light source L. It is suitable to divide it to two phases, first with strong variability and second with slow decline of mean attenuation rate.

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KNITTED FABRICS RESPONSE TO VIBRATIONS

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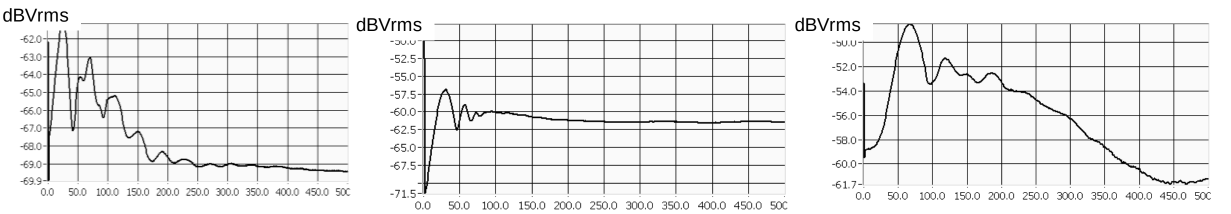
Human activities have involved exposure to vibration, coming from various sources, either from power tools, industrial machines or riding in trains, planes, auto vehicles. The energy gathered from these sources is dissipated in the form of vibration, some of which being transmitted to people [1]. In this regard, textile materials are sometimes used either for vibration or for shock isolators. While several studies exist of vibrating properties of textile yarns, the research field for vibrating textile surfaces is rather limited to the textiles with acoustical vibration properties [2].

Dynamic stiffness of the textiles may be indirectly evaluated through the natural frequency of the material, when is vibrated with a known load. The mechanical response of knitted fabrics under dynamic load can be directly related to their stiffness as a property influencing fabric performances in various technical uses.

The presented work is designed as a preliminary research on knitted fabrics response under dynamic stress and their capacity of vibration damping.

The dynamic behaviour of knitted fabrics has been evaluated through the recorded frequencies generated by an impact hammer. Fast Fourier Transformation-FFT has been applied and the Spectrum Analyzer application from the LabView software was employed to determine the natural frequencies of the system, as exemplified in figure 1. The tests were carried out on warp fabrics produced by Karl Mayer and Liba companies, for basic coatings and laminating, geotextiles, and reinforced composites [3]. The weft knitted fabrics were manufactured on a CMS 530 E6.2 Stoll electronic flat knitting machine, by using regular raw materials: acrylic, cotton, polypropylene and polyester yarns for each structure [4].



a. Wale b. Course c. Perpendicular

Hz Hz Hz

Figure 1. Natural frequency of the knitted fabrics

The effects of stitch density, structure and yarn type on the dynamic performance of knitted fabrics were evaluated in case of weft knitted fabrics.

The influence of stitch density, fabric thickness, spacer yarn type and threading on the natural frequencies of the warp fabrics are discussed by the comparative analysis of the samples.

Future research will be focused on the perpendicular fabric direction testing, and it will take into account other parameters, such as:

- yarns properties (nature, fineness, bending, rigidity, tensile);
- fabric cross section (number of contact points per square unit;
- finishing treatment of the knitted fabrics.

The fabrics with such a dynamic behaviour could find their destination as protective cushions, shock isolation boxes for fine mechanics apparatus, anti-vibration equipments, etc.

Key Words: Weft knitting, warp knitting, dynamic testing, natural frequencies

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SURGICAL THREADS MADE OF PGA-co-PLA & PHB BIODEGRADABLE FILAMENTS YARNS BY BRAIDED METHODS

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In the paper the results of research work are presented concern the technological solutions of braided product made of a new generation of multifilament yarns of PGA-co-PLA & PHB with the linear mass ca 60 & 80 dtex and 24 filaments. Due to the technological works a braiding technique was applied for the construction of the material. There is shown the way of modernised of braided machine to run untwisted filament yarns during the production process.

The different structural solutions of braided sutures were developed for medical applications as well as their mechanical and physical properties. The materials have biodegradable properties confirmed experimentally. The chemical purity of materials was determined on the basis of medical product criteria. For medical applications the chemical purity analysis a s well as biocompatibility evaluation have been performed. The methodic of biological experiments on materials designed for surgical threads has been presented. Evaluation of biocompatibility of material implant will be performed on the basis of in vitro experiments cytotoxicity and genotoxicity experiments on allergic properties as well as on chronic toxicity and local reaction after implantation of produced surgical threads.

Result of experiments demonstrated the reasonability of applied technological solutions for yarns constructed from degradable PGA-co-PLA & PHB raw materials. As the presented stage of experiments both applied materials and the final product fulfil basic demanding of biocompatibility for medical use.

Final products were not cytotoxic in vitro moreover selected braided sutures designed for implants did not demonstrate allergenic effects. For selected group of materials the radiation based sterilization process has been proposed.

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Key Words: Aliphatic polyester, multifilament yarns, sutured threads, braided materials

MODIFICATION OF COTTON MATERIAL WITH PRECURSORS OF SILICON ALKOXIDES FOR IMPROVED FLAME RETARDANCY

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Our previous results with zeolite in cotton finishing bath suggested that this complex silicone compound may have a considerable influence on cotton flammability [1]. Silicone has excellent thermal stability and high heat resistance with very limited release of toxic gases during the thermal decomposition. In this paper cotton material has modified with sol-gel method. Cotton fabric was treated with two precursors of silicon alkoxides; 3-Aminopropyltrietoxysilane and 3-Methacryloxypropyltrimethoxysilane [2-3]. These two precursors were combined with conventional flame retardants to improve their initial flame retardancy.

Twill weave chemical bleached cotton fabrics (211 g/m^2) were firstly treated by pad-dry procedure in with conventional compound ammonium hydrogen phosphate (Ap2). For sol-gel method in padding bath firstly the precursors, 3-Aminopropyltrietoxysilane (A) or 3-methacryloxypropyltrimethoxysilane (M) has been added. For the third treatment both components ammonium hydrogen phosphate and precursors, 3-Aminopropyltrietoxysilane (Ap2A) or 3-Methacryloxypropyltrimethoxysilane (Ap2M) have been added to the padding bath, dried at 110 °C for 2 min and cured at 150 °C for 5 min. In the case of ammonium hydrogen phosphate cotton samples has been only dried.

Burning behaviour was performed by standard method (ISO 4589:1996 – Plastics – Determination of burning behaviour by oxygen index, LOI). For better understanding the thermal changes of cotton structure under the heat conditions thermogravimetric analyser (TGA) and micro combustion calorimeter (MCC) have been used.

The conventional compound for cotton flame retardancy, ammonium hydrogen phosphate (Ap2) shows expected high LOI values (LOI 25). Cotton fabric treated by sol-gel method with only precursors of silicon alkoxides shows no improvement compared to untreated cotton (LOI 19). By addition of ammonium hydrogen phosphate and precursors in padding bath flame protection reached the high LOI values (LOI 30 and LOI 32) presented in Table 1. The proposed fire retardancy of these compounds seems to be the formation on the cotton surface the barrier against heat transfer. This high LOI values could be explained by eventually synergism between silicones and phosphate.

Table 1. Burning behaviour of Limiting Oxygen Index, LOI according to ISO 4589:1996

Sample	ISO 4589:1996	
	$t_{100\ mm}$ [s]	LOI
0	105	19
A	107	19
M	104	19
Ap2	80,7	25
Ap2A	64	30
Ap2M	52	32