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Textile Engineering Department

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PREFACE

Technical textiles have attracted more and more attention in recent years. These high performance materials are widely used in civil engineering, electrical engineering and electronics, agriculture, medical and automotive industries in addition to protective and military clothing.

Developed countries have focused their strategy on technical textiles to carry forward their competitive advantage and to control technical textiles market and consequently have held the global technical textiles market.

5th International Technical Textiles Congress is held in İzmir on 7-9 November 2012, where it started with 1st International Technical Textiles Congress. The congress targets to gather all the players of the industry; the experts and the researchers with the manufacturers, the consumers and the investors from Turkey and abroad. 5th International Technical Textiles Congress provides the possibility to share the industrial experiences and scientific investigations, which have very important contributions to the development of the sector.

We would like to thank to all sponsor companies, to all authors and participants for their kind supports. We hope that this international event will also generate an occasion to create new opportunities.

We are happy to welcome you.

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PROCEEDINGS

DEVELOPING PSYCHO TEXTILES FOR MOOD CHANGING GARMENTS

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Abstract: *The talk puts forward a new area of research named PsychoTextiles and Garments PT and PG. It will describe the development of photonic fabrics and how they are made up into garments and it will show how the development and incorporation of wearable electronics can develop a Psycho Garment System PGS which interacts with the wearer and through psychometric real-time data feed-back can change the mood of the wearer.*

In the PGS, sensing of sound becomes input and colour changing through the photonic fabric the corresponding output. Between each set of input and output, there are key steps in data acquisition, processing, computing and testing. A transducer and a programmable mini-microcontroller are used to decode the wearer's mood intelligibly in the information system. Purposed printed-circuit boards (PCBs) are designed and made by integrating, programming and implementing ICs.

A collection of tailored garments with high level of aesthetics (couture) will be presented through a video which will show the full implementation of the PGS in fashion.

Keywords: *smart textiles, mood changing, luminescent, psycho textiles, psycho garments, wearable electronics, fashion.*

WHAT ABOUT STANDARDIZATION OF SMART TEXTILES?

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Abstract: *Research in the area of smart textiles has been going on for over a decade but products are reluctantly coming to the market. However, when smart textile products really break through, test methods to prove their "smartness" and reliability will have to be developed. These give the manufacturers a tool to show that their products are of good quality on the one hand, and it gives the user the certainty that his purchase will perform as foreseen, next to being safe and comfortable. In other words, confidence in smart textiles will be increased if quantified test methods are established.*
This paper reports on the initiatives that have been undertaken to start setting up standards for smart textiles.

Keywords: *smart textile materials, smart textile systems, standardization, material classification.*

1. INTRODUCTION

Over the years, "smart textiles" has become a well-known term, not only in the textile community but also in other fields of technology. However, if we look at the retail trade, only few "smart textiles" are available for purchase by the consumer. The European project SysTEX [1] focused on enhancing the breakthrough of smart textiles and concluded that, amongst others, lack of standardization slows down the commercialization of these high added value products. In 2007 a working group (WG 31) was assembled to start setting up standardization of smart textiles. This was done in the framework of CEN, the European Committee of Standardization, within the Technical Committee 248 (CEN/TC 248 WG 31) [2].

2. MATERIAL AND SYSTEM CLASSIFICATION

As a starting point for setting up smart textile related standards, some clear definitions were formulated. Three important groups of textiles were identified: functional textile materials, smart textile materials and smart textile systems.

Functional textile materials do not have any 'smartness' as such, but in many cases they form the basis of a smart textile, e.g. electroconductive textiles, fluorescent materials or optical fibres.

Smart textile materials are the next class of textile materials, having a certain inherent degree of smartness by responding to a stimulus. This additional property is something that is normally not expected from a textile material. E.g. chromics, phase change materials or piezoelectric materials.

Finally, a **smart textile system** was defined as a textile comprising comprises following components: sensors, actuators, energy supply, communication device and a data processing unit [3].

The Technical Report suggested to classify smart textile systems according to the presence of an energy supply and a communication function with the environment.

Energy is defined by the presence of an internal energy source, capable of either producing or supplying energy e.g. batteries.

The communication function refers to the presence of a means of communication with the environment, which can be uni- or bidirectional. This can be visual or auditive or even a fragrance release.

Distinction between these functions leads to a classification into four categories:

No energy, nor communication function - No energy, but communication function - No communication but energy function - Both communication and energy function

3. STANDARDISATION

Classifying smart textiles in such a way helped in revealing the standardization needs.

When can a garment be labeled as ‘smart’? How can we be sure that the heating garment we buy is safe? Will my illuminating T-shirt survive the washing machine? Will my mother’s shirt correctly record the vital signs? Will the electronics in the intelligent firefighter suit of the future sustain the heat? Will it be complicated to maintain a smart cloth in daily life? These and many other questions arise from people who are interested and those who are skeptic about smart textiles.

However, because of the multidisciplinarity of this product range, standardization is not a straightforward process since it involves an overlap between the standardization of “traditional” textiles products with the one of functional properties of the “smart” product. This overlap may include the legislation, expertise, testing and other synergies resulting from the combination of the different technologies. This information should be gathered from other standardization bodies or committees such as CENELEC, operating in the electro-technical domain or ETSI in the telecommunication domain.

As a starting point, existing standards can be used and adapted to the new materials, but existing standards in other areas such as for electronics or fibre optics should also be looked at.

4. CONCLUSION

With the emergence of smart textiles, the need for standardization has arisen. Test methods related to performance reliability of a smart textile will improve the confidence of the manufacturer and the consumer into smart textile products. In Europe, the standardization process has already started with the formation of a Working Group on Smart Textiles. Recently, this group has finished the Technical Report, which has been accepted by CEN. It has been suggested that two topics are ready to start the standardization process: electroconductive textiles and phase change materials.

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POLYANILINE: APPLICATION AS SOLID STATE ELECTROCHROMIC IN A FLEXIBLE TEXTILE DISPLAY

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Abstract: *A composite of polyaniline with a flexible nonwoven textile spacer (viscose or PET) has been successfully prepared. Aniline monomer units were initially bound to the surface of the nonwoven substrate and subsequently chemically polymerised in its solid state.*
The prepared composite was then employed within a flexible four-layer electrochromic device (ECD), previously developed by ourselves. The device consists of the polyaniline-nonwoven composite sandwiched between two electrodes. The lower electrode is silver or carbon black deposited on a flexible PET textile substrate and the upper is flexible and transparent PET/ITO. A reversible colour change of the polyaniline-nonwoven composite is observed, from green to blue, when an electrical voltage (± 3 V) is applied to the prepared device. Because polyaniline is used in its solid state it offers an alternative to the liquid state electrochromic previously applied within the developed flexible textile ECD and reduces problems owing to satisfactory sealing and leakage. This paper outlines the preparation and characterisation of the electrochromic polyaniline-nonwoven composite and the electrochromic display prototype in which it is applied. The benefits and drawbacks of the technology are discussed.

Keywords: *composite; electrochromic; flexible display; polyaniline; sandwich structure; spacer textile.*

A MULTIPLE CRITERIA DECISION MAKING APPROACH FOR FIREFIGHTER PROTECTIVE CLOTHING FABRICS SELECTION

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Abstract : *Clothing for firefighter consists of three layered structure as an outer shell, a moisture barrier and a thermal liner. The fabric selection for these layers is an important subject for the firefighters' protective clothing sector in terms of benefits and costs. It is usually a complicated task to give a decision which materials should be used for the producing of protective clothing, especially when firefighters' lives are in consideration. In terms of firefighter; their protective clothing has a variety of different requirements that are protection against thermal radiation, flame and hot liquids; resistance to abrasion; being light, water resistant, breathable and comfortable. It may be a challenge to find everything that is needed in one firefighters' protective clothing. Therefore; in this study, the protective performances of different materials were tested and the most appropriate fabric assembly, for producing firefighters' protective clothing is determined by making use of multiple criteria decision analysis along with a cost/benefit evaluation.*

Key Words: *Firefighters' protective clothing, three-layer structure, multiple criteria decision making, cost/benefit analysis.*

1. INTRODUCTION

Firefighters' protective clothing is thermal protective clothing, which protects against the thermal radiation, hot gas convection, and heat conducted from hot surfaces [1]. It usually consists of three main layers that are an outer shell, a moisture barrier and a thermal liner. The outer shell is in direct contact with flame heat and mechanical impacts. The moisture barrier is the middle layer that keeps the thermal liner dry and it is comprised of materials that are waterproof and breathable. The thermal liner provides thermal protection, comfort on the users' skin, and moisture management [2, 3].

Firefighters may receive serious burn injuries even though they are wearing protective clothing and are standing at a safe distance from a fire source. The reason is that conventional protective clothing has definite physical limits to its ability to protect the wearer [1].

In this study, the protective performance of different fabric layers was tested and an attempt was made to carry out a multiple criteria decision making analysis along with a cost/ benefit evaluation for the best fabrics selection of firefighters' protective clothing. Moreover, this paper also presents one of the first attempts in using multiple criteria decision making methods and cost/benefit analysis to the present problem.

2. MATERIAL AND METHOD

2.1. Testing of Material

Different fabric assemblies with the outer shell, moisture barrier and thermal liner layers, which are of different materials, different mass per unit area and thickness, were tested and evaluated in terms of this measurements, resistance against heat and flame (TS EN 367), water vapor resistance (TS EN 31092) and cost.

2.2. Multiple Criteria Decision Analysis

For selecting the most suitable fabrics and combinations of fabric layers, a multiple criteria decision analysis technique along with a cost/benefit evaluation is applied. A weighting scheme by CRITIC (Criteria Importance Through Inter-Criteria Correlation) method is used in determining objective weights during decision analysis technique. The quantitative values of alternatives for conducting the analysis are collected from the experimental tests' results.

Cost/benefit analysis is a set of procedures for defining and comparing benefits and costs. In this sense, it is a way of organizing and analyzing data as an aid to thinking. Decisions are made by decision makers, and cost/benefit analysis is properly regarded as an aid to decision making and not the decision itself [4]. In this study benefits are evaluated by considering the test results and costs are determined by considering unit material costs.

3. CONCLUSION

The outer shell, moisture barrier and thermal liner combination affect the performance of firefighters' protective clothing dramatically. It was aimed to form a basis for making effective selection decisions between different fabrics in three layers, in order to produce firefighter protective clothing which is affordable, durable, light, comfortable and resistant to heat and flame.

In this study for selection of the most appropriate fabric assembly, the fabric combinations were ranked by considering the performances and the costs of materials.

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DEVELOPMENT OF A VERY HIGH TENACITY DENIM FABRIC FOR MILITARY AND SPORTS USES

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Abstract: *The classical protective fabrics for military and sports purposes have uncomfortable an unpleasant appearance as well as tactile properties. In contrast to these facts, denim fabrics posses rather comfortable touch and pleasant look whilst lack of protection against sharp edges as well as long lasting friction against rough surfaces. This paper reports the development of a denim fabric with very high tenacity in both warp and weft directions. The developed denim fabric is suitable for military and police force use against sharp objects such as knives and stabs as well as daily use for motorcycle riders.*

Keywords: *denim fabric, high tenacity in warp and weft direction, core-spun yarn*

1. INTRODUCTION

In 1953, Karl Ziegler of the Kaiser Wilhelm Institute (renamed the Max Planck Institute) and Erhard Holzkamp invented high-density polyethylene (HDPE). The process included the use of catalysts and low pressure, which is the basis for the formulation of many varieties of polyethylene compounds. Two years later, in 1955, HDPE was produced as pipe. For his successful invention of HDPE, Ziegler was awarded the 1963 Nobel Prize for Chemistry [1].

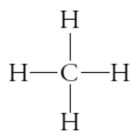
Figure 1-1a: Methane

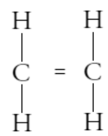
Figure 1-1b: Ethylene

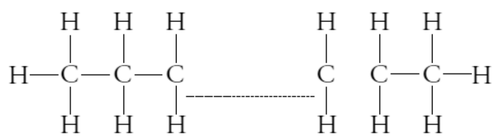
Figure 1-1c: Polyethylene Molecular Chain

Figure 1. Product of HDPE

HDPE (0.941 < density < 0.965) is a thermoplastic material composed of carbon and hydrogen atoms joined together forming high molecular weight products as shown in Figure 1-1c. Methane gas (Figure 1-1a) is converted into ethylene (Figure 1-1b), then, with the application of heat and pressure, into polyethylene (Figure 1-1c). The polymer chain may be 500,000 to 1,000,000 carbon units long. Short and/or long side chain molecules exist with the polymer's long main chain molecules [1].The most attractive properties of this type of fibre are: very high tenacity, very high specific modules, low elongation and low fibre density that is lighter than water [2].

2. MATERIAL AND METHOD

2.1. Preparation of Warp and Weft Yarns

Although all the processing steps involved special care and optimization, only few of these steps will be reported here. HDPE filament yarns with 440 dtex have been wound onto suitable bobbins for feeding to the core yarn spinning process. The outcome of the core yarn spinning process is a yarn where the high tenacity HDPE filament yarn in placed at the core of the cotton yarn. The indigo dying of very high tenacity ropes required very special attention and lowered process speeds without affecting the dyeing quality. The following rope opening, warp preparation, weaving as well as fabric finishing processes has also been optimized.

3. RESULTS AND DISCUSSION

This work involves the development of a denim fabric consisting of very high tenacity indigo dyed warp and weft yarns. Both warp and weft yarns are core spun cotton yarns with HDPE filament yarn cores. Due to the fact that yarns and fabrics involved in this work have extreme tenacities, all steps of the processing should have been adjusted and hence optimized for effective processing.

4. CONCLUSION

The developed work involving all steps of denim fabric production has been carried out with extreme caution and the end result was an extreme high quality denim fabric in both warp and weft direction. The fabric is converted into denim apparel (both jeans trousers and denim tops) for motorcycle riders.

The end result was a causal look denim wear with protection capabilities against sharp knives and to stab as well as long lasting friction against asphalt road surfaces in case of an unwanted motorcycle accident.

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SMART TEXTILES – GAINING MORE FUNCTION BY INTEGRATING ELECTRONICS

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Abstract: *Intelligent Textiles are a combination of textiles and electronics. By integrating sensors, actuators and other electronic devices common textiles are converted into high-tech products which can be used for new applications in the automotive and medical industry etc. The lecture covers the development of new intelligent textiles such as medical devices for the monitoring of vital parameters or lighting modules for automotive applications. Furthermore, new technologies for the automatic manufacturing of textile circuits will be shown.*

Keywords*: smart textiles, actuator, sensor, conductive textiles*

1. INTRODUCTION

Smart textiles are intelligent textiles which

- Record conditions or perceive situations,
- Analyse and interpret them,
- Become active and
- Achieve the desired effect in the user.

The integration of electronics and microsystems technology in textile materials allows a number of additional functions for different applications.

2. TECHNOLOGIES FOR THE INTEGRATION OF ELECTRONICS

Different technologies are suitable for the manufacturing of smart textiles. As the possibilities for the mass production of smart textiles are limited, the research activities at the TITV Greiz mainly focus on the development of new technologies for their continuous manufacturing. In particular, we discuss the construction of special fabrics for lighting and heating applications and solutions for the automatic manufacturing of embroidered electronic circuits.

3. APPLICATIONS OF SMART TEXTILES

Smart textiles can be used for lighting, conducting or heating purposes. Alternatively, they can be applied as sensors or actuators. Many prototypes show the different applications in:

- Car interior
- Medical science, wellness, sports
- Advertisement
- Home textiles, furniture
- Protective clothing for rescuers, school children.

At present, the TITV Greiz is developing smart textiles for applications in medical science, vehicle construction or for protective clothing. Current examples are:

- Textile electrodes for medical applications – glove for the treatment of stroke patients (therapeutical glove)
- Actively luminescent textiles by means of LED or electro-luminescence.

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MEDITISS: HEALTHCARE MATTRESS TICKING FABRICS

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1. INTRODUCTION

Mattresses are very important in healthcare sector and the patient before and after the medical actions/operations takes his/her time over the mattress, sometimes for elder people it take months/years that cause *decubitus*. In existing solutions, market focus on functions like waterproof/water&oil repellence that we can easily see in any hospital nowadays. But the comfort and allergy reduction was the missing point and we focused on that. For the comfort in medical applications you should manage pressure, heat and humidity, and in order not to have additional health problems like allergy on your mattress it should help to reduce allergy. For the new concept; we need to combine and find industrial application processes to realize it. It should include all; allergy reduction function, waterproof, comfortable (pressure relief and heat management). This solution will lead an industrial growth and help healthcare market to improve their quality. WHO (World Health Organisation) declared that there is no product available decreasing allergy yet. But **Purotex®**'s first test results show that it has good reduction effect of allergy. These are patent pending projects and certification to "Asthma and Allergy Foundation of America" is in progress.

2. ANALYSES AND DISCUSSIONS

A) **Allergy reduction effect;** For the allergy reduction effect, we focused on very important problem in an innovative way. What is allergy? Allergy is the over-reaction of the (bored) immune system to harmless substances, called allergens and house dust mite allergy is the allergic reaction against DerP1, an enzyme used by the house dust mite to decompose and digest food (micro skin cells, dander, organic matter). How we can reduce the allergy? We developed our active product "**Purotex®". Purotex®** is not a biocide and unique mix of probiotics. The active system kept in microcapsules and when you lay on your mattress they are broken and they are released into your ecosystem when you need them. So we call it "nature's own technology to reduce allergy".

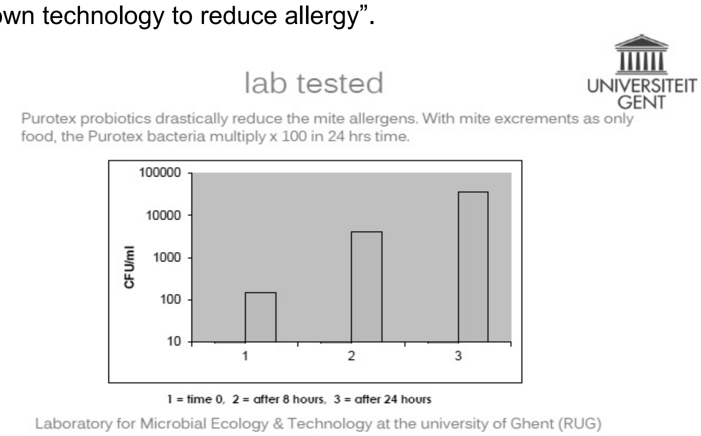

Figure1. The test results of Purotex® in the ecosystem.

B) **Waterproof effect:** This is known application for many years in industry. With the PU film lamination the system is:

Breathable: 700-2000g/m²/24h (ASTM E-96)

Waterproof: > 10.000 mm (ISO811)

C) **Heat Management and Comfort-pressure reilef effect:** With new "**Cairfull®**", a 3D knitted fabric, which is produced in one piece and consists of two layers of fabric and high elastic spacer fibres. Thus a "layer of air" is created which offers a number of advantages increasing sleeping comfort. The material functions as a breathable layer, which combines qualities of moisture regulation with pressure distribution and compensation.

Figure 2 a) **Cairfull®**, 3D knitted fabric
b) **Cairfull®** Meditiss, Top layer: 3D knit, Bottom layer: PU Membrane,
c) **Cairfull®** Inside, Top layer: Ultra soft knit, Middle layer: 3D knit, Bottom layer: PU Membrane

3. CONCLUSION

We combined 3D knitting technology, active probiotics and waterproof functionalities with lamination technology and finalise with the Meditiss product "Protect".
This product is also Ökotex 100 Class-1 certificate that you can use for healthcare and babycare applications. And the **Cairfull®** product has been awarded as "High Product Quality Winner" in Interzum2007 and the **Purotex®** has been awarded as "Best of the Best" in Interzum2009.
For further steps we developed our Meditiss range with four different applications:

1- 3D knitted fabrics applied Purotex application, we call it "PURE"
2- 3D knitted fabrics laminated with PU membrane, we call it " SAFE"
3- (1+2) 3D knitted fabrics applied with Purotex and laminated with membrane, we call it " PROTECT"
4- Soft knitted fabric laminated with Nr.3. "CAIRFULL INSIDE"

PURE SAFE PROTECT CAIRFULL ® INSIDE purotex® active probiotics

Key Words: *Mattress ticking, meditiss, probiotics, 3D knitting, lamination, babycare, cairfull, allergen reduction*

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BOTANIC SAFETY WITH LENZING FR® DIVAN! – NEW TEXTILE SOLUTIONS FOR TRANSPORTATION

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Lenzing FR, an inherently flame-resistant cellulose fibre, was developed over 30 years ago.

With the totally new DIVAN fiber Lenzing is setting new standards for seat covers in aircraft, railway vehicles and ships, as well as for technical applications such as fire blockers and insulation felts.
DIVAN fiber is a cellulosic fiber produced out of beech wood, a natural and sustainable raw material source.

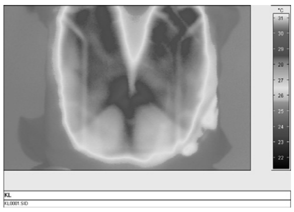
Products made with DIVAN fibres are permanently flame resistant, with no topical FR treatments needed. They have no toxic fumes, unmatched seating comfort and functionality, are washable, and are aesthetically pleasing with their brilliant colours. The flame resistance is so durable that it can't be removed, be it by trough washing, abrasion, chemicals, or other mechanical influences: no additional flame resistance treatments need to be applied. Seat covers made out of DIVAN are wet-washable and can also be dry-cleaned.

Other flame retardant treatments, which are currently the industrial standard for aircraft upholstery fabrics, contain chemicals that not entirely compatible with environmental soundness and alter the good properties of the natural raw material. The DIVAN pigment is based on an organic substance and is environmentally sound, biodegradable and contains no halogens, brominates or anti-monies. In fact the DIVAN fiber is according to the USDA label, the world's only Biobased FR fiber.

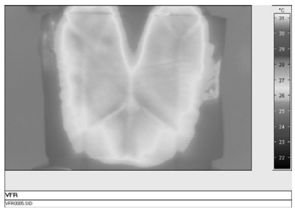
[Iberia equipped with Lenzing FR® Seating Fabrics]

Taking into consideration that a third of the human body surface from a seated person is in constant contact with the seat, the functional properties of the fabric plays an important role to provide comfort to the passenger. Many hours are spent sitting during a journey. This causes body moisture and heat, which often greatly affect seating comfort. The fabric feels hot, damp, clammy and uncomfortable. The functional effect was originally developed for sports wear. The idea was to support and increase the performance of the person wearing the sports wear by using materials with different properties that provide, for example, better moisture and heat management and body cooling, and are more comfortable than standard items on the market.

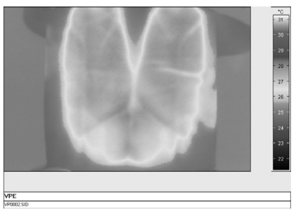
A similar effect is achieved by using fabrics made of DIVAN and wool. DIVAN absorbs the vapours and releases them very easily. Wool supports the transport and even has a very unique property. It absorbs moisture and doesn't feel wet. Additionally, it is important that the body is kept at an optimal temperature, which is also responsible for the comfortable feeling. DIVAN prohibits the accumulation of heat, and due to this, provides properties for ultimate seating comfort.



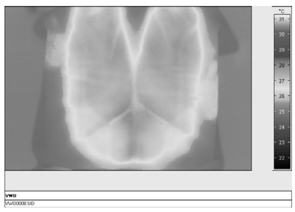
Leather



Lenzing FR®



FR PES



FRT WOOL

World-leading seating fabric manufacturers are now developing and offering fabrics that fulfil the flammability requirements of the aviation industry and show excellent seating climate and non-toxicity. Moreover, these products are biodegradable, do not melt when exposed to heat or flames, and are highly comfortable. These fabrics offer a lot of additional benefits to passengers, as well as the public transportation companies in general.

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2BFUNTEX : TRANSFER OF RESEARCH INNOVATION ON FUNCTIONAL TEXTILES TOWARDS INDUSTRY

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Abstract: *2BFUNTEX is a European Coordination Action with the objective to bring together all innovation actors in the field of functional textile structures and textile related materials, fostering a multidisciplinary approach between universities, research institutes, industry (especially SMEs) and sector associations. The 2BFUNTEX international 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 will be mapped, new joint international research disciplines will be identified and multidisciplinary laboratory teams will be created. 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. 2BFUNTEX partners will organise and participate in conferences, workshops and brokerage events. Through the development of an interactive website with an extensive database, collaboration will be boosted and rapid industrial uptake catalysed and enhanced.*

Keywords*: functional textiles, coordination action, industrial uptake, boosting efficiency, linking innovation actors*

1. INTRODUCTION

According to a recently published study focussing on textile research in Europe [1], the Textile and Clothing/Garment industry in Europe is one of the most important innovative manufacturing sectors. For many decades, the global industry has undergone a remarkable change, especially in Europe. Starting with classic and traditional applications such as clothing/garments, fibre-based materials are used in many industries today. Architecture, geology, landscaping, environment, automotive, aircraft engineering or medicine/healthcare are just some of the current areas of application. Technical textiles are materials and products manufactured primarily for their technical performance and functional properties rather than their aesthetic or decorative characteristics. Textile technology therefore gains understanding and acceptance and its resultant perspective features are recognized: diversity, compatibility, flexibility, interactivity, productivity and *functionality*.

2BFUNTEX 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".** This project deals with closing the gap between research and industry in this field. 2BFUNTEX will bring together researchers in different complementary research areas to allow enhanced development of functional textiles through collaboration at European level. Involving industry at all stages of the coordination action envisages the industry oriented approach of the project. The involvement of industry in defining research activities aims at enhancing the rapid uptake of innovation by SMEs.

2. OBJECTIVES

2.1. Main aims

- To be the **market place for all stakeholders** involved in functional textile structures and textile related materials to allow the traditional textile sector to move away from traditional products to speciality products.
- To develop a **platform for current and future actions** in research, education and technology transfer to support the textile industry in the most efficient and effective way to transform into a dynamic, innovative, knowledge-driven competitive and sustainable sector.
- To enhance **transfer of the knowledge** available at universities and research institutes to industry to **favour rapid industrial uptake**.

2.2 Scientific & technological objectives

- ***Collecting all relevant information*** related to ongoing research and activities and industrial needs in the field of functional textile structures and textile related materials;
- ***Detection of synergies and gaps and the creation of project ideas***;
- ***Development of an interactive database***;
- ***Training and education*** to increase the number of well-trained students and well informed people working in industry;
- ***Dissemination activities*** : organisation of conferences, workshops (for SMEs), brokerage events, training courses, … ;
- ***Creation of multidisciplinary project teams*** performing research in the field of functional materials and oriented towards *industry* aiming at the creation of new business worldwide.

3. CONSORTIUM

The 2BFUNTEX consortium includes 26 partners from 16 European countries deputizing 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 some national innovation agencies and governmental chambers of industry and commerce.

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

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RETHINKING OF CUSTOMARY DISPOSABLE NONWOVENS INTO NOW GREEN, DURABLE, BIODEGRADABLE AND COST-EFFECTIVE NONWOVENS

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Aim of the Research:

To explore new technology for efficiently producing nonwoven fabrics that, unlike the traditional one-use-disposable nonwovens, are durable in multiple uses, *green* to produce, easily biodegradable to complete their environmentally-safe life cycle, and, finally, cost-effective, as well.

Research Approach:

To investigate the feasibility and development of efficient replacement of existing, *non-green* manmade fibers, which most often are used today in the one-use disposable nonwoven products such as the work uniforms, lab coats, undergarments, wipes, kitchen crafts and tools, and certain hygienic/sanitory products, with natural fibers that are renewable, cost effective, and environmentally-safe to produce, use and dispose.

Materials and Methods:

Natural fibers of cotton, flax and jute, in that order, were considered for possible and at least partial replacement of certain synthetic and manmade fibers, such as polypropylene, polyester and rayon. This presentation only describes the research work done on the cotton fiber.

Light- and medium- weight nonwoven fabrics of 100% cotton were produced using greige (non-bleached) raw cotton that typically is cost effective compared to bleached cotton, using a state-of-the-art hydroentanglement (H-E) system, along with a commercial-grade web/batt formation system, of directly converting a fiberous cotton material (web/batt) into a strong woven-like, nonwoven fabric [1,2,3]. The H-E system was optimized to efficiently process greige cotton into a nonwoven fabric that did not require the traditonal chemical process of scouring (similar to the scouring of raw wool), which is costly, time-consuming, cumbersome and, above all, environmentally-sensitive. Figures 1, 2 and 3 show the commercial-grade, fiber processing equipment used to convert the fibers into nonwoven fabrics.

For the field biodegradation study, cotton, rayon, polyester, polypropylene, and PLA (polylactic acid) nonwoven fabrics were cut into 25 × 25-cm units and placed in tulle having 1 × 2-mm mesh openings. The tulle, which was resistant to degradation, was used to hold the fabric specimens intact as much as possible during the degradation process. The enclosed fabric samples were buried in a Captina silt loam soil (fine-silty, siliceous, active, mesic Typic Fragiudult) that had been tilled to a depth of 15 cm. The fabric was buried at a depth of 10 cm and oriented parallel to the soil surface. Plots were maintained vegetation free by an application of the herbicide Roundup®. At 7, 14, 21, 28, 63, 98, and 140 days, five replications of each experimental fabric were carefully excavated, lightly brushed to remove soil particles, dried to a constant weight at 55 ºC, and a representative subsample of the fabric ashed at 650ºC. All fabric weights were reported on a dry, ash-free weight basis. The initial weight of the fabrics at 0 days also was determined. During the field study, mean soil temperature at a depth of 10 cm was approximately 25 ºC and ranged from 14 to 34 ºC. Optimal soil moisture of approximately -33 kPa, which corresponded to 18% gravimetric moisture, was maintained through rainfall and supplemental irrigation during the study. The resulting fabrics were examined to determine how their mechanical and physical properties changed with burial time.

PICTORIAL VIEWS OF THE MAJOR NONWOVENS EQUIPMENT AT SRRC-ARS-USDA, NEW ORLEANS, LOUISIANA, USA

Figure 1. Needle-punch Line (TechnoPlants, Italy.)

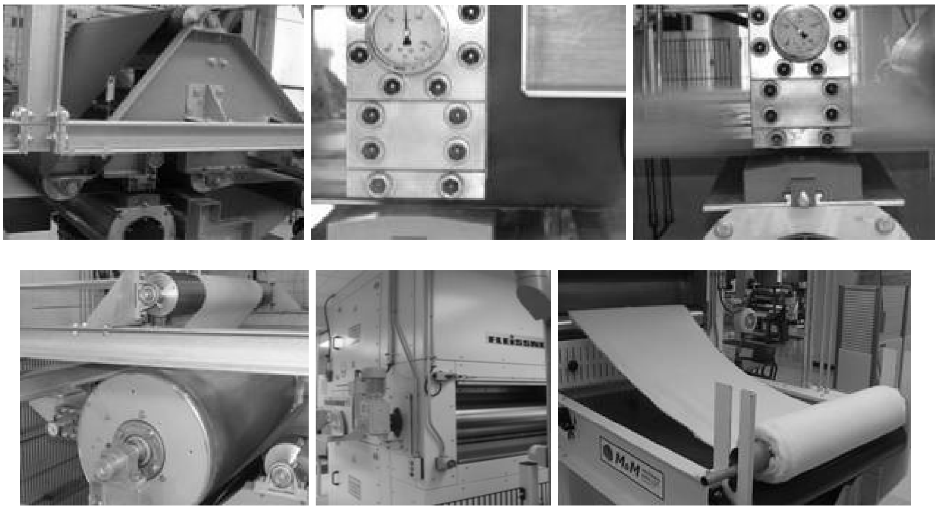

Figure 2. Hydro-entangling Line (Fleissner, Germany)

Figure 3. An overview of the new Mathis (Swiss) textile finishing laboratory

(The Mathis lab currently is comprised of the following equipment: 2-Roll Padder; High Temperature Overflow Jet Dyeing Apparatus; Jig Dye Machine; Continuous Oven/Dryer; Laboratory Pad-Steam Range; Electric 2 Roll Calender; Lab Dryer (small samples); Lab Steamer (small samples); and preparation area for chemical recipes, formulations, etc.)

RESULTS

The nonwoven fabrics were tested for the desired properties before and after repeated cycles of household machine washing and drying. Table 1 shows the test results obtained [4,5,6]. As seen, the fabrics, especially after the first wash, have their desired properties reasonably intact even after 20 laundering cycles, which thus far has been generally unheard of in case of the traditionally disposable nonwoven end-use products that predominantly are made with the *non-green*, manmade fibers and are discarded after one use only. Although the above properties of the greige cotton, greige (unfinished) nonwoven fabrics studied in this work are not yet ideal when measured with a yardstick for woven fabrics, it is encouraging to note that when the greige fabric was finished with a conventional durable-press finish (used for woven fabrics), the fabric properties, including the Durable-Press rating, were almost as consistent as generally seen in a similarly finished woven fabric. The research to further improve the processing and functional properties and performances of cotton-based nonwoven fabrics is continuing via. applications of other special fabric finishes, such as the flame-retardant and antimicrobial finishes, using the conventional bulk-solution methods as well as the new, layer-by-layer, non-bulk deposition of the required chemicals formulations and treatments.

Table 1. Test results of the cotton nonwoven fabrics before and after the repeated laundering cycles.

	Control	Std. Dev.	1 Wash	Std. Dev.	5 Washes	Std. Dev.	10 Washes	Std. Dev.	20 Washes	Std. Dev.
Weight *(g/m²)*	68.8	3.90	------	------	------	------	------	------	------	------
Weight loss *(%)**	------	------	1.04	0.15	1.37	0.09	1.19	0.15	2.26	0.29
Thickness *(mm)*	0.62	0.02	0.89	0.04	0.99	0.06	1.00	0.04	1.07	0.07
MD Tensile Strength *(N/50 mm)*	100.98	6.49	77.49	5.06	75.23	5.12	73.76	4.87	74.96	4.83
MD Elongation *(%)*	38.92	2.73	62.07	3.07	66.12	2.72	64.49	2.82	62.29	3.20
CD Tensile Strength *(N/50 mm)*	125.29	12.40	121.72	8.78	114.88	10.24	113.10	6.91	111.28	8.17
CD Elongation *(%)*	40.20	3.01	49.91	1.86	50.16	2.47	50.64	2.56	51.10	2.10

** The weight loss was calculated based on the weight of the original (unwashed) material. "MD" Tensile Strength stands for the breaking strength of the fabric in the (producing) machine direction and "CD" stands for the fabric strength in the latter's cross direction (widthwise).*

In a separate study [7], the biodegradability of nonwoven fabrics made with cotton, polyester, polypropylene PLA and rayon fibers was investigated according to established test methods and it was found that the cotton fabric degraded and totally disintegrated within 21 days, whereas the synthetic nonwoven fabrics showed little to no biodegradation after 140 days. the time it took for some of the other-fiber fabrics. Table 2 shows the data revealing the said statement above. As seen in the SEM images shown in Figure 4, the cotton fibers are significantly degraded after 21 days, while the polypropylene fibers generally remain intact after 140 days.

Table 2. Biodegradability of natural-fiber and synthetic-fiber fabrics

Fiber content of Nonwoven Fabric	Fabric still present after soil burial time (days)						
	7	14	21	28	63	98	140
Cotton	Y	Y	N	N	N	N	N
Rayon	Y	Y	N	N	N	N	N
Polyester	Y	Y	Y	Y	Y	Y	Y
Polypropylene	Y	Y	Y	Y	Y	Y	Y
PLA	Y	Y	Y	Y	Y	Y	Y

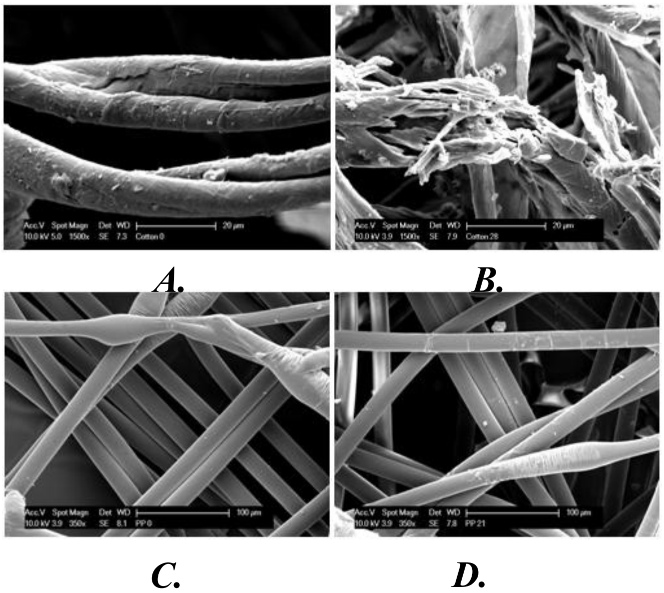

Figure 4. SEM images of cotton (a. 0 days, b. 21 days) and polypropylene (c. 0 days, d. 140 days) nonwovens before and after being buried in soil. The images of cotton were taken at a magnification of 1500X and the polypropylene was taken at 350X.

To further investigate the biodegradation of cotton nonwovens compared to synthetic nonwovens, ATR-FTIR spectra were measured uisng a Bruker Vertex 70 spectrometer equipped with a MIRacle ATR accessory (Pike Technologies) that used a diamond crystal plate as the reflector. All spectra were recorded with a resolution of 4 cm^{-1} and 64 scans. Three measurements were performed on each specimen at different locations on the specimen and the average measurement was used to construct the spectra. As seen in Figure 5, the spectra of the cotton fabric changes with time, while the spectra of the polypropylene, Figure 6, remains constant over the entire duration of the experiment (140 days).

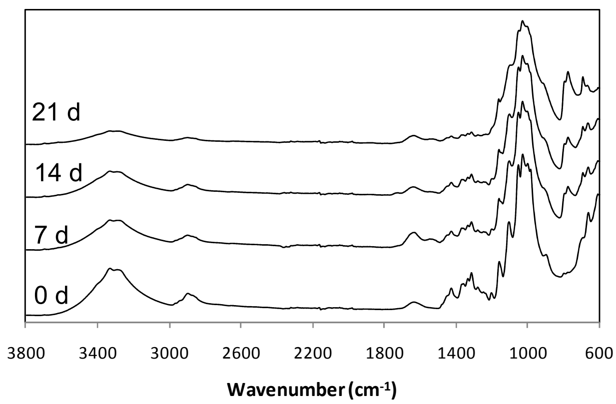

Figure 5. ATR FTIR spectra of greige cotton nonwoven fabrics after soil burial.

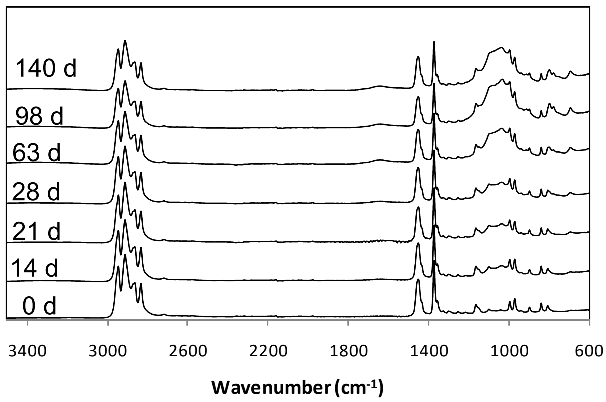

Figure 6. ATR FTIR spectra of polypropylene nonwoven fabrics after soil burial.

Although any comprehensive cost analyses were not within the scope of this work, it may be mentioned that, today and in the near-future commodity contracts, the griege cotton is considerably less expensive than comparable bleached cotton (that often is used in part in some nonwoven fabrics for wiping, work uniforms, medical, and other nonwoven products), rayon and polyester, as indicated in a current – costlier-to-less-expensive -fiber – cost structure given below.

Bleached cotton > Rayon > Polyester > Greige Cotton (least expensive)

CONCLUSION

In summary, the USDA-ARS research presented here at this conference has demonstrated that cotton fiber can be efficiently processed into nonwoven products that are durable in repeated uses and are environmentally safe to produce, use and dispose, which is what the ongoing *"green revolution"* is all about!

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NOTES:

1. The Southern Regional Research Center is a Federal research facility of the US Department of Agriculture in New Orleans, LA.

2. The names of the companies and/or their products are mentioned solely for the purpose of providing information and do not in any way imply their endorsements by the USDA over others.

IMPROVEMENT ON MODE I INTERLAMINAR FRACTURE TOUGHNESS OF STITCHED GLASS/EPOXY COMPOSITES

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Abstract: *This research examines an improvement of Interlaminar Fracture Toughness (IFT) properties of multilayered 3D textile composites by using through thickness bridging techniques as reinforcement. Stitching was used as the crucial technique of reinforcement, and an alternative stitching technique was used beyond the existing stitching techniques.*

Keywords: *mode I interlaminar fracture toughness, delamination resistance, stitching, glass/epoxy composite.*

1. INTRODUCTION

Fibre reinforced composite materials generally consist of 2D textile fabrics. Because of their weak through thickness mechanical properties, they substantially suffer from interlaminar delamination when exposed to out of plane loading. To improve the interlaminar delamination resistance of laminated textile composites, universally braiding, knitting, 3D weaving, and stitching were used as a through thickness reinforcement. Among these reinforcement techniques, the researchers have concluded that stitching technique is an effective reinforcement technique to catch crack propagation and to prevent delamination interior to the laminated composites [1-3].

2. EXPERIMENTAL

In this experimental work, the preform panels were used for producing laminate samples consist of 8 layers E-Glass fibre fabrics. The preform panel either was stitched with Nylon 6.6 yarn and S-Glass yarn for Modified Lock Stitch technique on sewing machine, or was stitched with S-Glass yarn for Orthogonal Stitch technique by hand. To investigate the interlaminar delamination resistance (IDR) of glass/epoxy composite specimens, in different stitching steps, two different stitching techniques were used as a through thickness bridging techniques which are commonly used Modified Lock Stitch (MLS) and Orthogonal Stitch (OS) as an alternative method respectively. IDR of each group of glass/epoxy composite specimens, and Mode I interlaminar fracture toughness was measured by using Double Cantilever Beam (DCB) testing method [4].

3. RESULTS AND DISCUSSIONS

For the unstitched composite specimen group, it was observed that crack grows were easily progressed and specimens were effortlessly delaminated through the specimen length. In observation of the stitched composite specimens testing process, it was noted that crack propagation gradually proceeded during the length of the test specimen although they were stitched with different stitch steps in either modified lock stitched or orthogonal stitched specimens. The overall detailed comparison of Mode I interlaminar fracture toughness among the composite specimen groups is illustrated by a bar chart in figure 1.

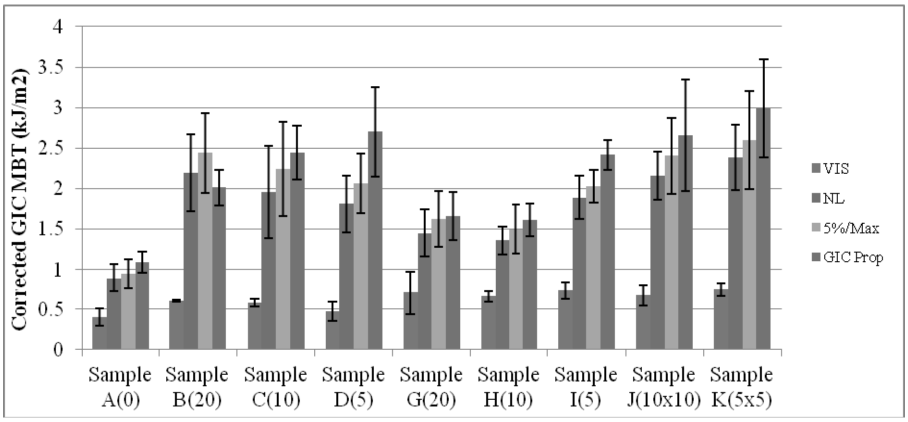

Figure1. The bar chart for $G_{IC\ PROP}$, VIS, NL, and 5%/Max values with their standard deviations for all tested composite specimens groups.

4. CONCLUSIONS

It can be said that the $G_{IC\ PROP}$ value of the orthogonal stitched composite specimen groups increases depending on the number of per stitch columns as they are enhanced and upon length of stitch steps as they are diminished.

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EMI SHIELDING EFFECTIVENESS OF POLYPYRROLE COATED GLASS FABRIC

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Abstract: *Many layers of glass fabric was coated by polypyrrole by chemical oxidation polymerization and composite was prepared with epoxy resin. The very low resistance (below 10 ohm/sq) samples were specially prepared by multiple dips. Electromagnetic shielding effectiveness (EMSE) was obtained by open space-TEM cell measurements at 700 MHz and 2.5 GHz, and surface resistivity was characterized from HP high resistance meter respectively. The insertion loss (IL), which is equivalent to shielding effectiveness (SE) and transmission (Tx) loss, decreases with increasing electrical resistance.*

Keywords*: glass fabric composite, electromagnetic shielding effectiveness, polypyrrole.*

1. INTRODUCTION

Electromagnetic waves are emitted by a variety of electrical and electronic appliances which are an integral part of our lives: at work place. The emitted electromagnetic waves may interfere with other appliances and also influence people's health and quality of life and the environment. Numerous medical studies describe the risk to people from constant exposure, for example the tendency of increased cell division speeds as well as affects to the immune system.[1]

Based on the above mentioned risk of health, the question is often raised, whether protection against electromagnetic waves is possible by appropriate clothing. Compared to metalized fabrics, the absorption component of a conducting polymer fabric represents a higher contribution to the overall shielding; metal-coated fabrics shield predominantly by reflection.

An important, useful property of any conductive fabric is its ability to shield against electromagnetic radiation. In this paper, we discuss the properties of conducting polymers, predominantly polypyrrole, deposited onto the surfaces of textile substrates related to EMSE and IL. By coating thin layers of conducting polymers onto substrates, such as fabrics, one overcomes many of the processing problems associated with pure conducting polymers.

2. MATERIAL AND METHOD

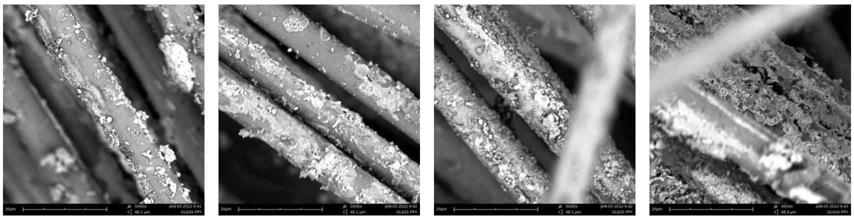
Polypyrrole (PPy) was coated on E-glass fabric 3/1 twill having 54x30 warp and filling per inch, by vapour deposition of pyrrole monomer in the presence of tetraethyl ammonium p-toluene sulfonate (TEA-PTS) as dopant with $FeCl_3$ as an oxidant in the ratio 1:2 respectively.

The morphology of glass fibre before and after PPy coating was characterized by Scanning Electron Microscope (SEM). Surface R_s and volume R_v electrical resistivity [k.ohms] of PPy coated fabric samples were measured by HP® high resistance meter whereas EMSE [dB] was characterized with the help of Agilent®

EMI receiver and an open space TEM cell specially customized for conductive textile substrates.

3. RESULTS AND DISCUSSION

A TESCAN WEGA SEM was employed for morphological studies. At low concentration of TEA-PTS, PPy partially covers the fibre in the form of the particle of micron size Figure 1(a), whereas concentration above deposits patches of PPy on fibre. Further increase in concentration covers whole fibre completely and deposits several layers on the fibre Figure 1(d).



(a) (b) (c) (d)

Figure. 1 SEM micrographs of E-glass fibres after vapour deposition of PPy, (a) to (d) concentration of doping agent was increased from 0.05M to 0.11M.

Figure 2 and 3 show the curve of EMSE against surface resistivity R_s of the E-glass fibre fabric

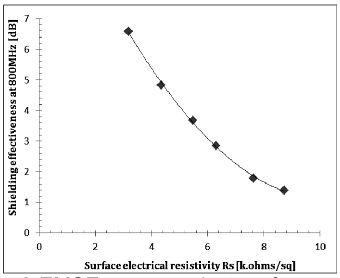


Figure 2 EMSE curve against surface resistivity of PPy coated E-glass fabric at 800MHz

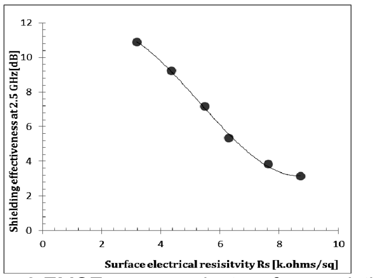


Figure. 3 EMSE curve against surface resistivity of PPy coated E-glass fabric at 2.5GHz

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INJECTION MOULDED PLA COMPOSITES REINFORCED WITH BANANA FIBRE PARTICLES OBTAINED AFTER BALL MILLING

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Abstract: *In the given research paper, banana fibres were first refined to nano/micro scale particles by high energy planetary ball milling in dry condition for one hour. These particles were later added in PLA as reinforcing fillers for preparation of green composites by injection moulding. Various testing methods (tensile, flexural and impact) were performed to investigate the mechanical performance of composites. It was observed that the mechanical properties of composites decreased as a result of addition of banana nanoparticles due to poor bonding with biopolymer.*

Keywords: *ball milling, particle size distribution, banana fibre nanoparticles, biodegradable plastics, mechanical properties*

1. INTRODUCTION

Due to limited availability of petroleum resources and increasing concerns over disposal from clean environment point of view, green composite materials has gained importance in recent years. Conventional petroleum based matrices (polyethylene, polypropylene, etc.) have been rapidly replaced with polymer matrices from renewable resources (poly lactic acid) in nondurable applications and short term products such as load bearing roof systems, framing components, doors, furniture, and automotive interior parts[1].The purpose of the present paper is to explore the reinforcing capabilities of nano/micro scale particles of banana fibres obtained after ball milling in PLA matrix for injection moulding applications [2,3].

2. MATERIALS AND METHODS

2.1 Materials

Banana fibres were obtained from India. Poly lactic acid (PLA 2002D) was purchased from NatureWorks LLC, USA through local supplier Resinex, Czech Republic.

2.2 High energy planetary ball milling

Pulverization of banana fibres was carried out using a high-energy planetary ball mill of Fritsch Pulverisette 7 with zirconia balls of 10 mm Φ for the duration of one hour in dry condition under 10:1 BMR. A particle size distribution of milled material was carried on Malvern Zetasizer Nano.

2.3 Preparation of composites

Standard test specimens were prepared according to DIN EN ISO 527-2 (for tensile test) and DIN EN ISO 179 (for flexural and charpy impact test) using twin screw extruder and injection moulding machine (Allrounder, Arburg, Germany).

3. RESULTS AND DISCUSSIONS

3.1 Effect of ball milling on refinement of banana fibres

After one hour of dry milling, banana fibres were pulverised in multimodal size distribution where most of the particles sized around 1000 nm as shown in Figure 1 and Figure 2. Multimodality in distribution appeared due to increase in temperature during milling which led to sticking of material on wall.

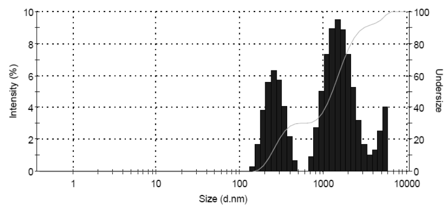

Figure 1 Particle size distribution after one hour of dry milling

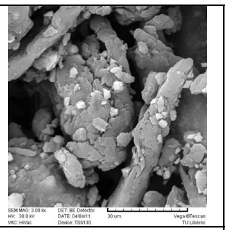

Figure 2. SEM image

3.2 Mechanical properties of composites

The reduction of mechanical properties (Figure 3, Figure 4 and Figure 5) resulted due waxy materials which hindered the hydroxyl groups from reacting with polymer matrices. This led to the formation of ineffective interfaces between the particles and matrices, with consequent problems such as debonding and voids in resulting composites.

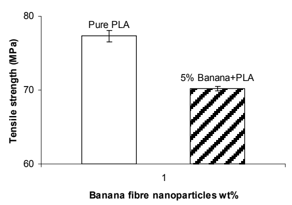

Figure 3. Tensile strength

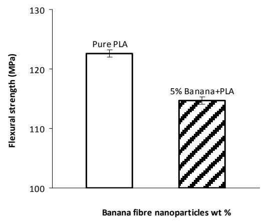

Figure 4 Flexural strength

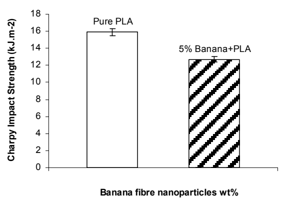

Figure 5 Impact strength

4. CONCLUSION

The addition of natural fibre particles after milling into PLA matrix provides benefits of reinforcement and cost reduction along with easy processability unlike when short fibres added without milling. The reduction in mechanical properties can be improved with surface modification of particles to adjust compatibility with the hydrophobic PLA matrix.

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WOVEN FABRIC SHEAR BY YARN PULL-OUT METHOD

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Abstract:*The aim of this study was to determine fabric shear by the pull-out method. For this purpose, various fabric types were tested. The fabric width/length ratio and the number of pull-out ends were identified as important testing parameters. After the yarn in the fabric was pulled from the top ravel region before the crimp extension stage started, it was found that fabric shear strength increased when the number of pulled ends increased. On the other hand, when the fabric width/length ratio decreased, fabric shear strength increased. Fabric shear rigidity was also identified for each fabric type. It was found that the number of pulled ends and the fabric width/length ratios influenced fabric shear rigidity. Also, shear jamming angles were found to be based on the number of pulled ends. It was considered that the pull-out method was a simple way to define general and local fabric shear properties for various end-uses.*

Keywords*: fabric shear, single and multiple yarn pull-outs, shear rigidity, fabric sample sizes, pull-out fixture.*

1. INTRODUCTION

Shearing allows dry fabric to be formed into complex shapes [1]. It was observed that the largest shear angular deviation was obtained when wrinkles appear [2]. The energy loss of the total work carried out indicated large frictional losses at yarn cross-over points at high normal stresses. Spivak also found that rectangular specimens were better than square specimens due to the latters' tendency to wrinkle during shearing[4]. On the other hand, it was observed that hysteresis occurs when the direction of shear was reversed due to its overcoming the frictional forces that exist in the intersection region between the warp and the weft. Frictional forces always oppose applied shearing force[5]. A shear tester (KES-F) based on the simple shear test principle was developed. Another method used for measuring fabric shear was by bias-extension where a rectangular fabric sample was cut at 45° in the principal yarn directions and uniaxial tensile load was applied to identify the shear angle[8-11]. The aim of this study was to determine fabric shear by the pull-out method and to interpret the shear behavior of various dry fabrics based on the generated data.

2. MATERIAL AND METHOD

2.1. Woven fabrics

Three types of fabric were considered: polyester, para-aramid and E-Glass. Continuous filaments of polyester air-entangled textured yarn were used to produce the woven fabrics. The linear density of this yarn is 33.33 tex and it has 68 filaments in a cross-section. It also has 10/10 cm entanglement. The woven fabric was designed as 1/1 plain. On the other hand, it was constructed with para-aramid type fibers (Twaron® of Teijin, Japan). This fabric was Twaron CT® 714 (CT714); it was plain weave and the densities of the warp and fillings were 8.5 ends/cm. E-glass woven fabric (Cam Elyaf A.S., Turkey) was used. This was made from 2400 tex fibers and was plain weave and the densities of the warp and fillings were 1.6 and 1.8 ends/cm, respectively.

2.2. Pull-out tests for shear

A pull-out fixture was developed to determine fabric shear in the frayed edge of the plain fabric structure under no pre-tension. The fixture consisted of a base to hold the testing instrument. Figure 2 shows the fixture with fabric, and the pull-out test carried out in the testing instrument (Instron 4411). The test speed was 100 mm/min.

3. CONCLUSIONS

The results generated from this study showed that fabric shear could be measured by the yarn pull-out test. Various fabric types were tested to define fabric shear by the pull-out method. Fabric shear generally depends on fiber modulus, yarn linear density, fabric density, fabric interlacement and yarn or fabric surface finish. During shear testing by pull-out, it was found that fabric width/length ratio and the number of pull-out ends were important testing parameters.

Shear strength increased when the fabric width/length ratio decreased, but it increased when the number of pulled ends increased. Fabric width/length ratio and the number of pull-out ends influenced fabric shear rigidity. Generally, when the number of pull-out ends increased, the shear rigidity values increased. On the other hand, when the fabric width/length ratios decreased, the shear rigidity values increased. Therefore, the number of pull-out ends and fabric width/length ratios influenced fabric shear rigidity.

Shear jamming angles were found to be based on the number of pulled ends. The maximum and minimum shear angles were generated by 5-9 and 1 ends, respectively. On the other hand, fabric local shearing properties could be identified by pulling the ends in various regions of the fabric which was especially important for fabric handling during formation. It was concluded that the pull-out method was a simple way to define general and local fabric shear properties for various end-uses.

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MONITORING THE VITAL SIGNALS: SMART GARMENTS FOR TEMPERATURE SENSING SENSOR NETWORKS

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Abstract: *Recently there has been a growing interest in wearable sensors used for monitoring the vital signals of indivudually or group of patients, elderly or newborn, such as ECG, heart rate, body temperature, breathing frequency, etc., and also providing long-term monitoring .*
The goal of this paper is to present a system and service architecture to make use of sensor networks for health monitoring. It has been demonstrated that the sensor integrated knitted fabrics can be used in biotelemetry applications effectively. System architecture uses Zigbee devices to communicate between wearable sensor devices. Sensors measure patient´s temperature and convey the information to the Zigbee devices. For smart garment design, single jersey and 1x1 rib (with and without lycra) have been knitted and capillary wetting, dimensional stability and spirality have been measured and compared to each other. From measurement, best suitable knitted fabric structure for smart garment design has been chosen.

Keywords*: smart garment, temperature sensing sensor network, vital signals, comfort of knitted smart garment*

1. INTRODUCTION

Some of smart products are emerged from the combination of textiles and electronics, so called electronic textiles. They expand the borders for the usage of electronic devices and enable the integration of electronics directly onto the yarns of textile fabrics. With the increased number of the world's aged population, the need for a comfortably wearable system with capability to measure and wireless transmit vital signals is becoming more important. The integration of the sensors to the garment takes the monitoring into a more natural setting which enhances the comfort of the patients and also provides long-term monitoring thus enabling early detection of abnormal conditions and prevention of its serious consequences. Integration of the sensors to the textiles forms the basis for a novel system that can provide the remote control of the patients with the use of the wireless body area network systems (WBAN). WBAN is an efficient way to support noninvasive and pervasive services demanded by future healthcare environments. To monitor the signals in a natural way, there is a need for integrated sensors that are comfortable, wearable and straightforward to use. Textile based sensors which are compatible with textile manufacturing processes are essential for such technology to become accessible. Maintaining the normal tactile properties of the garment when integrating sensors is a prerequisite when the aim is to increase the comfort of the patients [1].

2. MATERIAL AND METHOD

In this paper, we propose a system architecture that uses Zigbee devices to communicate between wearable sensor devices. This sensors measure patient´s temperature and convey the information to the Zigbee devices. Zigbee devices operate in low data rate and ensures low power consumption and long life time. The physical layer and medium access control sub-layer of Zigbee are defined by the IEEE standard 802.15.4. Zigbee uses three unlicensed frequency band. In the current study we used CC2530 wireless Zigbee devices which are produced by Texas Instruments. These devices use 2.4 GHz ISM band at a rate of 250 kb/s. Zigbee network layer allows different network topologies like mesh, cluster-tree and star topologies. Choosing the right topology effect the performance and cost efficiency of the system. In this study, patient to patient communication is not required, that is why mesh network is not needed. In our system model, Zigbee devices on patients communicate with a control point, then these control points communicate each other. For this architecture star topology is very suitable and it is also generally used network topology for WBAN. Besides, the use of a star topology abolishes sophisticated routing algorithms as required by other topologies such as mesh [2].

For smart garment design, different knitted fabric structure such as single jersey and 1x1 rib (with and without lycra) have been knitted and several important comfort and usage properties such as capillary wetting, dimensional stability and spirality have been measured and compared to each other. From measurement, best suitable knitted fabric structure for smart garment desing has been chosen (Table 1).

Table 1. Fabric properties

		Single jersey without lycra	Single jersey without lycra	1x1 Rib without lycra	1x1 Rib with lycra
Capilary wetting	Course %	62	114	53	96
	Wale%	92	130	78	84
Dimensional change	Course %	4,7	3,4	6,5	5,3
	Wale %	3,4	2,4	3,4	4,8
Spirality (degree)		7,4	2	1,4	1

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A RESEARCH ON THE SEWING PROBLEMS OF PROTECTIVE CLOTHES

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Abstract: *In a protective cloth, all the components should possess at least some certain properties to provide a complete protective and/or functional effect. Otherwise the integrity of the protective clothes' properties impairs and although being made of high quality fabric, the cloth can not achieve the total protective property. For this reason in this research, it is focused on one of the latest but the most important processes, namely sewing process.*

Keywords*: sewing problems, protective clothes, seam sealing tape, waterproofness, seam strength.*

1. INTRODUCTION

Protective clothes are produced to protect the wearer against harsh environmental conditions and/or chemical, biological, nuclear or similar threats. Protective clothes such as active sportswear, military clothes, medical clothes and chemical protective clothes are expected to show various functional and performance properties according to their individual application areas. All the cloth components as well as the main fabric should exhibit these performance and functional properties. Otherwise, the properties of the end product will be limited by the weakest cloth component [1]. In this point of view, seams are one of the most important elements that can affect the performance of the protective cloth. The pinholes which are formed during the sewing form hundreds of weak points along the seam line and this can adversely affect some vital properties of protective clothes such as waterproofness and seam strength. To obtain waterproof seams, various seam finishes can be applied. Taping the sewn seams is one of them [2]. For this reason in this study, the influences of taping parameters (taping temperature and feeding speed) on the waterproofness and seam strength of protective clothes are evaluated.

2. MATERIALS AND METHODS

The materials of the study were sewn and seam taped fabrics. Waterproof breathable laminated polyester fabrics for military applications were used as the raw material. The laminated fabric consisted of Polyurethane/Teflon bicomponent membrane and polyester base fabric. The fabric was 135 gr/m^2 in weight.

Test specimens were sewn by a Juki DDL-8500-7 model electronic lock stitch machine. The stitch density was 5 stitches/cm. As the sewing thread, 50 tex core spun polyester thread was used. Seam allowance was 4 mm. After sewing process, the seams were taped by a Pfaff 8302 Weldtronic model hot air sealing machine at 4 different taping temperatures (450, 500, 550 and 600ºC) and with 3 different feeding speeds (25, 30 and 35). Waterproofness and seam strengths of the prepared specimens were determined according to TSE 257 EN 20811 and TS 1619-2 EN ISO 13935-2 standards, respectively. Tests were repeated for 5 times.

3. RESULTS AND DISCUSSION

Results of the experiments are given in Table 1. Taping temperature and feeding speed during the sealing process are abbreviated in the table as T and S, respectively.

Table 1. Mean values of waterproofness and seam strength values of specimens

Specimen/ Test results	Pressure for 1st drop (cm w.c.)	Pressure for 3rd drop (cm w.c.)	Bursting pressure (cm w.c.)	Seam strength in weft direction (kgf)	Seam strength in warp direction (kgf)
Without sewing	944.40	944.40	944.40	91.85	80.99
Only sewn	16.56	19.56	108.16	26.62	9.60
T=450 S=25	241.00	241.00	241.00	30.01	9.02
T=450 S=30	227.20	236.40	236.40	26.62	9.39
T=450 S=35	221.40	221.40	221.40	25.24	8.06
T=500 S=25	48.84	78.02	239.20	29.33	8.77
T=500 S=30	228.20	247.80	247.80	20.70	6.94
T=500 S=35	246.20	246.20	246.20	24.22	7.15
T=550 S=25	28.46	34.26	254.20	29.35	8.07
T=550 S=30	144.84	234.40	259.00	33.07	8.20
T=550 S=35	199.80	216.00	216.00	28.38	8.50
T=600 S=25	18.30	21.30	266.20	33.39	9.68
T=600 S=30	35.92	45.78	272.00	28.34	7.72
T=600 S=35	140.18	172.36	241.80	33.12	8.50

4. CONCLUSION

According to statistical analysis, it was found that the systematic changes of the taping temperature and feeding speed have significant influence on the waterproofness and seam strength of taped seams. Best results for both waterproofness and seam strength were obtained at 450ºC taping temperature and 25 feeding speed. Also, it is recommended to determine optimum sealing conditions for each type of fabric (for coated and laminated fabrics) which will be used in manufacturing protective clothes.

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THE INFLUENCE OF SILVER NANOPARTICLES DEPOSITION ON ANTIBACTERIAL ACTIVITY AND COLOUR CHANGE OF COTTON FABRICS DYED WITH DIRECT DYES

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Abstract: *This study discusses the synergism between loading of cotton fabric with colloidal silver nanoparticles and dyeing with direct dyes. The influence of order of silver nanoparticles loading and dyeing as well as the effect of dye concentration on antibacterial activity and colour change of cotton fabrics was examined.*

Keywords: *cotton, silver nanoparticles, direct dyes*

1. INTRODUCTION

The application of silver nanoparticles to textile materials gained much scientific and industrial attention in the last decade [1-2]. Only small amounts of deposited silver nanoparticles can provide extraordinary antimicrobial activity against a wide range of bacteria, fungi and viruses. However, the yellow shade of the fabrics due to the presence of silver nanoparticles may negatively affect the dyeing effects. Therefore, this study is aimed to discuss the synergism between loading of cotton fabric with colloidal silver nanoparticles and dyeing with direct dyes. The influence of order of silver nanoparticles loading and dyeing of cotton fabrics on their antibacterial activity and colour was explored.

2. MATERIAL AND METHOD

Desized and bleached cotton woven fabric (Co, 168 g/m^2) has been used as a substrate in this study.

Cotton fabrics were loaded with colloidal silver nanoparticles that were synthesised without employment of any stabilizer. The synthesis of colloidal silver nanoparticles was based on the reduction of $AgNO_3$ with strong reducing agent $NaBH_4$.

The fabrics were dyed with C.I. Direct Yellow 86, C.I. Direct Red 79 and C.I. Direct Blue 78. Dyed fabrics were colorimetrically evaluated using a CIE L*a*b* colour system.

Fibre morphology was analysed by scanning electron microscopy (SEM, JEOL JSM–6610LV).

Antibacterial activity was tested against the Gram-negative bacterium *E. coli* and the Gram-positive bacterium *S. aureus*.

The stability of these textile nanocomposite materials in acidic (pH 5.5) and alkaline (pH 8.0) artificial sweat was studied.

3. RESULTS AND DISCUSSION

The presence of silver nanoparticles agglomerates with dimensions of approximately 40 nm was recorded by scanning electron microscopy. Dyed cotton fabrics loaded with silver nanoparticles provided excellent antibacterial properties against both bacteria, independent of dye concentration and order of dyeing and loading of silver nanoparticles. Maximum bacteria reduction was obtained. Colour change of cotton fabrics due to presence of silver nanoparticles was highly affected by the order of operations, certain dye and dye concentration. Colour change was particularly pronounced when dyeing was performed prior to loading of silver nanoparticles. The release of silver nanoparticles in artificial sweat depends on the pH of the sweat as well as on the initial amount of silver in the fabrics. More intensive silver release from the fabrics that were loaded with silver nanoparticles after dyeing occurred in alkaline than in the acidic sweat.

4. CONCLUSION

This study indicated that application of silver nanoparticles to textile materials must be carefully planed and many different aspects should be taken into the consideration. As antibacterial properties are equally good independent of order of dyeing and loading of silver nanoparticles, more attention should be paid on colouristic aspect. Apparently, dye hue and dye concentration should be carefully selected in order to diminish the negative effect of silver nanoparticles on the colour of the fabric.

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DEVELOPMENT OF POLYMER BASED CARBON NANOFIBER PRODUCTION

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Abstract: *The aim of that project is to develop polymer based carbon nanofiber production. Polyacrylonitrile (PAN) based carbon nanofiber is produced by electrospinning and subsequent thermal treatments which are stabilization and carbonization. After carbon nanofiber had obtained, it was characterized by different methods. Production processes are optimized considering datas and parameters.*

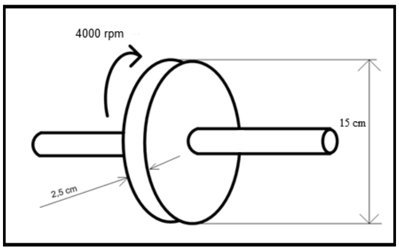
Keywords*: carbon nanofiber, electrospinning, carbonization, polyacrylonitrile*

1. INTRODUCTION

In this work, carbon nanofiber production is performed in three steps. Firstly, electrospinning process is used in order to obtain polyacrylonitrile-based (PAN) nanofiber. High speed rotational collector which is illustruated in figure 1 is employed to take up nanofibers. Then, oriented nanofibers are stabilized under tension to increase crystallinity and provide thermally stable structure during high temperature carbonization process. Finally, carbonization process, which determines the final properties of carbon nanofiber, is implemented. Effect of electrospinning, stabilization and carbonization process on fiber properties and morphology are the subject of this work. The product is characterized in order to examine the properties. SEM (Scanning Electron Microscopy), FT-IR(Fourier Transform-Infra Red), DMA (Dynamic Mechanical Analysis), XRD (X-Ray Diffraction), DSC (Differantial Scanning Calorimeter) are very useful methods to observe the conversion of PAN nanofibers into carbon nanofibers and to determine the fiber morphology.

2. MATERIAL AND METHOD

Electrospinning is used to fabricate nanowebs consisting of PAN nanofibers. PAN copolymer purchased from AKSA Akrilik Kimya Sanayi A.S. is used in the experiments. Oriented electrospun nanofibers which are illustrated in figure 1 is produced by using high speed collector working 4000 rpm of rotational velocity.



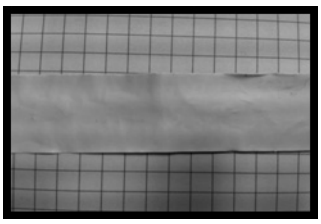


Figure 1. Rotational collector and electrospun PAN nanofibers

Prior to carbonization, stabilization process should be carried out in order to prepare PAN nanofiber to withstand to relatively high temperatures which they would come under during carbonization process. Stabilization is performed in air atmosphere because oxygen is an important gas to initiate the reactions which provide the thermally durable structure for carbonization process. Applying tension to nanofiber is crucial during stabilization to improve properties of carbon nanofibers. Tension mechanism, shown in figure 2, is designed to stretch PAN nanofibers opposite the direction of shrinkage.

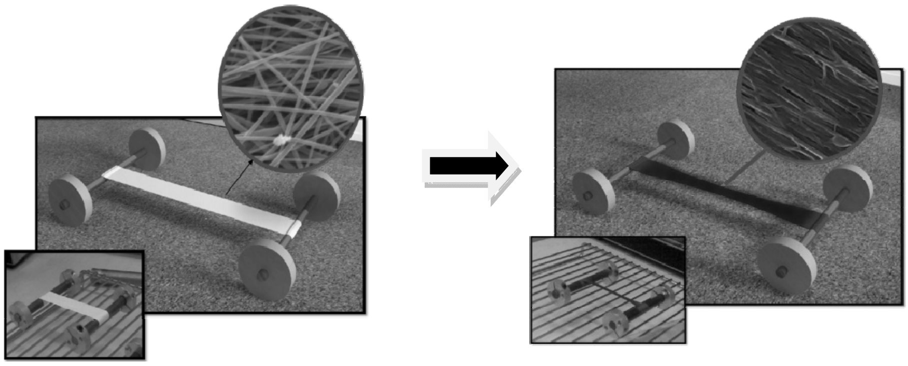


Figure 2. Tension Mechanism

Carbonization is the last step to obtain carbon nanofiber. An inert atmosphere is created using nitrogen gas to hinder undesirable reactions during carbonization which is carried out at high temperatures. Various carbonization recipes are used in order to perceive the effect of carbonization parameters (carbonization temperature, heating rate, pending time) on fiber morphology and properties

3. RESULTS AND DISCUSSION

Effects of electrospinning and carbonization parameters on average fiber diameter, fiber morphology and fiber properties are the subject of this project. Collector speed, needle to collector distance and solution concentration are the determined electrospinning parameters to examine while the stabilization and carbonization parameters are temperature, heating rate and duration. Carbon nanofibers produced at 1200 °C did not give a significant peak under FT-IR analysis and this means that the honeycomb structure is obtained at that temperature. Carbon nanofibers with minimum avarage diameter of 66 nm are obtained.

4. CONCLUSION

Carbon nanofiber manufacture is eventuated in three steps. Firstly, PAN nanofibers are produced by one of the cheapest and easiest nanofiber production methods, electrospinning. Then, PAN nanofibers are stabilized and carbonized with varying recipes. At 1200 °C PAN nanofibers are mostly converted into carbon nanofibers.

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THE EFFECT OF FABRIC SURFACE PROPERTIES AND SWIMSUIT DESIGN ON SWIMMER'S PERFORMANCE

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Abstract: *In the early days of organized swimming, swimsuits were designed only to cover the body. However, as competition intensified, attention turned to finding a swimsuit could lead to higher speeds with lower hydrodynamic resistance such as drag force. The factors which reduce the drag force are the surface resistance, the swimmer projected area, the vortex generator and the bouyant force. This study was conducted experimentally using Drag Force Measuring System to measure the drag force for different samples. The samples were prepared using two weft knitted fabrics. The statistical analysis of results showed the fabric surface properties and swimsuit design affect the swimmer's performance.*

Keywords: *swimming, swimsuit, fabric surface properties, weft knitted fabrics, drag force measuring system*

1. INTRODUCTION

Almost over 90% of swimmer's energy is spent to overcome hydrodynamic resistance during forward motion. Hence, the swimsuits might play a key role in reducing the hydrodynamic resistance such as drag force [1]. In the early days of organized swimming, swimsuits were designed only to cover the body [2]. In the early 18th century, wool and flannel were chosen as a swimsuit fabric. After the World War II, Nylon replaced the silk and wool in major events' competitive suits [1]. However, as competition intensified, attention turned to finding a swimsuit could lead to higher speeds [2]. In 1990s, swimsuits continue to evolve to mimic skin and the Lycra was introduced. In 2000s, Speedo lunched the full-body Fastskin swimsuit based on so called Shark Skin mimicked in V-shape ridges. Since 2008, almost all major manufacturers introduced full-body swimsuits made of polyurethane combined with Lycra fabric such as LZR Racer [1]. Many studies formed to find faster swimsuits with lower hydrodynamic resistance, different strategies used. As a concolusion these strategies can be summerise in four groups:

The surface resistance; full-body swimsuit with small drag coefficient which is smaller than the skin drag coefficient reduces the drag force [3].

The swimmer projected area; Tight swimsuits compress the body, so the projected area would be decrease which reduces the drag force [4].

The vortex generator; While swimming in the laminar flow, swimmer is in contact to a large amount of water which must be moved, but in turbulent flow the volume of water in contact to the swimmer decreases. Grooves on the fabric surface can provide this desired turbulence [5].

The bouyant force; The buoyant force (buoyancy) and bodyweight form a force couple that creates a torque that tends to disrupt streamline. If the bodysuit increases the amount of the buoyant force, or shifts the point of application toward the feet, it could have a drag reducing effect [5].

The study was conducted experimentally using Drag Force Measuring System to measure the drag force of different samples.

2. MATERIAL AND METHOD

Two weft knitted fabrics have been selected for this study. Two simple samples were made with these fabrics to study the effect of fiber. A creased sample was designed to study the effect of clothing design. In order to investigate the effect of fabric cut direction on drag force, another sample was prepared, see table 1. The speed of all experiments was 0.4 m/s. Each experiment repeated 15 times.

Table 1. Properties of different samples

Sample code	NL	NLC	NLW	PE
Fiber Kind	Nylon-Lycra	Nylon-Lycra	Nylon-Lycra	Polyester
Design	Simple	Creased	Simple	Simple
Cut Direction	Course	Course	Wale	Course

3. RESULTS AND DISCUSSION

The results statically were analyzed using SPSS (ANOVA). The drag force for various samples were significantly different. The results showed the fabric properties and swimsuit design affect the drag force.

Table 2. Drag force data for different samples

Sample code	NL	NLC	NLW	PE
Drag force *(N)*	3.01 *N*	3.51 *N*	3.11 *N*	3.31 *N*

4. CONCLUSION

The results of this study indicated that the kind of fiber has significant effect on drag force. Also the drag force of the creased sample is more than the simple one and the direction of cutting has significant effect on the drag force and wale direction leads to more drag force. The results show the importance of fabric surface properties and swimsuit design on swimmer's performance, so clothing engineering and technical clothing design can play a key role in sport engineering.

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DEFORMATION PROPERTIES OF KNITTED FABRICS SUITABLE FOR SPORTSWEAR

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Abstract: *Deformation of fabrics is a topic that many researchers have been studied for years. To produce the fabrics which will be suitable for customer demands and to predict fabric performance before usage and deformation is very important. This study aims to examine the deformation properties of knitted fabrics suitable for sportswear. Three different test methods comparing the stretch abilities of fabrics were used for this purpose and 12 knitted fabrics having elastane yarn were tested. As a result, comparative analysis has been made between these three methods and all the test results were discussed according to customers' opinions.*

Keywords: *sportswear, elastane, deformation, knitted fabric*

1. INTRODUCTION

Knitted fabrics are more elastic structures when they are compared with woven fabrics and because of their elastic nature they are especially preferable for clothing like sportswear. During daily activities or sport activities, fabrics permitting physical activity in a comfortable way are desired. Stretch of fabric in a desired value and recovery after deformation is very important. Repetitive movements of the body and different extension abilities between skin and garment restrict the movements of wearer during usage and a physical problem occurs or an undesired appearance occurs on garment and this difference becomes an esthetical problem.

Many researchers studied on this topic by examining the deformation problem from different views [1-12]. The objective of the work is to compare the deformation characteristics of elastic knitted fabrics by using three different methods and to evaluate the stretch and recovery properties of sports fabrics.

2. MATERIAL AND METHOD

12 knitted fabrics suitable for tights as sportswear were used in the experimental study. The test fabrics were selected from commercially common types for the customers. The raw materials of the test fabrics were different according to the fabric types and all of them were knitted with punta di Roma by using elastane yarn in all structures. Three different test methods were used to examine the deformation properties of the test fabrics. M&S P15 A test method were used in the experimental study because of its being a common method amongst many companies. Bursting tester was used to obtain a spherical deformation on fabrics to simulate especially deformation on knees as a second test method. As a third method, artificial arm [12] was used to evaluate the deformation properties of knitted fabrics by making a number of cycles to any desired deformation angle.

3. RESULTS AND DISCUSSION

In Figure 1, the deformation characteristics of test fabrics according to the test methods used in the study were given.

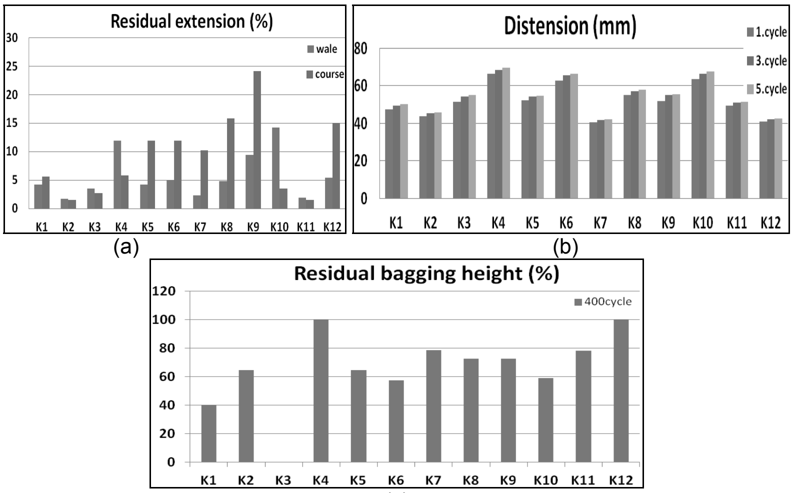

Figure 1. Deformation characteristics of test fabrics according to the test methods used in the study (a)M&S P15A, (b)Bursting tester (c)Artificial arm with human elbow

As seen in Figure 1, there are similarities and differences in test results between the fabrics according to the test methods. Generally, it can be said that the test fabric coded as K3 (contains viscose, poliamid, elastane fiber) has less residual deformation while K9 coded fabric (contains cotton, poliamid, elastane fiber) having generally higher deformation values amongst the other fabrics. When K4 coded fabric is examined, it is possible to say that according to M&S P15 A, it has a less residual deformation although this fabric has a higher value of residual bagging height amongst the other fabric types.

4. CONCLUSION

It is very important to understand the deformation behaviour of fabrics suitable for garments and to predict the deformation properties before customer is crucial. By comparing the results of different test methods, it may be possible to evaluate fabric properties with a reliable way. By making this kind of researches, it will be possible to find out the willing stretch and recovery properties of sports fabrics.

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MEASUREMENT OF SOCK-SIMULATED HUMAN LEG FRICTION PROPERTY IN AXIAL DIRECTION IN SPORTWEAR APPLICATIONS

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Abstract: *Friction coefficient of fabrics against skin surface is an important factor in sport clothing comfort. In this study measurement system was developed and the friction force between sock and human leg was measured in an axial directional cylindrical surface of the simulated leg and then coefficient friction in axial direction of the cylindrical surface calculated. In this experiment the influence of various conditions on the friction coefficient were investigated. Results show that speed factor has no significant effect on the friction coefficient while it is considerably dependent on diameter of the simulated human leg for the same sock.*

Keywords: *friction coefficient, sport socks, skin*

1. INTRODUCTION

Several previous studies for investigation of fabric-skin friction property have done in which using various methods fabric-skin frictional force on the flat surfaces or in radius direction of the curvature surfaces have been measured. There is no methodology for measuring friction in axial direction of the cylindrical surfaces. The aim of this research is present a suitable instrument for measurement the friction in axial direction of a cylindrical surface by simulating human leg.

2. MATERIAL AND METHOD

2.1. Developing the friction force measurement system

As shown in figure 1 the proposed friction tester consisted of Instron strength-elongation tester, simulated human leg in which fixed on the lower jaw of the Instron device, and force stabilizer frame.

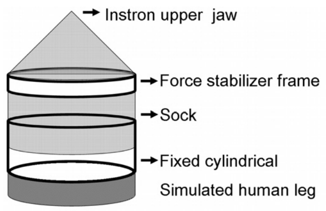

Figure 1. diagram of the measurement system

2.2. Preparation of the material

Experiments conducted on a set of knitted sock fabrics with 120 cm^2 stitch density and sample width average of 8.5 cm. For simulating various sizes of the human leg, teflon cylinders of 6, 8 and 12 cm in diameter were used. Several materials such as polyurethane films and silicone have been used for mechanical model of the skin until now [1, 2and 3]. For simulating fabric-skin frictional interaction a foam sheet was used as mechanical model of the skin. Before Instron moving up, the pressure between sock and human simulated leg was measured.

2.3. Experimental

Friction experiments were conducted in various test conditions consisted of: the movement speed of the Instron upper jaw, the diameter of the simulated human leg, and the elongation of the socks for various cylinder diameters. The displacement distance of the Instron upper jaw and its corresponding friction force were recorded during each test conditions.

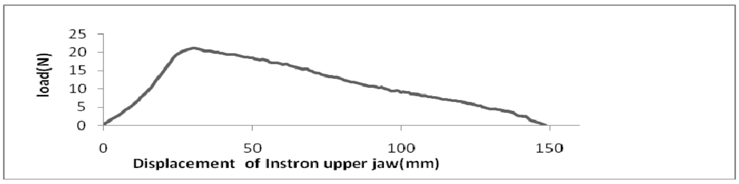

Figure 2. A sample of force-dispalcement curve

3. RESULTS AND DISCUSSION

For calculating the friction coefficient between sock and simulated human leg, the curve of the force-Instron upper jaw movement was changed to the curve of the force-sock residual length. The friction coefficient of the cylindrical surface was calculated using the new curve from equation:

$$F = 2\pi r P \mu X$$

Where r is the simulated human leg diameter, X is the sock residual length, P is the pressure between sock and simulated human leg, and F is the force resulted from the Instron recorded curves. Results from statistical analysis showed that speed has no significant effect on the friction coefficient in a constant diameter and with change of the simulated human leg diameter in a constant speed, the friction coefficient considerably changed.

4. CONCLUSION

In this study a new device is designed to measure the sock-simulated human leg friction force in an axial direction of a cylindrical surface.

The proposed measurement instrument can play an effective role in sport clothing engineering and technical clothing design.

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CHARACTERISATION OF ENERGY GENERATING POLYAMIDE-11 PIEZOELECTRIC MONOFILAMENT

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Abstract: *The work focuses on characterization of polyamide-11 (PA-11) based flexible piezoelectric monofilament. The voltage response of the produced material was investigated under an impact load. Produced filaments were also investigated under Differential Scanning Calorimetry (DSC) and Fourier Infrared Spectroscopy (FTIR) for their thermal and infrared characteristics. The results showed that produced filament material was able to convert mechanical energy to electrical energy. The crystal phase change of the filament was observed in DSC thermograms and FTIR spectrograms of unpoled and poled PA-11 filaments.*

Keywords*: piezoelectric, monofilament, polyamide-11, energy harvesting*

1. INTRODUCTION

The term “smart material” designates a material that shows an extraordinary behaviour in respond to an external stimulus, such as stress, temperature, moisture, pH, electric or magnetic fields. Piezoelectric materials are well known smart materials that can convert mechanical energy to electrical energy and vice versa. This property of some polymers has been widely studied ever since the discovery of piezoelectric effect in polymers [1]. Due to synergistic alignment of the amide dipoles, the odd-numbered monomer exhibits a net dipole moment which contributes the piezoelectric behaviour of odd-numbered polyamides [2].

2. MATERIAL AND METHOD

PA-11 monofilaments were extruded and poled at The University of Bolton. The detailed information about piezoelectric filament extrusion can be found elsewhere [3-4]. Voltage response of a 3-layer test specimen, containing poled PA-11 fibres aligned parallel to each other in between two electrodes, was investigated using Instron Dynatup 9200 series impact test ring. TA Instruments DSC Q2000 equipment was used to analyse the endothermic and exothermic reactions of unpoled and poled PA-11 filaments as a function of constantly increased temperature and Thermo Scientific’s IS10 Nicolet FTIR Spectrometer was used to analyse the spectrographs of unpoled and poled PA-11 filaments. OMNIC software was used to plot the transmittance spectra as a function of wave numbers.

3. RESULTS AND DISCUSSION

The impact test results showed that prepared 3-layer structure was able to produce more than 3V under applied impact by standard impact test ring.

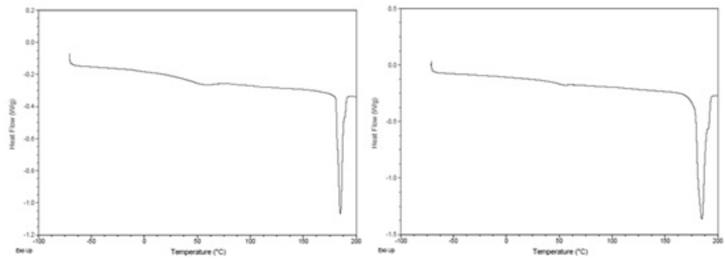

Figure 1. DSC thermogram of (left) unpoled and (right) poled PA-11 fibre

The results obtained from DSC thermograms (Figure 1) show that both unpoled and poled materials have a T_g around +50°C and and T_m around +185°C. However, the melting peak for the poled PA-11 fibre is somewhat broader than the unpoled fibre that may be due to the existence of different crystal polymorphs of the polymer.

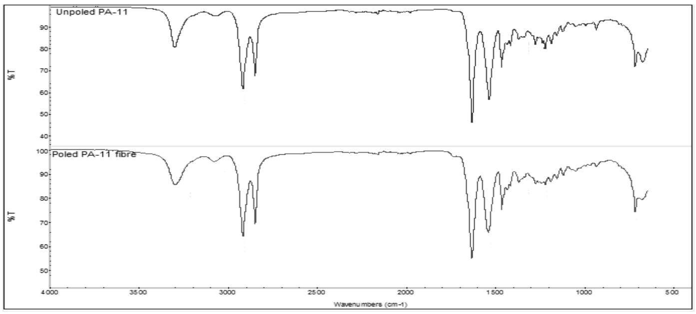

Figure 2. FTIR measurement of unpoled PA-11 granule (purple) and poled PA-11 fibre (red).

FTIR spectograms for both unpoled and poled PA-11 filaments (Figure 2) showed similar peaks but in different intensity levels in the finger print region of the spectra (500 cm^{-1} and 1600 cm^{-1}). These intensity changes explain the change in the molecular structure from non-polar phase to polar phase which determines the piezoelectric effect of the materials.

4. CONCLUSION

Poled PA-11 filaments generated >3V under impact which proves the piezoelectric property of produced filaments. Slightly different DSC thermograms and different intensity levels in FTIR spectrograms showed that poled filament undergoes a phase change from non-polar crystal phase to polar crystal phase.

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MEASUREMENT OF THE ELECTRICAL PROPERTIES OF PIEZOELECTRIC YARNS

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Abstract: *A variety of piezoelectric yarn was deformed under impact and their electrical behavior was monitored. The resultant static voltage produced was measured and recorded. Results were compared between different geometries as well as between different yarn compositions.*

Keywords: *piezoelectric yarns, electrical properties, piezoelectric polymers*

1. INTRODUCTION

Piezoelectricity is the ability of certain materials to produce static electric charges when the material is mechanically stressed. The oppposite applies as well i.e. the material is deformed when an electric charge is applied to it. Piezoelectricity in polymers depends upon alignment of the ferroelectric domains, since in their non-polarised condition polymers do not exhibit piezoelectric properties[1]. This alignment is achieved through poling, by application of a combination of elevated temperature, mechanical strain (drawing) and an exernal electric field [2].

2. MATERIAL AND METHOD

Testing was carried out on two types of piezoelectric yarns, flat ribbon and cylindrical monofilament. Furthermore three different compositions were examined namely PVDF ribbon and monofilament yarns, PP ribbon and monofilament yarns and PA-11 monofilament yarns.

Specimens of various lengths have been prepared. One edge of the specimens was securely fixed by a clamp containing the measuring probe. The other edge was protruding from the clamp and was free to be displaced along the y axis by an impact force. The static voltage waveform produced by the stimulation of a mechanical impact was monitored and recorded by a digital oscilloscope.

3. RESULTS AND DISCUSSION

The values of the electrical voltage produced by each piezoelectric fiber with specific geometry and polymer composition were analyzed. Also the results for different compositions and geometries were compared between fibers. The piezoelectric phenomena have been observed and correlated to the necessary electrical conductivity of the material, since the electrical energy produced must be collected in order to realize the energy harvesting system. Additionally the correlation between the mechanical stimulation and the electrical energy produced has been investigated.

4. CONCLUSION

The piezoelectric effect of the polymer materials enables the production of multifunctional fibres with electrical energy producing properties. The use of the piezoelectric fibres incorporated in the clothes may support the future development of self powered wearable systems independent of external power supplies[3].

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RECENT DEVELOPMENTS IN PLASMA COATING OF FIBERS

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Abstract: *Different fibers are distinguished by their mechanical, physical, optical, thermal and electrical properties. However, not all properties are compatible, for example, high crystallinity goes with low surface functionality, and polymers generally lack of electrical conductivity. Surface treatments are thought to overcome these limitations.*
Plasma processes gain increasing interest as a dry and eco-friendly technology for textile applications. Due to the specific requirements for textile treatments (complex structure, use of sizes, water uptake etc.) plasma treatments occupy so far only a niche market within the textile sector. Even more, the direct plasma treatment of fibers (instead of fabrics) raises the question of its competitive capacity considering processing and costs. Therefore, we evaluate different possibilities of plasma coating of fibers offering chances for innovative textile companies.

Keywords: *fiber coating, plasma polymer, metallization, adhesion*

1. INTRODUCTION

Sustainable growth of the textile industry in developed countries requires a shift toward highly functional and added-value textiles. The demand for tailored surface modifications for water repellence, long-term hydrophilicity, enhanced adhesion, antibacterial properties, etc., is therefore increasing. At the same time, the environmental restrictions concerning waste water produced by conventional textile finishing techniques are becoming more and more severe, generating higher running costs. In this context, plasma processing might become an attractive alternative method to add new functionalities to textiles [1,2]. Plasma processing is a clean (dry) and sustainable technology that generates minimal amounts of waste. It is also characterized by much lower materials and energy consumption in comparison to wet chemical-based finishing methods, potentially resulting in reduced running costs.

Furthermore, plasma processing is very versatile, since it can be used to impart a broad range of different properties, some of which are unattainable with conventional methods [3]. It can also be applied to both individual yarns and fabrics [4]. Finally, because plasma processing results in a nanoscaled surface modification, it has the advantage of preserving the bulk properties as well as the touch of textiles.

Regarding the treatment of fibers, handling becomes simplified by air-to-air processing (winding in air, processing at low pressure). In this respect, we are investigating sputtering processes for the metallization of yarn as well as plasma polymerization processes for the functionalization of fibers.

2. MATERIAL AND METHOD

Pilot-scale plasma reactors for the continuous processing of web and fibers were used for the development of plasma coatings on fibers. The unique fiber coater consists of several separated chambers in order to enable different pressure stages (for air-to-air treatment), plasma pre-treatment and plasma coating by magnetron sputtering or plasma polymerization. For process velocities in the order of 100 m

min^{-1}, the fibers are guided several times through the plasma zone while the fibers are at floating potential.
Two different treatments are discussed: Metallization of fibers with silver (Ag) using magnetron sputtering and amino-functional plasma polymer deposition (a-C:H:N) using RF discharges.

3. RESULTS AND DISCUSSION

For continuous fiber treatments floating conditions, i.e. the substrates are guided through the luminous plasma zone instead of being processed in front of an electrode or substrate holder, were found to be advantageous with respect to process stability, reduced filament ruptures and maintenance cycles. In order to enable good adhesion requiring chemisorption processes, the energetic conditions during film growth have to be taken into account. Those are determined by the energy flux per deposition rate, i.e. the energy density dissipated per atom. Well adherent Ag coatings on fibers can thus be obtained showing excellent electrical, optical and antibacterial properties [4,5].

Permanent functional plasma polymers such as e.g. amino-functional a-C:H:N coatings can be deposited on fibers, as well. 20 nm thick plasma polymers were found to markedly improve the adhesion of e.g. aramid yarn within a fiber-reinforced composite material (pull-out force around 32 N compared to 13 N untreated).

4. CONCLUSION

The properties of plasma coatings on fibers is strongly affected by the energetic conditions during film growth. Optimization of process parameters enable well-adherent, high quality coatings such as silver for conductive yarn or a-C:H:N for amino-functional surfaces, which are of high interest for all kind of unreactive (crystalline) synthetic fibers.

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FABRICATION OF SILVER COATED FIBERS FOR ANTISTATIC AND ANTIBACTERIAL APPLICATIONS

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Abstract: *Various techniques have been developed to functionalize textile materials. Physical vapor deposition can be applied to modify textile materials to create various functions. In this study, we designed a new magnetron sputtering system which is called inverted magnetron sputtering. The surfaces of monoflament (60 dtex) and multifilament (70 dtex, 17 filament) syntetic fibers, such as polyamide, whose diameters are in the range between 60-125 μm, coated with silver. These fibers weaved into fabrics in order to investigate antistatic and antibacterial properties. For characterization optical microscope and SEM images were taken. Besides, XRD, electrical results, mechanical strength tests were done. Besides, the obtained fabrics have potentials to be used for surgery room garments, electromagnetic shielding, radar absorbing materials and infrared camouflage.*

Keywords: *magnetic sputtering, antibacterial, antistatic, conductive fibers, metal coated fibers, silver*

1. INTRODUCTION

Various techniquies have been developed to functionalize textile materials [1]. Physical vapor deposition (PVD) has been applied to modify textile materials various functions and solvent-free process. High vacuum physical vapor deposition method due to its inherent merits, such as environmental friendly properties, to modify and functionalize textile materials started to find new applications. Sputter coating produces very thin metallic or ceramic coatings (nanometer thickness) on to a wide range of substrates, which can be either metallic or non-metallic in different forms [2]. To be defined a fabric as an antistatic it should show 10^6-$10^8\Omega$/sqr surface resistance. For this aim, the fibers were coated with enough Ag to provide antistatic properties. These fibers were weaved in to fabrics, and antistatic and antibacterial properties of these fabrics were investigated.

2. EXPERIMENTAL

We used inverted cylindrical magnetron sputtering system. In order to optimize coating parameters for our system we study on different parameters for pressure, magnetic field and applied power. Depending on these parameters we investigate thin film thickness. The surfaces of monofilament (60 dtex) and multifilament (70 dtex, 17 filament) synthetic fibers, such as polyamide, whose diameters are in the range between 60-125 μm, coated with silver [3]. Our system designed for 3-dimensional continuous thin film coating. Cylindrical magnetron sputtering system has 3 parts. The first one is filament unloading part, second is metal coating cylindrical target area and finally filament loading part.

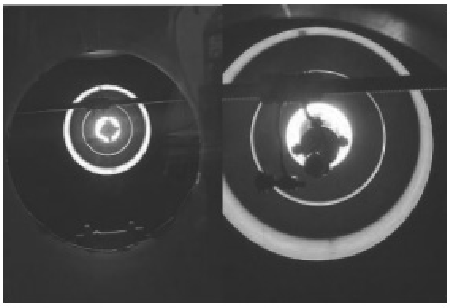

Figure 1. Plasma in Inverted Cylindrical Magnetron Sputtering System

3. RESULTS AND DISCUSSIONS

In this study, we coated the fibers in desired thicknesses with Ag. We reached the value of 10 Ω/cm in coated fibers. The adhesion of Ag on fibers is an important parameter. EN 1149-1 and EN 1149-3 test methods were used for fabrics that contain Ag coated monofilament and multifilamanet fibers. The electrical results of the coated fibers after washing shows that the electrical conductivity persists. After 30 washing, we found that the surface resistivity is sufficient for the antibacterial and antistatic purposes. These experiments were completed for coated monofilament fibers. Furthermore, we also studied coating on multifilament yarns and electrical results of the multifilament fibers are compatible with monofilament fibers.

4. CONCLUSION

The vacuum deposition system can be used for fiber coating. After getting fabrics woven with these fibers, they exhibit antistatic properties.

ACKNOWLEDGEMENT

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SCREEN-PRINTED TEXTILES – THE EFFECT OF AGING AND WASHING ON THEIR ELECTROCONDUCTIVE PROPERTIES

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Abstract: *The emerging of smart textiles in recent years has exposed the necessity for the electroconductive textiles. In this paper the potential method of screen printing textiles with conductive ink is presented. This printing technique is an interesting method because it is flexible and cost effective. The electroconductive properties of the printed textiles were investigated by measuring the square resistance after aging and after repeated washing cycles. To make these screen-printed textiles resistant to washing cycles they were covered with a polyurethane layer.*

Keywords: *screen printing, smart textiles, aging, washability*

1. INTRODUCTION

During the last decade a lot of research is performed in screen printing with conductive silver-based inks on different textile fabrics [1-2] to obtain smart textiles. This method offers flexible and lightweight conductive textiles with excellent electroconductive properties. Furthermore, the printed textiles can find use in different applications such as textile antennas, feed lines or simple one-layer routing structures, electrodes and circuits [3-4]. The problem that this method was facing is the maintenance of the printed textiles in daily life. Therefore, ageing and washing should be studied because the electroconductive properties can change when the textiles are exposed to different conditions. Since the electrical properties were not so good after several washing cycles, it was decided to put a protective layer on top of the conductive layer as a solution for obtaining washable electroconductive textiles.

2. MATERIALS AND METHODS

In this study seven fabrics were selected; Viscose, Polyamide, Polyester, Aramid, Cotton/Polyester 1, Cotton/Polyester 2 and Polyester/Viscose with different physical-mechanical properties.

A commercially available silver-based ink from Acheson was used to print squares of 6 by 6 cm on textile substrates.

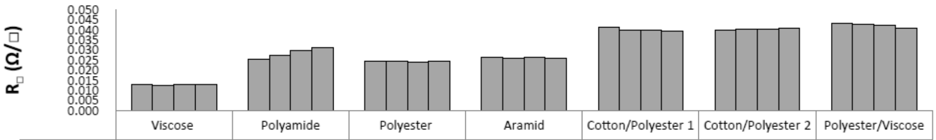
The electroconductive properties of the printed textiles were studied by measuring their direct current (DC) resistance with the Van Der Pauw method.

Ageing is a measure of how much the resistance changes with time/days. The samples were placed in an oven at 60°C for 24 hours. The square resistance was measured after cooling down and this cycle was repeated for 15 days.

To avoid cracks in the printed surface during the washing cycles, and thus lose conductivity, a thermoplastic polyurethane (TPU) layer was put on top of the printed square. Here, the International Standard ISO 6330:2000, programme 8A was chosen for the washing process, which washes at a temperature of 30°C (±3°C).

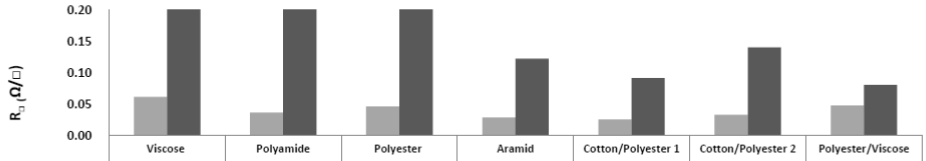
The square resistance was measured before and after repeated washing cycles, up to a total of 60 cycles.

3. RESULTS AND DISCUSSION



	Viscose	Polyamide	Polyester	Aramid	Cotton/Polyester 1	Cotton/Polyester 2	Polyester/Viscose
Before aging	0.013	0.026	0.025	0.027	0.042	0.040	0.044
after 5 days	0.013	0.028	0.025	0.026	0.040	0.041	0.043
after 10 days	0.013	0.030	0.024	0.027	0.040	0.041	0.043
after 15 days	0.013	0.031	0.025	0.026	0.040	0.041	0.041

Figure 1. Square resistance versus time



	Viscose	Polyamide	Polyester	Aramid	Cotton/Polyester 1	Cotton/Polyester 2	Polyester/Viscose
Before washing	0.061	0.036	0.046	0.028	0.025	0.033	0.047
60 times washed	0.270	0.208	0.308	0.122	0.091	0.140	0.080

Figure 2. Square resistance of printed samples covered with TPU (before and after 60 washing cycles)

Figure 1 reveals that the values of the square resistance do not really change versus time/days. After a period of 15 days the electroconductive textiles were not ageing.

In Figure 2 a slight increase in square resistance can be observed after 60 washings, but not as much as without the TPU layer, when half of the samples lost their conductivity. However, all resistance values remained under 0.308 Ω/□.

4. CONCLUSION

The combination of textiles and conductive ink makes it possible to produce flexible, conductive and lightweight ``smart textiles``. The effect of ageing upon the screen-printed textiles are negligible for a period of 15 days at 60 °C.
The square resistance, obtained with the conductive ink on the textiles used, before and after washing cycles are influenced by the amount of ink. It was shown that electroconductive textiles obtained with screen printing ink and protected with a thermoplastic polyurethane layer are suitable for washing up to 60 time.

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MORPHOLOGICAL BEHAVIOR OF NONWOVEN MATERIALS UNDER COMPRESSION LOADING

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Abstract: *Nonwovens have amongst the most complex morphologies in textile materials and they are often being compressed in a range of applications. The morphology of a typical nonwoven is defined in terms of fiber orientation, fiber volume fraction, number of fiber-to-fiber contacts, distance between the contacts, porosity and pore size distribution. In this study, an attempt has been made to predict the morphological characteristics of nonwoven materials under the state of compression. A concept of compression ratio has been introduced in predicting the fiber volume fraction at a defined level of compression strain that has significantly influenced the other morphological characteristics of nonwoven materials. A mechanistic model of pore size distribution of nonwoven has been proposed by updating the structural and morphological parameters under predefined compressive stresses. A comparison has been made between theoretical and experimental pore size distributions of compressed nonwoven fibrous materials.*

Keywords: *compression, fiber volume fraction, morphology, nonwoven, pore size distribution, porosity*

1. INTRODUCTION

Nonwovens have amongst the most complex morphologies in textile materials and it is a result of inherent properties of constituent fibers and difficulty in controlling the effect of numerous process variables involved in their fabrication. These materials are often subjected to various degrees of compression loading in numerous applications including geotextiles, composites, scaffolds, sound absorbers and battery separators. Hence, the morphology of a nonwoven becomes further complex under the state of compression. Some of these morphological characteristics for general fibrous assemblies have been investigated during compression loading.

2. THEORETICAL

In this study, the morphological characteristics of thermally bonded nonwoven materials have been predicted which primarily consists of fibrous network orientated either in random or in non-random manner and the bonds are formed by fusing the constituent fibers. The micro-mechanical models that have been developed for generalized fibrous assemblies' need to be modified by incorporating the characteristics of nonwoven materials. Therefore, we simplified and modified some of the previous theories of compression to suit the present system but comprehending the first principles in important steps.

2.1 Porosity and Pore Size Distribution of Nonwoven Materials under Defined Compression Strain

Porosity in nonwovens is defined as the fraction of voids present in the total volume of the material. In other words, the total volume of the nonwoven should comprise of volume of fiber and volume of the pores or voids. Hence,

$$V_f + \varepsilon = 1 \tag{1}$$

where V_f and ε are fiber volume fraction and porosity of nonwoven material. Consequently, when a compression strain (ξ) is applied, the equation (1) remains valid.

$$\varepsilon(\xi) = 1 - V_f(\xi) \quad (2)$$

The pore size distribution as computed by Rawal et al. [1] incorporates the effect of the compression strain (ξ) by updating the structural parameters. Therefore,

$$F_f(d) = 1 - \left[\left(1 + \omega d + \frac{\omega^2 d^2}{2}\right) e^{-\omega d}\right]^N \quad (3)$$

where $\omega = \frac{4V_f(\xi)K_z(\xi)}{\pi \bar{D}}$ and $N = \frac{T_{g0}}{\bar{D}}$

3. RESULTS AND DISCUSSION

The pore size distributions of thermally bonded nonwoven materials have been theoretically calculated using equation (3) under defined level of compressive stress and subsequently, a comparison has been made between the theoretical and experimental results. In general, a good agreement has been found between the theoretical and experimental results of pore size distribution with the compressive stress, as shown in Figures 1.

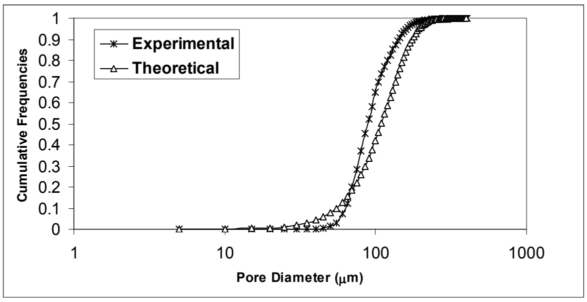

Figure 1. Comparison between theoretical and experimental pore size distributions of thermally bonded nonwoven, TB1 under 0.69 kPa

4. CONCLUSION

In this research work, the morphological parameters of thermally bonded nonwoven materials including fiber orientation, fiber volume fraction, and porosity have been successfully predicted under a defined level of compression strain. It has been observed that the effect of compression ratio on the fiber volume fraction is non-negligible and has significantly influenced other nonwoven morphological parameters namely, porosity, and pore size distribution. A mechanistic model of pore size distribution of nonwoven based on sieving-percolation pore network theory has been modified by accounting for compression loading.

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EVALUATION OF HYBRID YARN'S APPEARANCE BASED ON IMAGE PROCESSING TECHNIQUE

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Abstract: *The aim of this study is to evaluate the appearance of the hybrid yarns containing copper wire. When different metals used bare or in the form of hybrid yarns to produce some kind of functional fabrics, some problems occur depending on the end use form of the product especially in respect of wearing and aesthetic comfort. In this study, copper visibility ratio (CVR) of hybrid yarns on the fabric surface is determined with the supreme fabrics, which were knitted from different hybrid yarns, by using image thresholding method in CIE (L*a*b) color space.*

Keywords: *copper wire, hybrid yarn, image thresholding method, functional clothing.*

1. INTRODUCTION

The demand for new and superior property products is increasing with the change in the life style of the human race. One of these products is functional clothing. Conductivity in textiles is essential for functional clothing since electrical conductivity provides pathways to carry information or energy for various functions [1]. Hybrid yarns containing copper wire are used in order to provide conductivity of fabrics which are produced for functional clothing. On the other hand, fabric containing hybrid yarns has to provide at least acceptable aesthetic and comfort properties, especially if it will be used as a garment.

The aim of this study is to evaluate the effect of yarn production method and number of twist on the CVR of hybrid yarns. Initially, new hybrid yarns are produced for the fabrics offering electromagnetic shielding properties in this study. Then copper visibility rate of hybrid yarns on the fabric surface is investigated. To determine the CVR of hybrid yarns on the fabric surface, image thresholding method is used in CIE (L*a*b*) color space.

2. MATERIAL AND METHOD

In this study, 15 different types of hybrid yarns containing copper wire, were produced with 5 different production methods as cross wound covering with double yarn, classical twisting with single yarn, covering with single yarn, classical twisting with double yarn, covering with double yarn and which have 3 different twist counts as 200 T/m, 250 T/m ve 300 T/m using Ağteks "Directwist-2B" machine.

For the production of copper containing hybrid yarn, Ne 25/1 ring-spun, Ne 50/1 ring-spun yarns and 50 micron (Ne 33/1) copper wire were used. Supreme knit structured sample fabrics were knitted from hybrid yarns on sample sock knitting machine.

An image processing technique, image thresholding method in CIE (L*a*b) color space, is used to determine the copper visibility of the produced hybrid yarns. An image is a two dimensional function of the light and composed of pixels. The intensity value of a pixel represents the color of that pixel. Image thresholding is used for determining if a pixel is dark or light [2]. When an image of the hybrid yarn is inspected, copper's color can be easily distinguished from the background and the yarn. The experiments realized in RGB color space show that the detection of the copper wires is not satisfactory. Therefore, CIE (L*a*b) color space is used. The image thresholding is conducted on the 'a' component of the images and copper wires are determined successfully. Finally, the number of the pixels which are labeled as copper is divided to the whole pixel count to obtain the CVR.

In order to evaluate the effect of yarn production method and number of twist on CVR of hybrid yarns, each sample fabrics were photographed ten times with Olympus SZ61 stereo microscope. Then CVR of hybrid yarns obtained from the photographs of samples were also statistically analyzed with two-way repeated measures analysis of variance (ANOVA) method. The mean differences of subgroups were also compared by SNK test at 95 % significant level in the COSTAT statistical package.

3. RESULT AND DISCUSSION

The highest CVR value is obtained from the sample fabric knitted from the hybrid yarn produced with cross wound covering with double yarn method. The lowest CVR value is obtained from the sample fabric knitted from the yarn produced with covering with double yarn. It was seen that the CVR of 300 T/m hybrid yarns was lower than that of 200 T/m and 250 T/m hybrid yarns.

4. CONCLUSION

In this study, according to the data obtained from image thresholding method, the production methods and the twist count have influence on the CVR value of the hybrid yarn. All these data can be used to design functional textile products according to the end use purpose.

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UTILIZATION OF ACOUSTIC AND INITIAL MODULUS FOR EVALUATION OF ORIENTATION IN STAPLE YARNS

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Abstract: *It is well known that twist has crucial influence on the mechanical properties of short staple fiber yarns. Increase of the staple yarn twist level leads to the decrease of the yarn acoustic and initial tensile modulus and orientation of fibers as well. Main aim of this work is to predict of twist influence on the fibers orientation in the staple polypropylene yarn from information about acoustic and initial modulus.*

Keywords: *staple yarns, fibers orientation, acoustic modulus, initial tensile modulus*

1. INTRODUCTION

It is well known that twist has crucial influence on the mechanical properties of short staple fiber yarns. The possibilities of prediction of twist influence on the fibers orientation in the staple polypropylene yarn are discussed in this work. Increase of the polypropylene yarn twist level leads to the decrease of the yarn acoustic and initial tensile modulus and orientation of fibers as well.

Let the staple yarn is composed of thin, elastic cylindrical rods with dynamic modulus E and density ρ. The rate of longitudinal sonic waves propagation c in this structure is computed from well known relation [5]

$$c = \sqrt{(E/\rho)} \qquad (1)$$

The acoustic dynamic modulus of yarns is much lower than acoustic dynamic modulus of fibers (multiple factor is in the wide range from 0.05 to 0.6). Acoustic dynamic modulus of yarns decrease is influenced by the twist level mainly. From the acoustic dynamic modulus of yarns E_y at some twist level Z it is possible to calculate the approximate orientation factor η_β from simple relation

$$\eta_\beta = \frac{E_y}{E_b} \qquad (2)$$

where E_b is the acoustic dynamic modulus of yarns without twist (i.e. fibrous bundle). The E_b is in fact replaced by the the fiber modulus. The eqn (2) can be used for prediction of orientation from yarn initial tensile modulus as well.

2. MATERIAL AND METHOD

The thirteen compact polypropylene yarns of the same fineness T = 25 tex with different twist were spun. Instead of twist level Z the Phrix's twist coefficient α [$m^{-1}ktex^{2/3}$] was computed.

Yarns were produced in the pilot plant conditions. The yarns sonic velocity was measured on the apparatus Dynamic Modulus Tester (Lawson Hemphill). The initial tensile modulus of yarns was calculated from smoothed stress strain curves measured on the tensile testing machine under standard conditions. The smoothing was realized by using of optimal cubic smoothing splines [8]. The limit packing density μm = 0.7 and optimal value of parameter M = 0.0919 [m] for polypropylene yarns were used.

3. RESULTS AND DISCUSSION

The acoustic dynamic modulus of yarns without twist E_b was calculated from linear dependence of yarn sonic velocity on the twist coefficient α (extrapolation to the α = 0). The linear dependence of sonic velocity on the twist coefficient is fairly good with squared correlation coefficient r^2 = 0.77. The extrapolated sonic velocity of yarns without twist is 1.898 km/s. Corresponding acoustic dynamic modulus of yarns without twist E_b calculated from eqn. (1) is equal to 3.367 GPa. The dependence of yarn initial tensile modulus on the twist coefficient α is nearly linear with squared correlation coefficient r^2 = 0.918. Extrapolated initial tensile modulus of yarns without twist is equal to 1.624 GPa. The experimental orientation factors computed from sonic modulus and initial tensile modulus are shown in the fig. 3. The lines corresponding to the orientation factor calculated from Gegauff [1], Pan [2, 3] and White [4] models are shown as well.

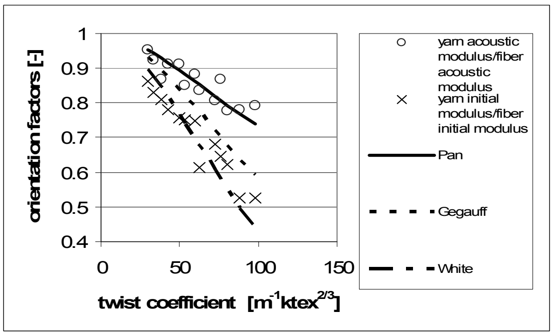

Figure 3 Various orientation factors as function of yarn twist coefficient

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A NEW APPROACH ON MEASUREMENT OF SHIELDING EFFECTIVENESS FOR HYBRID SPACER FABRICS

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Abstract: *With the development of science and technology, the use of electrical and electronic devices, which occurs the electromagnetic pollution, increases day by day. Shielding is a very popular method of protecting electronic devices and human beings against electromagnetic radiation. Currently there are two main electromagnetic shielding effectiveness EMSE measurement techniques; one is the 'insertion loss technique' (ASTM D 4935) and the other is the 'shielding chamber technique' (IEEE-STD-299). However, each method has some limitations in respect of the test samples' size, labor and capital cost, etc. and related these limitations, there is a lack of method for newly developed hybrid spacer fabrics. This paper presents a new approach on EMSE measurement of hybrid spacer fabrics.*

Keywords: *electromagnetic pollution, shielding effectiveness, spacer fabric, conductive materials.*

1. INTRODUCTION

EMSE is a key parameter which often determines the field for application of a given material. There are several methods such as ASTM D 4935, IEEE-STD-299 available which allow the EMSE to be measured [1-3]. These methods depend not only on the parameters of the shielding materials but also on the test sample's size, the geometry of the test set-up, and the parameters of the source of electromagnetic radiation. At the current state of research, it is not always possible to take all of these additional factors into account [3] and current methods have some disadvantages. The ASTM D 4935 standard device has a complex shape and it is difficult to manufacture. In addition to this, coaxial holder method has limitations in terms of fabric thickness. The thickness of the tested materials cannot exceed 1/100 of wavelength of the electromagnetic wave in open space. In other words, the thickness of the material should not exceed 2 mm for a test frequency of 1500 MHz and 3 mm for 1000 MHz. Measuring shielding effectiveness using the shielding chamber is time-consuming and troublesome. It requires excellent proficiency and measurement experience from the test operator.

In this paper, a new test method developed for EMSE measurement of hybrid spacer fabrics which can be used to attenuate the strength of electromagnetic fields, is explained in detail and the test results of some samples are evaluated.

2. MATERIAL AND METHOD

5 different types hybrid spacer fabrics were produced on a circular knitting machine. Fabric samples were tested for EMSE with a new method. In this new method which is based on shielding chamber technique, shielding chamber was provided by means of a cardboard cylinder covered with aluminum foil. A transmitter device having 446 MHz frequency was placed into this cylinder. A measuring device called as Spektran was put 3 cm away from the shield material (Figure 1). Spektran was connected to a Network analyzer as seen in Figure 1. Measurement without fabric was performed and it was recorded as reference value. After that, the test measurement was made with the fabric samples placed in front part of the cylinder covered with aluminum.

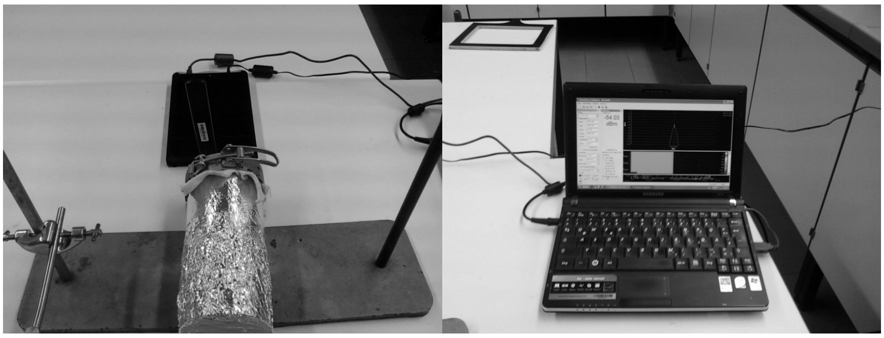

Figure 1. Test Setup of Presented Method

3. RESULTS AND DISCUSSION

Hybrid spacer fabric samples were tested by the presented method and the results were evaluated.

4. CONCLUSION

According to experience about the new presented technique, the test procedure is simple, repeatable and quick. It is found that it is neither labor-intensive nor capital-intensive when compared to widely used measurement methods. Also it is seen that this presented method can be used easily for EMSE measurements of relatively thicker fabrics. However, studying with different frequencies and different samples could help to determine the limitations of this new presented method.

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LUMINESCENT APPLICATIONS IN TECHNO-FASHION

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Abstract: *Even if science and fashion seem to be contradictory notions, recently they meet together for innovative approaches both in the conceptual collections as well as the functional developments in garments. Nowadays, fashion industry benefits from the increasing possibilities of technology not only as a concept, but also to develop alternative functions, one of which is the use of luminescent applications. This study includes an overview and some samples of designers and clothing brands using optic technologies such as the led integration into garments.*

***Keywords**: techno- textiles, fashion brands and designers, luminescent applications*

During the history, fashion has always been influenced by science and technology and showed parallel changes both in themes and the use of materials. 1960s was the time when technology interfered highly into fashion designers' collections, mostly inspired from the space-age aesthetics and developed with high tech materials. However, science, technology and fashion have never been so parallel and together as they are now in the 21st century. Most fashions designers believe that the future of their discipline lies in the textiles and technology. New fibres, new fabrics and innovative applications are nowadays being integrated into the world of fashion and the touch of technology extends the boundaries of clothing and fashion [1].

The use of technology in clothing and fashion design can be investigated in a large field by categorizing the technological developments. In this study use of light has been taken as a sample issue and the interpretation of this technology into fashion is discussed. Since light can be linked with the fashion items easily, many designers and clothing brands at various levels started to add (electro)luminescent applications to their collections. These are also in fabric design as home textiles, interior design (Décor Swiss Interior Textile Company) to increase colour, light reflection and many other (optical) visual possibilities [1].

Embedded electronic circuits evaluate sensory information and in this way some technological advances can be added to the textile and clothing products. This can be possible with two types of technology, where the first option is realized by mounting electronic devices. With the second option wires or electronic functions are created on the textile fibres. Because of its technical simplicity and applicability, first option is preferred in many applications; similarly, this is preferred mostly in the collections of designers and clothing brands [2].

This study is an overview trying to identify the affects of technology in contemporary fashion. Since “fashionable technology” or “techno fashion” is an amazingly developing field, use of luminescent applications by fashion designers and fashion brands was taken as a category to look into. This study covers both the conceptual works and the functional uses of luminescence in clothing and fashion, and within this context, in textiles.

Works of the contemporary designers on luminescence and reflection of recent developments in these fields to fashion is taken as a research topic, where Hüseyin Chalayan’s collection “Airborne” in Autumn/Winter (2007) is an example using led technology (Figure 1).

Figure 1. Hüseyin Chalayan, “Airborne”, Autumn/Winter 2007

Apart from the few examples of fashion designers using similar electronic insertions in their collections, wearable technologies are not integrated much into designer brands. However, it is possible to see an increase in the use of luminescent applications in various clothing brands, mostly with the aim of increasing functionality of the garments.

As an example of a premium level lingerie brand, Victoria Secret showcased a technology integrated look to its fashion show in 2011. Even though this was a piece of showcase, it is possible to increase the number of examples in ready-to-wear clothing brands with the use of luminescent applications in their collections.

Fashion designers and brands are following the recent technological developments and trying to find the most appropriate choices for their collections to create differentiation. Mix of traditional and natural materials with techno textiles offer alternative looks and functions to the garments. This can be called as a field where engineering and art come together to create aesthetic quality as well as the functionality. Within such recent observations, it can be claimed that fashion community is becoming more open towards technology enabled clothing.

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THE EFFECT OF POLYMER ANODE ON THE PERFORMANCE OF ORGANIC PHOTOVOLTAIC FIBRE STRUCTURE

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Abstract: *In this study, photovoltaic fiber generating electricity by using sun light was developed. The effect of polymer anode on the performance of photovoltaic devices was investigated. A nano-blend of photoactive materials was used in device for light harvesting. A semi-transparent top metal electrode was evaporated thermally under vacuum. Polymer thin films allow textile fibers for flexibility and easy processibility. A traditional PA fiber was used as the fiber substrate. The device geometry was as polymer anode-active layer-metal cathode. Dip-coating for sol-gel applications and thermal evaporation technique for metal electrode deposition were employed. Photovoltaic performances of the devices were investigated according to current-voltage characteristics measured under AM 1.5 conditions.*

Keywords: *organic, photovoltaic fiber, polymer anode, smart textile, solar cell.*

1. INTRODUCTION

Renewable energies had a great attraction due to exhaustion of other conventoinal energies and global warming [1]. Photovoltaic technology is the one of the cleanest and promising alternative energy that uses infinitive sun light in order to generate electricity [2].

The polymer solar cell consists of a thin active layer sandwiched between two electrode which at least one of them is transparent that allows the light to access the active area [3-6]. In our previous studies, different approaches [7-10] were investigated.

2. MATERIALS AND METHODS

Four different types of devices were fabricated: one of them ITO coated glass structure for reference cell, one other is ITO coated flexible PET substrates as reference cell again for flexible surfaces, one of them PET stripes and the last construction is PA mono filament. Conductivity grade PEDOT:PSS solution was used as a hole transporting layer. The photoactive material solutions were prepared using blend of P3HT:PCBM in chlorobenzene solution which was stirred for 24h at room temperature. Standard type of solar cell layer sequence was used in this study. Non-transparent and non-conductive PET stripes and PA filaments were used without metal layer. The glass substrates were 25 mm x 25 mm squares covered with ITO layer. Device preparation processes consist of gently cleaning in various alcohols and distilled water, respectively and dried in a nitrogen flow. For reference cells, one third of the ITO layer was etched from glass in acid bath. Then, the glass substrated were cleaned in ultrasonic bath in various alcohols and rinsed with distilled water, dried in nitrogen flow. Sol-gel applications for fibers carried out with dip-coating, for reference cells spin coating is employed. For metal electrode deposition, all types of samples were coated by thermal evaporation method. Deposition of semi-transparent Al layer was the last step of producing photovoltaic fiber structure. Thermal vacuum deposition technique was employed for metal electrode. Standard type of solar cell (right) and photovoltaic fibre structure (right) is given in Figure 1.

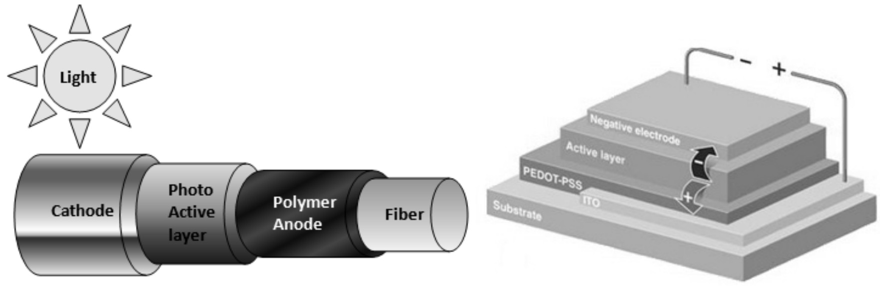

Figure 1. Photovoltaic fiber structure (left) and standard type of solar cell (right).

Electrical characterization was carried out in oxygen environment. A solar simulator used having 100W/m^2 light intensity, and a Keithley 2400 sourcemeter was used to obtain current and voltage measurements. All datas saved by a help of computer synchronisated with sourcemeter.

3. RESULTS AND DISCUSSION

In this study, development of photovoltaic fibers using polymer based materials as anode and photoactive layer was studied. This approach can be integrated into photovoltaic textile structures. This study proves that highly conductive PEDOT: PSS solution and the semi transparent metallic layer can be used successfully as the anode and cathode of the organic solar cells, respectively, for flexible devices. Moderate efficiencies were obtained from this study.

4. CONCLUSION

Summarising, improvement of coating processes can optimize the photovoltaic performances of devices.

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EFFECT OF MICROFILAMENT FINENESS AND FABRIC PROPERTIES ON TEAR STRENGTH PROPERTY OF POLYESTER MICROFILAMENT WOVEN FABRICS

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Abstract: *One of the most important developments in synthetic fiber industry is absolutely producing microfilaments which have a linear density below 1 dtex or 1 denier. Tightly woven polyester microfilament fabrics are superior to conventional fiber fabrics, due to their distinguishing properties for different end uses such as parachutes, sails, wind-proof clothes, sleeping bags, tents, filters and surgical textiles. For these end uses, good fabric tear strength implies a long useful life time. In this study dynamic and static tear strength properties of polyester microfilament and conventional filament woven fabrics were observed comparatively. For this aim, 60 woven fabric samples were produced for investigating the effect of filament fineness, weft sett and weave type on tear strength of polyester filament woven fabrics.*

Keywords: *microfilament, woven fabric, tear strength, weave type, filament fineness.*

1. INTRODUCTION

Synthetic fiber industry has been enforced to make developments due to the increasing performance demand for textile products. One of the most important developments in synthetic fiber industry, is absolutely producing extremely fine fibers which are named as microfibers and nanofibers. A fiber finer than 1 dtex or 1 denier as microfiber [1-8]. In the literature there are some studies of the effects of conventional and microfilament fineness of woven fabric performance properties [9-12]. These types of fabrics are superior for different end uses such as parachutes, sails, wind-proof clothes, sleeping bags, tents, filters and surgical textiles. For these end uses, good fabric tear strength is extremely important. Because low tear strength shortens the useful life time as well disables the functionality of these end use products.

2. MATERIAL AND METHOD

This study is focused on the effect of filament fineness, weft sett and weave type on dynamic and static tear strength property of 100% polyester microfilament woven fabrics. Fabrics were made in three weave types; 1/1 Plain, 2/3 Twill (Z) and 4/1 Satin. For plain 30, 32, 34, 36 wefts/cm, for twill 41, 43, 45, 47 wefts/cm and for satin 43, 45, 47, 49 wefts/cm were determined. Polyester microfilament textured yarns of 110 dtex with 0,33, 0,57 and 0,76 dtex, 1,14 and 3,05 dtex filament finenesses were used as weft. By this way 60 woven fabric samples were produced. The static tear strength property of fabrics was determined according to ISO 13937-2 and dynamic tear strength property was determined according to ISO 13937-1. Design-Expert statistical software package was used to interpret the experimental data.

3. RESULT AND DISCUSSION

3.1. Dynamic Tear Strength

Filament fineness and weft sett do not have significant effect on dynamic tear strength. On the other hand, satin weave types have higher dynamic tear strength values than those of twill weave types for same fabric sett values.

3.2.Static Tear Strength

A slight decrease is available in weft direction static tear strength for whole weave types by increasing filament fineness. In addition there is an important difference between static and dynamic tear strength values. This result is in agreement with earlier studies in the literature [13,14].

4. CONCLUSION

Filament fineness and weft sett had no effect on dynamic tear strength for the filament fineness and weft sett values chosen for this study, But, on weft direction static tear strength, there was a slight decrease for 3,05 dtex filament fineness. Besides, the satin weave type had slightly higher weft direction dynamic and static tear strength than that of twill weave type. Dynamic tear strength results were considerably higher than static tear strength results, similar with former studies [13,14]. The effects of filament fineness and weft sett on static and dynamic tear strength were statistically found to be significant. But, it can be said that the filament fineness and weft sett values chosen for this study has no significant effect on static tear strength.

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EFFECT OF ELECTROSPINNING PROCESS PARAMETERS ON THE PRODUCTION OF POLYURETHANE NANOFIBERS

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Abstract: *Electrospinning is a simple and versatile technique that produces continuous micro- and nano diameter polymer fibers through the action of an external electric field imposed on a polymer solution or on its melted for. In this study, polyurethane(PU) nanofibers were made with electrospinning method. The effect of electrospinning process parameters including solution concentration, the distance between needle and collector, voltage and injection velocity, on the resultant fiber diameter has been studied. The mechanical and morphological analysis of the resultant fibers were made.*

Keywords*: polyurethane nanofibers, electrospinning, morphological analysis, mechanical properties*

1. INTRODUCTION

Polyurethanes (PU) are versatile materials used in a wide variety of application areas. Thermoplastic polyurethanes are well established in various applications because these materials combine the processability of thermoplastics with rubber like elastic properties. Some of the advantages of TPU are excellent tensile strength, anti- abrasion, wear resistance and flexibility at room temperature [1]. Polyurethanes can be used in the textile industry, medicine, environmental fields and so on [2]. Polyurethane has also been applied to waterproof-breathable fabrics, synthetic leather, antishrink wool, military textiles, adhesives and fine chemicals [3]. Furthermore, combining ordinary fabrics with semi-conductive polyurethane films can lead to the development of smart textiles.

2. MATERIAL AND METHOD

2.1. Preparation of Polyurethane Nanofiber

For preparing electrospinning solutions, PU was dissolved in Dimethylformamide. The electrospinning apparatus consists of a syringe pump, a high-voltage direct current (DC) power supplier generating positive DC voltage up to 30 kV and a grounded collector that was covered with aluminum foil. The solution was loaded into a syringe and a positive electrode was clipped onto the syringe needle, having an outer diameter of 0.8 mm.

The feeding rate of the polymer solution was controlled by a syringe pump and the solutions were electrospun onto the collector. The effect of electrospinning parameters including solution concentration, tip-to colector distance, voltage and injection velocity was studied. The concentration of the solution was changed between 4% and 12%. All solution preparations and electrospinning were carried out at room temperature.

The diameter measurements of the fibers were made with SEM analysis. The mechanical properties were tested using TA Q800 Model Dynamic Mechanical Analyzer.

3. RESULTS AND DISCUSSION

The electrospinning process parameters for bead-free nanofibers were determined. At some solution concentrations, no fiber could be formed. 4% concentration gave no fiber, whereas 10% concentration gave bead-on-a-string construction. 12% concentration produced bead-free nanofibers and the SEM images are given in Figure 1.

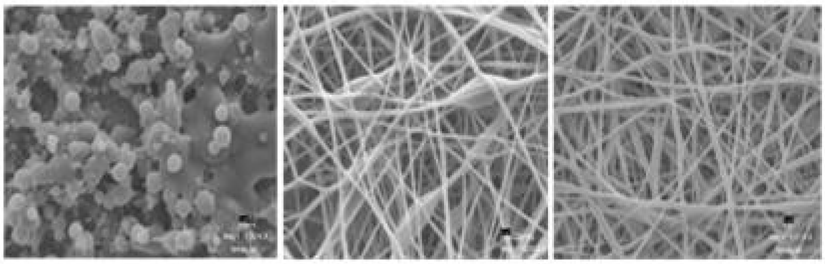

Figure 1. SEM images of the produced nanofibers

4. CONCLUSION

Polyurethane nanofibers were formed by the electrospinning method. The effect of electrospinning parameters were studied. Morphological and mechanical characterization of the produced nanofibers were made.

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STRUCTURAL AND ANTIBACTERIAL PROPERTIES OF PP/CuO COMPOSITE FILAMENTS

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Abstract: *In this research, composite polypropylene (PP) filaments containing different amounts of cupric oxide (CuO) were produced in order to obtain fibers having antibacterial effect. Spinnability of different cross sectional shaped fibers with different cupric oxide concentrations was also investigated. By this way, both physically and chemically modified fibers were evaluated. As experimental analysis firstly, structural and mechanical properties of the fibers were tested. Then effects of fiber cross section and additive content on antibacterial properties of the samples were determined and discussed.*

Keywords*: polypropylene fibers, cupric oxide, composite fibers, antibacterial properties.*

1. INTRODUCTION

Man-made fibers can be modified by several physical and chemical methods. One of the methods for modification is changing the cross sections of the fibers from circular to non-round shapes like trilobal, flat, hollow and triangular [1-2]. Another method of improving chemical fiber properties is to incorporate organic or inorganic additives into the polymer matrix. By this way, functional properties such as conductivity, antimicrobial activity, UV stability, smell absorbing property, electromagnetic shielding, higher strength and modulus, fotocatalytic effect, flame retardancy and some other properties can be introduced to the chemical fibers [3-4].

2. MATERIALS AND METHODS

Cupric oxide microparticles (dimensions<5µ, 98%, Aldrich, Germany) were used for chemical modification. Commercially available polypropylene chips (Ecolen HZ21X, Hellenic Petroleum, Greece) having 35g/10min melt flow index and 0.9g/cm^3 density were used to manufacture composite multifilament yarns.

Before spinning, polypropylene chips and cupric oxide microparticles were melt compounded with cupric oxide content of 0.3% and 1.0% (w/w) by using a twin screw extruder. Compounds were spun to multifilament yarns which contain respectively circular, trilobal and triangular cross sectional shaped filaments. Cross sectional shapes and the surface properties of composite fibers were investigated by using an optical microscope. Structural properties such as fiber crystal phases, melting (T_m) and crystallization (T_c) temperatures and crystallinities were determined. Tensile properties of single fibers were measured according to ASTM D-3822-07 standard by using Instron 4411 Tensile Tester. Antibacterial tests of the fibers were performed according to the JIS L 1902:2002 test method quantitatively against *E. coli* (ATCC 25922) bacteria.

3. RESULTS AND DISCUSSION

Results of the experimental analysis are summarized in Table 1.

Table 1. Properties of different cross sectional shaped composite fibers

Filament type		**Cristallinity (%)**	**T_m (°C)**	**T_c (°C)**	**Strength (gf/denier)**	**Bacterial reduction (log_{10})**	**Antibacterial results**
circular	Neat PP	64.17	170.31	121.60	1.76	-	No activity
	PP+0.3% CuO	66.91	169.58	124.60	1.68	>3	Strong
	PP+1.0% CuO	62.48	169.82	124.51	1.63	>3	Strong
trilobal	Neat PP	62.85	170.64	121.27	1.77	-	No activity
	PP+0.3% CuO	65.44	170.35	125.02	1.77	>3	Strong
	PP+1.0% CuO	63.41	170.47	125.25	1.75	>3	Strong
triangular	Neat PP	61.22	169.48	122.05	1.79	-	No activity
	PP+0.3% CuO	64.10	169.81	125.02	1.76	>3	Strong
	PP+1.0% CuO	63.67	168.88	125.36	1.73	>3	Strong

4. CONCLUSION

Experimental results show that PP/CuO composite filaments having three different cross sectional shapes can be produced without any important changes in thermal behavior of fibers. With the increasing content of micron size cupric oxide, only slight decreases of strength were observed. Micro-particles also led to some crystallinity changes. It can be concluded from the antibacterial test results that antibacterial activities of all cupric oxide doped PP fibers are very high. Activity is independent from cross sectional shape and cupric oxide concentration. Cupric oxide can be used in PP fibers as an antibacterial agent in low concentrations successfully.

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MECHANICAL PROPERTIES OF HYBRID NEEDLEPUNCHED NONWOVEN GEOTEXTILES

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Abstract: *Needlepunched nonwoven geotextiles (both natural and synthetic fibre based) are widely used for various civil engineering applications. In this preliminary research work, the wide width tensile (both virgin and damaged at the centre), puncture resistance and compression properties of hybrid geotextiles were analysed. These hybrid geotextiles have been produced from the blend of jute/ polypropylene fibres in defined weight proportions (0%, 20%, 40% and 60%). Subsequently, a comparison has been made between various physical and mechanical properties of needlepunched nonwoven geotextiles. In this research work, it was found that hybrid geotextiles made of jute (up to 40 wt.%) showed better performance among the hybrid jute/polypropylene nonwoven geotextiles.*

Keywords: *hybrid geotextiles, tensile, puncture, needlepunched nonwoven, porosity*

1. INTRODUCTION

Geotextiles can be made from synthetic and natural fibres but the synthetic fibres are widely used in civil engineering applications primarily due to their superior mechanical properties and long-term durability [1]. Natural fibre based geotextiles are environment friendly, less costly, easily available, and biodegradable as they are easily degraded within the soil [2]. Several researchers have reported the use of natural fibres including jute, flax, coir, hemp, wood and bamboo in various applications of geotextiles such as soil erosion control, vertical drains, road bases, bank protection and slope stabilisation [3-5]. However, the overall objective of the present work is to compare and analyse the mechanical properties of hybrid needlepunched nonwoven geotextiles produced from jute and polypropylene fibres that can be effectively used for reinforcement applications.

2. MATERIAL AND METHOD

2.1 Fabrication of Needlepunched nonwoven geotextiles

Four samples of hybrid jute/polypropylene (Jute/PP) needlepunched nonwoven geotextiles have been prepared from polypropylene staple fibres(60 mm, 6.6 dtex) after blending with jute fibres(51 mm, 26 dtex) in defined Jute/PP proportions, i.e., 0/100, 20/80, 40/60 and 60/40. These hybrid needlepunched nonwoven geotextiles have fabric area density of 400 g/m^2 and were prepared using DILO needlepunching nonwoven line based at IIT Delhi.

2.2 Mechanical properties

Various mechanical properties including wide width tensile test (both virgin and damaged at the centre) in the machine and cross-machine directions (ASTM D4595-09), CBR puncture resistance (ASTM D6241-04) and compression properties of hybrid needlepunched nonwoven geotextiles were determined.

3. RESULTS AND DISCUSSION

The porosity of hybrid needlepunched nonwoven geotextiles are calculated by determining the geotextile thickness at defined normal pressures of 2, 20 and 200 kPa. The minimum reduction in porosity was found in the higher jute content hybrid geotextiles i.e. 40/60 jute/PP and 60/40 jute/PP geotextiles specifically under higher level of compressive stresses. Figure 1 illustrates that 40/60 jute/PP geotextile has yielded higher value of tensile strength and initial modulus when damage was artificially created at the centre of the specimen specifically in the cross-machine direction. These results are comparable to that of 100% polypropylene based geotextiles, as shown in Table 1.

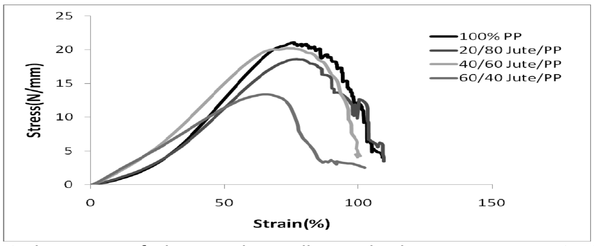

Figure 1. Stress-strain curve of damaged needlepunched nonwoven geotextiles in the cross-machine direction

Table 1. Comparison between tensile strength and puncture resistance of needlepunched nonwoven geotextiles

Sample ID	Tensile strength from wide width tensile test (kN/m)		Tensile strength (kN/m)	Tensile strength from CBR test (kN/m)	% deviation	Puncture resistance (kN)
	Sample test direction	Tensile strength (kN/m)				
100% PP	MD	10.65	19.70	20.56	4.18	3.23 ± .0845
	XMD	28.75				
20/80 Jute/PP	MD	9.01	15.71	13.75	14.25	2.16 ± 0.145
	XMD	22.41				
40/60 Jute/PP	MD	8.51	17.65	14.71	19.98	2.31± 0.171
	XMD	26.79				
60/40 Jute/PP	MD	6.92	11.21	11.84	5.32	1.86 ± 0.108
	XMD	15.50				

MD-Machine direction
XMD-Cross-machine direction

4. CONCLUSION

From the preliminary research work, it may be concluded that 40/60 jute/PP hybrid geotextiles have resulted in higher tensile strength, initial modulus and puncture resistance amongst the hybrid geotextiles. The minimum reduction in porosity was also found in hybrid geotextiles having jute content of 40-60 wt%.

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BREATHABLE AND WATERPROOF FABRIC STRUCTURES USING CONVENTIONAL FABRICS AND MICROPOROUS FILMS

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Abstract: *This work reports waterproof breathable layered fabrics consisting of simple fabric weave types (plain, twill) and microporous breathable films. The fabrics were pretreated and then treated with water repellent finishing chemicals. Afterwards, layered structures were generated by bringing the fabrics and the microporous breathable films together. According to the results of water repellency, water permeability and water vapor permeability tests conducted on the samples with/without microporous film layers, we were able to generate waterproof breathable layered fabrics.*

Keywords*: microporous film, breathability, waterproofness, water repellent.*

1. INTRODUCTION

Waterproof breathable fabrics balance two contradicting properties: They are waterproof and yet water vapor permeable. These fabrics can be categorized into four main types:

1. Closely woven fabrics with water-repellent treatment
2. Microporous film laminates and coatings
3. Hydrophilic film laminates and coatings
4. A combination of microporous coating with a hydrophilic top coat

All these methods are closely related to high production costs [1-6]. On the other hand nowadays, breathable film fabric laminates are finding increasing acceptance in end uses requiring selectively water proof but breathable barrier characteristics. Therefore in our study, we tried to make waterproof breathable fabrics in a reasonable way by generating a layered structure consisting of a simple fabric weave (plain, twill) treated with different water repellent chemicals and a microporous breathable film.

2. MATERIAL AND METHOD

2.1. Materials

Fabrics were kindly provided from Madosa Tekstil Ltd. Şti. and pre-treatment procedure was carried out in Hasözgen Tekstil San. ve Tic. A.Ş. Properties of the fabrics woven and pre-treated are shown in Table 1. Two types of water-repellent finishing were applied. 1) Asahi Guard® AG 7600 (Asahi Glass Company, Japan). Asahi Guard is a fluororesin based on Perfluoroalkylethylacrylate as the main component. 2) Nano-pel™ (Nano-tex Company, USA). This is a nanotech application of water-and-oil repellent finishing. The chemicals used in Nano-Pel™ finishing can not be disclosed here for proprietary reasons. Microporous breathable lineer low density polyethylene (LLDPE) films with a 14 gsm (gram square meter) were kindly provided from Pelsan Tekstil Ürünleri San. ve Tic. A.Ş. Ethylene vinyl acetate (EVA) based hot-melt adhesive films (AOT 110) were kindly acquired from ATEG Mühendislik Ltd. Şti.

Table 1. Properties of the pre-treated fabrics.

Sample No.	Warp	Warp density (thread/cm)	Weft	Weft density (thread/cm)	Weight (gr/m^2)	Weave
1	20/1 Combed Cotton	51	20/1 Carded Cotton	23.5	227	1/1 plain
2	20/1 Combed Cotton	50	20/1 Carded Cotton	23	222	2/2 twill
3	20/1 Combed Cotton	51	20/1 Carded Polyester	24	231	1/1 plain
4	20/1 Combed Cotton	51	20/1 Carded Polyester	23	231	2/2 twill

3. CONCLUSION

In this study, we have shown that alone water-repellent-treated fabrics and alone microporous breathable films couldn’t provide waterproofness. Nonetheless, water proof and yet water vapor permeable structures were obtained when generated layered structures consisting of water-repellent-treated fabrics and microporous films in a reasonable way which can find application in construction industry.

Acknowledgements

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DEVELOPMENT OF SKELETAL TEXTILE INLAY FOR A FLEXIBLE CERAMIC FLUE LINER SOLUTION

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Abstract: *Flue liner technology in chimney has lagged behind as compared to the development of highly efficient solid fuel stoves currently available in the market. Hence it leads to failure of the flue liners resulting in serious chimney fires due to: 1) increased flue gas temperatures as a result of highly efficient solid fuel stoves; 2) increased yield of highly corrosive flue gases due to processed and poor quality solid fuels. This paper studies the development of a new textile and ceramic based solution to address the above mentioned issue. The textile inlay proposed in the paper provides important properties such as corrosion resistant lining, good insulating layer that can withstand high temperatures, flexible liner construction and good binding. This liner along with a complementary ceramic matrix will provide a textile based solution that aims to reduce fire risk to a building with the help of the current research.*

Keywords: *flue liners, textiles, 3D-spacer, ceramic matrix, braid*

1. INTRODUCTION

The current trend of high energy costs, fuel poverty and the need for cheap domestic fuel has led to a need to diversify the energy mix to meet energy targets [1-3]. As a consequence, again solid fuel stoves are in greater demand; however, this increase has led to an increase in stove / chimney related serious house fires [4,5]. The fire incidents are on the rise due to the high-efficiency of the solid fuel stoves and the over-specification leading to increased flue gas temperatures. In addition, poor quality fuel and processed solid fuels produce highly corrosive flue gases that significantly reduce the life span of flue liners (due to reaction between sulphur and chlorine mixtures from condensates with moisture that produces acidic complexes). Hence, the requirement is to develop solutions that enable the chimney to cope with poor quality / highly corrosive flues for solid fuel domestic heating.

2. CONCEPT AND MATERIAL CHOICE FOR THE TEXTILE LINER

3. MATERIAL AND METHOD

3.1. Textile inlay material selection

A wide variety of fibres available in market were considered for the textile inlay construction. The selection of the textile inlay fibre needs to fulfil the minimum requirements of the chimney liner: corrosion resistance, flexibility, temperature resistance and in comparison to existing solutions economical. A possibility considered was a combination of different fibre materials.

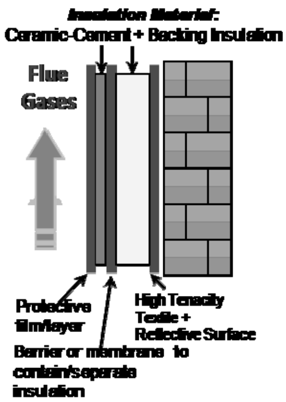

Figure 1: Flue liner schematic sketch

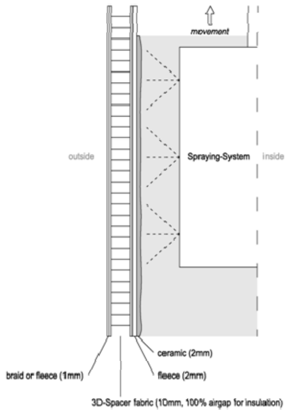

Figure 2: Detailed textile inlay concept

3.2 Sample production of the textile inlay

The sample production of the textile liner is a very important methodological stage in the current investigation. It sees the manufacturing ease of the proposed solution as well as considers the binding with the ceramic matrix which is highly important to achieve the research objectives.

4. RESULTS AND DISCUSSION

The original concept of the textile liner (figure 2) had some inherent issues which required considering other options / combinations of the textile fibre. The major issue found was the lack of bonding between the textile inlay and ceramic matrix and flexibility of construction. The second concept provided with a solution that ensured better bonding as well as worked on the flexibility aspects.

5. CONCLUSION AND FUTURE RESEARCH

Summarising, it is possible to conclude from the current textile inlay development an alternative for the chimney flue lining made from textiles. The new inlay when combined with a complementary ceramic matrix will provide a flexible flue liner that is able to withstand higher flue gas temperatures and provide better resistance against the highly corrosive flue gases. The future research can concentrate on the cheap manufacturing development of the braiding required for the flue liner.

ACKNOWLEDGEMENTS

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PRODUCTION OF SMART HEAT INSULATION MATERIALS FROM WASTE WOOL FIBERS

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Abstract: *In this study, production of smart heat insulation materials with heat storage property from textile waste fibers to use in builds was aimed. For this aim, poly ethylene glycol (PEG) polymer (molecular weight = 1000) was applied to the wool fibers in which PEG acts as solid-solid PCM. Two different cross-linkers were used to bind PEG polymer to the fibers chemically. PEG incorporated fibers analyzed by DSC (Differential Scanning Calorimeter), SEM (Scanning Electron Microscopy), and FT-IR (Fourier Transform Infrared) spectroscopy. T-history will be used to determine thermo-regulating property of fibers.*

Keywords: *PEG, PCMs, Thermo-regulating, Heat insulation.*

1. INTRODUCTION

Thermal energy storage is to store energy for using later and bridges the time gap between energy requirements and energy use. Among the various heat storage techniques, latent heat storage stands out because of high energy storing capacity [1]. Latent heat is stored or released by phase change materials (PCMs) when they change their phase at a certain temperature range. This latent heat can be used to prevent temporary temperature changing. PCMs are applied to textiles to improve thermal clothing comforts and to produce textiles with thermo-regulating property [1-4].

Phase change materials are classified two groups as organic and inorganic. Among the organic PCMs such as linear long chain hydrocarbons (paraffin), polyethylene glycol (PEG), fatty acids, paraffin and PEG are generally used. PEG is used to produce wool fibers with heat-storing property in this study. Poly (ethylene glycol) polymers as PCMs have enough latent heat energy and a proper phase change temperature region. Thus, it has been widely used to produce textiles with latent heat storing [5]. Vigo and his colleagues manufactured phase-change fibers by filling PEG into hollow fibers [6-7]. The same researchers also PEG grafted on the main chain of cellulose or cross-linked it on the surface of the fabrics made from chemical fibers [7-10]. In this study, PEG was applied to the waste wool fibers by using two different cross-linkers and aimed to produce wool fibers storing high capacity heat energy. Therefore, production of high value-added energy saving materials from a cheap raw material was aimed.

2. MATERIAL AND METHOD

2.1. Material

PEG polymer with Mw of 1000 (Alfa Aesar) was used as PCMs. To graft PEG on to the fiber two different cross-linkers were used. Arkofix ELF (Clarient) is a cross-linking agent with ultra-low amounts of formaldehyde. Other cross-linker, glutaraldehyde (25% water solution) was purchased from Sigma Ardrich. Glutaraldehyde is frequently used in biochemistry applications as an amine-reactive homobifunctional cross-linker. Waste wool fibers were supplied kindly from Çam Halı in Isparta.

2.2. Methods

The ratio of the PEG amount per fiber weight was 10:1 when Arkofix EFL was used as cross-linker. On the other hand this ratio is 5:1 when glutaraldehyde was used as cross-linker. PEG 1000 was applied PEG incorporated fibers was analyzed for phase change temperature and enthalpies by DSC (Differential Scanning Calorimeter), morphology by SEM (Scanning Electron Microscopy), and chemicals structure by FT-IR (Fourier Transform Infrared) spectroscopy. Steady state thermal conductivity measurements of the wool fibers treated with PEG and untreated were carried by P.A. Hilton Heat Conductivity instrument. Thermo-regulating property of fibers originated from latent heat storage/release properties of PCMs will be investigated by a system (T-history system) composed of temperature sensors and data-logger (Kimo KTH-350-P Humidity and Temperature Data-logger).

3. RESULTS AND DISCUSSION

According to steady state thermal conductivity test results, heat conductivity of PEG applied wool are determined as 0,06 W/m°C that is the same as that of untreated. According to DSC investigation, heat storage capacity of the fibers change significantly depending on type of the cross-linker. Although the amount of the PEG applied to fibers are two times less, enthalpy values of fibers are three times more when glutaraldehyde are used as cross-linker. Enthalpy values are 10,46 J/g and 32,61 j/g, respectively. After that, thermo-regulating properties of the wool fibers having various heat storage capacities will be investigated by using the T-history system.

4. CONCLUSION

It is concluded from the preliminary results waste wool fibers have very high heat storage capacity that can be used for thermo-regulating insulation materials. PEG was applied to the waste wool fibers by using different cross-linkers successfully. However, cross-linker has an important effect on binding of the PEG on the fiber.

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A WEARABLE LOW ENERGY MINI SIZE ECG FOR HEALTH MONITORING

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Abstract:*This paper describes latest research efforts in WEWear concept for devising new commercial low energy, mini size wearable ECG for health monitoring. We have used a single channel ADS1291 ECG analog front-end coupled with an MSP430F5309 ultra low power mixed signal processor and an ultra low power wireless connectivity blue tooth low energy, to construct a bespoke commercial low energy ECG health monitoring system.*
The particular characteristics of this system are its low power and its mini size ECG node, whilst keeping its 24 bit DC measurement accuracy needed for health monitoring at medical standards. The system is powered by a 300mAh Li-ion chargeable battery and the overall node size including the battery is 32 mm diameter and 9 mm thickness with three days continuous use before recharging.
The node uses a Google tablet as a monitor and communication relay of data which can be linked to a remote database. The data collection and analysis is based on data cloud calculation.

Keywords: *wearable electronics, werable ECG, Low energy, Smart Textiles, bluetooth low energy cloud computing.*

AN INVESTIGATION ABOUT DESIGN AND PERFORMANCE ANALYSIS OF AN ANTIBACTERIAL FOOT SWEAT PAD

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Abstract: *In this study, an antibacterial sweat pad was designed for the feet and some functional and comfort characteristics of the product were investigated. Top sheet of the pad was coated with two natural-based antibacterial materials (cinnamaldehyde, geraniol) and one commercial antibacterial zinc-based agent. Besides standard physical characteristics, research was focused on antibacterial performance, sweat removal and comfort performances of the sweat pad as these were crucial requirements for health and comfort of the feet especially with functional clothing. According to the results, performance of the cinnamaldehyde is quite good in case of antibacterial activity and comparable with the commercial product. Significant changes were observed for liquid absorption period, capacity and wetback performances of the designed pads that cinnamaldehyde coating increased absorption period and synthetic antibacterial material decreased wetback performance. Coolness and dampness evaluation results of forearm test gave significant differences especially for dry phases of the pads.*

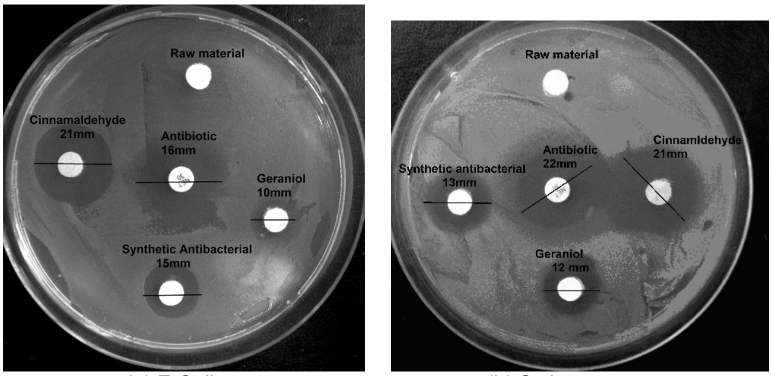
Keywords*: antibacterial foot sweat pad, liquid absorption, forearm test, thermal comfort.*

1. INTRODUCTION

Disposable absorbant products such as baby diapers, adult incontinance products and femine hygienic products have been one of the growing areas of medical textiles [1]. Sweat pads that have similar functions with the other hygienic absorbant structures; removal of the undesirable body fluids have been focus of some research studies and companies in underarm form [2-4]. But as far as we know, there is not a study about a disposable sweat pad for the feet. Sweating, which is a part of the body thermoregulation mechanism creates undesirable dampness sensation, smell and skin health problems. It is also a big problem for the feet clothing system in extreme conditions because of the dampness sensation, decrease of the clothing thermal resistance and foot health problems especially for the people having hyperhydrosis and diabetes [5]. Damp skin is more susceptible to mechanical deformation and hazards coming from bacteria and fungi.

2. MATERIAL AND METHOD

Disposable sweat pads for the foot were produced from standard layers (polypropylene top sheet, wood pulp-SAP absorbent layer and breathable polyethylene back sheet) of a hygienic absorbent product. Antibacterial activities of the selected herbal materials were determined according to disc diffusion method on antibacterial treated polypropylene top sheet fabrics. Concentrations of the solutions prepared with acetone were determined in advance according to the sufficiency of the antibacterial performance (0.1M, 0,5M ve 1M). After selection of the suitable concentration, two efficient herbal materials and a commercial zinc based antibacterial product (Sanitized® TH 27-24/Clariant) (Figure 1) were applied on the top sheet layers by spraying. Besides standard physical properties (weight, thickness, etc.), liquid absorption period, capacity (ISO 9073-6:2000, ISO 11948-1) and wetback (ISO 11948-2:1998) characteristics were investigated by standard methods and forearm test was conducted on 10 male and 10 female students to determine coolness and dampness sensations created by antibacterial treated sweat pads.



(a) E.Coli (b) S. Aureus

Figure 1. Disc diffusion test results of the antibacterial treated topsheet fabrics

3. RESULTS AND DISCUSSION

According to the results, among the herbal materials, cinnamaldehyde was found to be the most effective one in case of antibacterial activitiy. Liquid absorption and wetback test results showed that,cinnamaldeyde-coated pad had significantly higher absorption time values and sweat pad coated with synthetic zinc-based material decreased wetback performance. According to forearm test results, applied antibacterial materials created significant changes in case of coolnes and dampness sensations especially in dry form.

4. CONCLUSION

Results of the study showed that herbal antibacterial materials may have efficient applications for hygienic absorbent materials, foot sweat pad for this study. Some of its performance properties in case of foot health and comfort were investigated and further studies are necessary for functional optimization.

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THE EFFECT OF THERMAL TREATMENTS AND STERILIZATION ON ARTIFICIAL LIGAMENT MECHANICAL PROPERTIES

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Abstract: *Textile Artificial Anterior Cruciate Ligaments (ACL) were manufactured using braiding process. These artificial ligaments were designed to match the demanding mechanical requirements of a native human ACL. These fabrication conditions were determined in a previous work, which its objective is to optimize the braid mechanical properties in order to be close to those of native ligament.*
Initial mechanical failure characteristics of prostheses have been reported before and after thermal treatment (and sterilization (OE, UV and Wet temperature) in order to study the effect of these treatments on artificial ligament mechanical performance and to optimize the treatments parameters.

Keywords: *braid, PAM, PES, OE sterilization, UV Sterilization, wet heat sterilization, saturated vapour and dry heat*

ENHANCING DAMAGE TOLERANCE IN TEXTILE COMPOSITES

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Abstract: *Impact behaviour and damage tolerance of the E glass-Polypropylene/Epoxy composites were investigated. Different ratio of polypropylene yarns was applied during manufacturing of the composite preforms. Drop weight impact tests and compression after impact tests were used in order to evaluate damage behaviour of the specimens. Impact test results indicated that addition of the polypropylene yarns improved total absorbed energy of the composites by toughing mechanism and plastic deformation.*

Keywords: *damage tolerance, commingled yarns, hybrid composites, compression after impact test*

1. INTRODUCTION

Different methods were described to improve damage tolerance of composites. Resin modification, manipulating the fibre-resin interface, fibre toughness improvement, controlling the interlaminar shear resistance, optimizing the laminate stacking sequence, fibre hybridization are some solutions to improve damage tolerance of fibre reinforced polymer composite structures [1]. Hybrid yarns are commonly used in fibre reinforced composite applications with different forms such as co-wrapped, core spun, commingled and stretch broken yarns to improve some of the mechanical properties. In among them, commingling provides soft, flexible and drapable yarn properties, and these yarns can be used at textile preforming for high performance composites [2].

2. EXPERIMENTAL

E-glass-Polypropylene commingled hybrid yarns were produced with a lab air jet nozzle. Different polypropylene and E-glass volume fraction was chosen during the manufacturing of these yarns. Then, the hybrid yarns were used to make preform with a tow placement machine. Resin infusion method was used to produce the composite panels.

3. RESULTS AND DISCUSSIONS

Sample codes and the results of the impact test were presented in Table 1 and Figure1. Impact test results show that addition of the polypropylene yarn to the preform improved energy absorption capacity from 226.08 to 256.61. Compression after impact test will be also performed in future experiments.

Table1. Sample codes and results of the impact test

Sample Code	PP %Vf	Glass %Vf	Absorbed Energy (J)
E-Glass	-	100	226
1PP	13	87	256

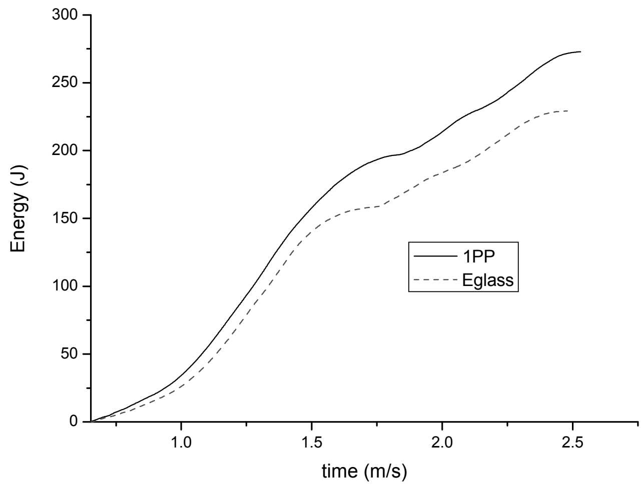

Figure1. Energy-time plot during impact test

4. CONCLUSIONS

Thermoplastic fibre addition to the composite system can enhance mechanical properties via plastic deformation and toughening mechanism. Plastic deformation may reduce the intensity of the stress at cracks [3], and causes increase in energy absorption capacity of the structures [4].

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MECHANICAL PROPERTIES OF FLUOROCARBON TREATED JUTE / HDPE COMPOSITES

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Abstract: *In this study, jute/high density polyethylene (HDPE) composites were fabricated for mechanical characterization. In order to enhance the interfacial adhesion between the polyester matrix and the fiber, jute fabrics were modified by fluorocarbon based agents. The effect of surface treatment of jute on mechanical properties of composites such as tensile properties, flexural properties, and interlaminar shear strength was determined. Adhesion between jute and HDPE in composites was evaluated and discussed considering experimental results.*

Keywords*: surface treatment, natural fiber composite, mechanical properties*

1. INTRODUCTION

Researches and developments on natural fiber composites and on their possible application areas have increased in recent years. Jute fiber reinforced composites are gaining more and more importance recently. Because, jute fibers have the advantages such as biodegradability, good physical properties (adequate mechanical properties with a low specific mass) and low cost as compared to manmade fibers or inorganic fibers used in the composites. It has also some short comings such as high level of water uptake or moisture absorption, quality variations and low thermal stability [1, 2]

The performance of any fiber reinforced composite is restricted by the properties of its constituents. Besides, it is essential that the fiber and matrix have a good compatibility and bonding. To improve the performance of the composites, the surface of the jute fibers can be modified by chemical and physical methods [3,4]. Fluorocarbons are organic compounds consisting perfluorinated carbon chain. They tend to decrease the surface tension of the substrate. Fluorocarbons generally lower the surface tensions by forming a thin film of coating around the textile fibers. Fluorocarbon resin is one of the most popular chemical for improving the water and oil repellency of textiles [5]. In this study, the effect of alkali and fluorocarbon fabric surface treatment on jute fabric reinforced HDPE composites was investigated.

2. MATERIALS AND METHODS

High density polyethylene was used as the polymer matrix. A woven jute fabric, having unit weight of 300 g/m^2, was used in this study. The jute fabric was supplied by Anil Limited, Turkey. Fluorocarbon based agent Lurotex Protection RP were supplied by BASF, Turkey.

For the surface treatment, at first jute fabrics were pretreated with alkali (5% NaOH) and then fluorocarbon treatment of jute fabrics were performed. Composite preparation was carried out with both untreated and treated fabrics and HDPE. Mechanical properties of composites were investigated by using tensile tests, flexural test, and short beam shear test. Adhesion between surface-treated jute fabric and HDPE was also examined by scanning electron microscope observations.

3. RESULTS AND DISCUSSION

In this study the effects of fluorocarbon treatment of jute fabric on the mechanical properties of jute/HDPE composites was investigated. The experimental results show that interfacial adhesion between the HDPE matrix and fluorocarbon jute fibers improve with respect to untreated ones. SEM micrographs of the tensile fracture surface of composites also exhibited improvement of interfacial and interlaminar shear strengths.

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NEWEST DEVELOPMENTS ON HOSIERY GOODS AND EVALUATION OF SOCKS USED BY MILITARY PERSONNEL

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Abstract: *Hosiery goods has special importance between garments of a human, bearing ready to wear production technology, direct affect to wearer's wellness and performance and wide production possibilities derives by raw materials, construction and finishing processes.*
In this article, essential properties of a sock has been firstly introduced and then newest innovations were declared. Finally new materials and advanced textile finishing applications used on hosiery goods and an evaluation about socks used by military personnel were presented.

Keywords: *sock, nano technology, military personnel.*

1. INTRODUCTION

1.1.Historical stages of hosiery production

Hosiery is probably one of the oldest manufacturing processes of textile world. It carried out by hand knitting for many centuries. First hosiery machines were appeared in England at the end of 16th century. Fully fashioned and electronically controlled machines are now on the market.

1.2. Importance of sock and stocking

Sock and stocking are important for both men and women because of hygiene and comfort affects to human body's extremity of leg.
People were used sock and stocking to protect themselves from cold waether during all historical ages.
In addition to be an effective protective garment against cold, socks are also used widely for getting a well balanced moisture and warm comfort on feed at moderate and hot weather conditions especially outdoor and military activities nowadays.
The relation of socks and stocking about fashion are also charming.
In this article socks are analysed.

2. CONSTRUCTION AND PERFORMANCE PROPERTIES OF SOCK

2.1. Construction

Socks are textile goods knitted on circular based hosiery machines. Main features of a sock construction are needle number of machine (or total loop count on sock circular), machine count, number of yarn and type of knit. Type of knit and closing methods on heel, leg and toe parts of a sock are also important properties of the construction.

2.2.Material

Cotton, wool, polyester, polyamid and acrylic fibers are commonly used for production of sock nowadays. Some new synthetical fiber derivatives such as from polyolefins, polyesters and polyamides are developed recent years

2.3.Performance Properties

Color fastnesses, shrinkage after laundering, elasticity, bursting strength, resistance to moisture transfer, washability, resistance to odor preventing and anti-bacterial features are essential performance properties of a sock.

3. NEW MATERIALS AND ADVANCED TEXTİLE FINISHING APPLICATIONS USED ON HOSIERY GOODS

Nano technology developments started to applicate on socks for a decade at global textile market.
Some special technical textile fibers suitable for hosiery manufacturing are now on market.
Finishing processes and materials which are results of nano technology has a bright future for performance socks for outdoor and military activities.

4. EVALUATION OF SOCKS USED BY MILITARY PERSONNEL

Socks used by Turkish Military Personnel are evaluated according to the data carried out from Technical Specifications available at Turkish Ministry of National Defence world web site.
Finally recommendations about the quality of socks in order to improve users' comfort and health are also presented.

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SOUND ABSORPTION BEHAVIOUR OF MULTI-LAYER ISLANDS IN THE SEA NONWOVENS

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Abstract: *In this study, we explore sound absorption properties of multi-layer spunbonded nonwovens that contain bicomponent filaments with islands in the sea cross section. Nylon 6 (PA6) and polyethylene (PE) were used as the islands and the sea polymers, respectively. Spunbonded webs made from islands in the sea bicomponent filaments with islands counts of 1, 7, 19, 37, and 108 were produced at the Nonwovens Institute's pilot facilities at NC State University. The filaments were fibrillated by hydroentangling, where 67,452 kj/kg specific energy was transferred with high-speed water jets. Multi-layer specimens were prepared by attaching a layer onto another with a commercial spray adhesive. The influence of number of layers on sound absorption behavior of each spunbonded nonwovens was investigated. Results have shown that sound absorption coefficients of the islands in the sea nonwovens increased with the increase in number of layers, especially at lower frequencies.*

Keywords: *spunbonding, sound absorption, bicomponent filaments*

1. INTRODUCTION

Noise is a problem that has to be reduced in a variety of environments such as lecture halls, theatres, and administrative buildings, etc. Porous sound absorber materials are frequently used in these places. Nonwovens as a porous and fibrous material are known to have useful acoustical properties and are used as sound absorbers because of their fiber network geometry, bulk, and low density. Generally, fibrous materials absorb sound good at high frequencies; on the other hand, they should be bulky to absorb more sound at lower frequencies. We believe, however, that nonwovens with a lower thickness can be designed to form a better sound absorber. The aim of this study is to investigate sound absorption behavior of relatively thin (under 2 mm) multi-layer spunbonded nonwovens that contain bicomponent filaments with islands in the sea cross section.

2. MATERIAL AND METHOD

2.1. Fabric Formation

Bicomponent spunbonded webs were produced by using Nylon-6 (PA6) as the 'Island' polymer and Polyethylene (PE) as the 'Sea' polymer. All the filaments in nonwovens had a polymer ratio of 75% for the 'Island' polymer and 25% for the 'Sea' polymer. Nonwoven webs with islands counts of 1, 7, 19, 37, and 108 were produced. The basis weight of the islands in the sea nonwoven webs prior to the hydroentangling was kept at ~ 100 g/m^2. The filaments were fibrillated by hydroentangling, where 67,452 kj/kg specific energy was transferred with high-speed water jets. Multi-layer specimens were prepared by attaching a layer onto another with a commercial spray adhesive. Nonwoven fabrics were produced by the spunbond process and bonded (and fibrillated) by hydroentangling as specified in US patent 7,981,226 by Pourdeyhimi, et.al.

2.2. Testing Methods

The impedance tube method was used in order to determine sound absorption coefficients of the nonwovens in this work. The most important advantage of this method and instrument is use of small samples [1]. The sound absorption coefficient measurement instrument that was used in experiments is impedance Tube Kit Type 4206. Air permeability tests were performed under ASMT D 737 conditions.

3. RESULTS AND DISCUSSION

Comparison was performed between 2-layered nonwovens. It should be noted that higher number of islands has resulted in more sound absorption. This result did not change for 3 and 4-layered nonwovens. Generally, sound absorption coefficients of the islands in the sea nonwovens increased with the increase in number of layers. However, sound absorption coefficients started to decrease at higher frequencies after two layers for 37 and 108 islands in the sea nonwovens. Similar behavior was seen from 7 and 19 islands in the sea nonwovens. On the other hand, sound absorption coefficients of the sheath core fabric increased at all frequencies with the increase in number of layers. Moreover, the increment rate is much higher at high frequencies than the middle and low frequencies. This behavior of sheath core fabric is similar with high loft nonwovens [2].

4. CONCLUSION

Sound absorption coefficients of the islands in the sea nonwovens increased with the increase in number of layers, especially at lower frequencies. Higher sound absorption results at middle and low frequencies are superiority of multi-layer 108 islands in the sea nonwoven over the other multi-layer islands in the sea nonwovens. Multi-layer islands in the sea nonwovens with higher islands counts can be potentially a good alternative for absorbing lower frequencies in applications where there is limited space available.

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CONCEPTS FOR AUTOMOBILE INTERIOR LIGHTING INTEGRATED INTO TEXTILES

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Abstract: *In recent years, the foundation for luminous textiles was laid in the Smart Textile domain. Luminous Textiles open up new possibilities for the design of automobile interior. Conventional automotive textiles can be expanded in their functions for developing innovative lighting solutions for vehicle interiors. Therefore, two different concepts of textiles lighting solutions are pursued. On the one hand LEDs are integrated into textile multilayer systems, and on the other hand optical fibres are processed into fibre-reinforced composites.*

Keywords*: smart textiles, luminous textiles, light-emitting diodes, optical fibres, automotive textiles*

1. INTRODUCTION

Textiles and automobiles are inseparably connected. As materials for seat covers and lining, textiles have become indispensable in the automobile interior. Smart Textiles can provide automotive textiles with additional functions. One important element in the interior design is lighting [1]. In the field of Smart Textiles luminous textiles offer novel lighting solutions. For instance, light-emitting diodes or optical fibers can be inserted into a textile structure. The luminous textiles can be installed in various places in the interior, replacing conventional lighting or serving as design elements. Their implementation guarantees space and weight saving. Several concepts have already been developed; so far, however, in the field of automobile interior lighting there are no solutions with luminous textiles ready for serial production [2].

2. INTERIOR LIGHTING CONCEPTS

2.1. ACTIVE LIGHT DESIGN WITH LEDS

LEDs are usually integrated into textiles by attaching them onto textile conductor traces. Therefore an adequate circuit structure is necessary. The integration is accomplished with different joining methods by fixing the LEDs onto the textile carrier and at the same time contacting them electrically. The joining methods used are primarily soldering, adhesion, sewing or ultrasonic welding. For the use in applications a textile multilayer structure with integrated LEDs is developed, which fulfils the requirements with regard to optical transparency and mechanical strength and finishes with an appealing decorative layer.

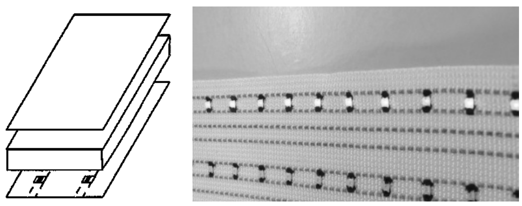

Figure 1. Textile multilayer structure with integrated LEDs; LEDs contacted by adhesive on textile conductor traces

2.2 PASSIVE LIGHT DESIGN WITH OPTICAL FIBERS

Unlike LED concepts, lightings with optical fibers do not emit the light from the lighting source but transmit it to defined emitting spots by channelling the light through polymer optical fibres (POF). The PMMA fibres with a diameter of 0.5 mm are deliberately damaged to permit the light to emerge. The light pipes are integrated as warp threads in woven fabrics and processed in fibre-reinforced composites The number of fibres can be raised for higher light transmission.. Large areas can be lighted with a small number of light sources.

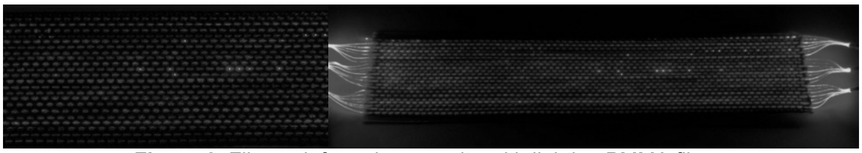

Figure 2. Fibre-reinforced composite with lighting PMMA fibres

3. RESULTS AND DISCUSSION

Textile interior lighting can be realised with the investigated concepts of active and passive lighting. Electrically conductive adhesive can be used for the LED contacting. Especially the problem of contacting needs improvement. Suitable conductive adhesive has been found, however, the process is not yet stable. The question of automation is still unclear. Maybe pick and place processes are applicable to textile processes. Optical Fibres can be integrated into woven fabrics. The light emission can be controlled by the number and damaging of the fibres.

4. CONCLUSION

The goal to contact LEDs and to integrate optical fibres into textile structures has been achieved. The investigated concepts are still in the process of development and need further refinement through automated processes before going into serial production.

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ANTIBACTERIAL CONVEYOR BELT MATERIALS TO CARRY FOOD PRODUCTS

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Abstract: *In this study, antibacterial additives doped coating pastes were applied to obtain an antibacterial conveyor belt. No bacteria colonies were formed at 24-hour contact time for zinc omadine containing samples.*

Keywords: *coating, conveyor belt, antibacterial, food, poultry*

1. INTRODUCTION

In daily use and cleaning processes, food conveyor belts are exposed to mechanical stress, and this stress damages the belts. In spite of the optimum cleaning intervals and HACCP principles, the damaged areas collecting the dirt result in microbial growth. Conveyor belts get contaminated by foodborne pathogens such as *Listeria monocytogenes* and *Escherichia coli.* Due to disinfection and cleaning techniques, pathogens grow on the belt surface and they form biofilm which is hard to remove by using conventional cleaning techniques [1].

2.EXPERIMENTAL

The aim of this study is to obtain antimicrobial conveyor belts for carrying food products, especially poultry. For this purpose, commercial antimicrobial additives; Ionpure (0.3, 0.5 and 0.7 wt%), Smart Silver (0,3 wt%) and Zinc Omadine (0.3, 0.5 and 0.7 wt%) were used. Each of them was first added to a coating paste which was composed of a PVC (polyvinyl chloride) polymer, plasticizer, defoamer, thickener and a heat stabilizer and then the prepared mixture was coated on carcass fabrics to obtain conveyor belts with antibacterial functionality. [2, 3].

Antimicrobial activity tests were carried out according to ASTM E 2180 and neutralization solution was prepared according to ISO 20743-Title 6.10 [4, 5, 6]. The bacterium *Listeria innocua* was chosen instead of *Listeria monocytogenes*. Because it very much resembles its family member, *Listeria monocytogenes,* but it is non-pathogenic.

3.RESULTS

After the antimicrobial tests, the coated conveyor belts materials showed antibacterial property. The results, which were obtained at 24 hour-contact time, can be seen from Table 1.

Table 1. The amount of bacterial colonies

Specimen	Dilution	Colony number
"0" h control samples	No	Too many to count
"0" h control samples	10^{-2}	2,62x10^{5} Cfu/ml.
"0" h control samples	10^{-3}	2x 10^{5} Cfu/ml.
"24" h control samples	No	Too many to count
"24" h control samples	10^{-2}	Too many to count
"24" h samples with 0,3 % IONPURE	No	Too many to count
"24" h samples with 0,3 % IONPURE	10^{-2}	Too many to count
"24" h samples with 0,5 % IONPURE	No	Too many to count
"24" h samples with 0,5 % IONPURE	10^{-2}	Too many to count
"24" h samples with 0,7 % IONPURE	No	Too many to count
"24" h samples with 0,7 % IONPURE	10^{-2}	Too many to count
"24" h samples with 0,3 % Smart Silver	No	Too many to count
"24" h samples with 0,3 % Smart Silver	10^{-2}	Too many to count
"24" h samples with 0,3 % Zinc Omadine	No	0
"24" h samples with 0,3 % Zinc Omadine	10^{-2}	0
"24" h samples with 0,5 % Zinc Omadine	No	0
"24" h samples with 0,5 % Zinc Omadine	10^{-2}	0
"24" h samples with 0,7 % Zinc Omadine	No	0
"24" h samples with 0,7 % Zinc Omadine	10^{-2}	0

Listeria innocua bacteria could not survive on the conveyor belts containing Zinc Omadine, however, they continued to survive on conveyor belts with Ionpure and Smart Silver. Results of antibacterial tests showed that Zinc Omadine had the same antibacterial activity for all concentrations (0.3, 0.5, 0.7 wt%) and with or without dilution.

ACKNOWLEDGEMENTS

The authors would like to thank to Izmir Institute of Technology, Biotechnology and Bioengineering Research And Application Centre for antibacterial tests.

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A FASHION DESIGN PROJECT ON ILLUMINATED TEXTILE APPLICATIONS

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Abstract: *By touching briefly on definitions of technical and smart textiles terms, it is mentioned how technical textiles had begun using on fashion design.*
Primarily, illuminated textile designs and applications are exemplified. Accordingly, a fashion design project titled "Utopia" is introduced from front end to the realization of the garments. The haute-tech collection is based on a smart fabric which is made of woven fiber-optics.

Keywords: *woven fiber-optics, illuminated textiles, Leds, high tech fashion, haute-tech*

1. INTRODUCTION

Wherefrom early nineties nonflammable and sportive textiles have been used by fashion designers, developments in e-textiles provided a basis for wearable-techs industry. Thus "haute-tech" and "high-tech fashion" terms have been ensued lately.
A garment is seen, felt, touched, heard and smelled.The many output options can stimulate any of our senses [1]. Smart textiles that relates to our visual senses can be made of Leds, fiber-optics, EL wires and e-ink. Such materials are named as illuminated textiles.
After displaying some design application references on illuminated textiles, an illuminated design project on clothing is presented that consists of six garments. A smart fabric that can emit its own light is the main material of the collection.

2. OBJECTIVE AND METHOD

2.1. Objective

In this fashion design project it is aimed at:
With the inspiration of traditional Ottoman clothes and techniques to achieve an innovative look by changing ancient materials with high-tech and new methods.
Instead of ancient(traditional) threads and techniques, the initial objective was using a high-tech material but remaining the same glamour and brilliance in a contemporary way.

2.2 Method

In the light of the objective, material research has been done and illuminated textiles, applications on fiber-optics and leds were investigated. As a result, "Luminex" was chosen as the best option for the garment forms and the collection. The smart fabric was integrated in the garments by special cutting, sewing and printing processes. Hereby technical structure and qualifications of the smart material took a leading part in the designing stage.

2.3.Technical properties of the material

Luminex is a fabric made of woven fiber-optics (P.o.f=Plastic optical fibers) that can emits its own light.
To obtain the elasticity, flexibility and resistance as the textile fibers, most suitable type of plastic fiber is used with advance technology.Luminex is normally produced

with a 250 micron diameter P.O.F (for the quantity of carried light and the pleasant touch of the weaved fabric. Some parts of the looms were modified to obtain a rather regular weaving process. The optic fibers are used as the weft threads of the fabric. it can be woven with conventional fibers; either natural and/or synthetic. The source of light normally used to illuminate the fabric is a 5 mm LED, in the basic colors red, white, blue, green and yellow.
To illuminate the fabric, the leds need to be connected to a small portable battery with electric cables [2].

3. RESULTS AND DISCUSSION

Fashion trends begins to show up on the catwalks first, then it leads to change in manufacturing. Therefore it is inevitable that as well as ready-to-wear industry is making use of haute couture, wearable-tech is taking advantage of fashion. First of all technical textiles had been used by fashion designers in the early nineties [3] with innovative purposes by disregarding the aim of manufacturing. Since then high-tech textiles have been taking place in design not only for safety, resistance, health etc. requirements but also for fashionable and artistic aspects.

4. CONCLUSION

Beyond comprising functional and technical qualifications, fashion design has to push the limits of creativity. The innovations in technology can only be put in practice by design. It would be unimaginable to exhibit exceptive attitude about fashion. On the source of all the things above, multidisciplinary approach on high-tech wearables has become a necessity. In academia leading Institutes has begun taking first step by providing interaction design programs.

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CAPTURE OF UNPLEASANT ODOUR BY BETA-CYCLODEXTRIN APPLIED COTTON FABRIC

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Abstract: *Cyclodextrins are special substances those can generate inclusion complex with a wide range of molecules by help of their special and unique chemical and physical properties of the host molecules are changing. Thanks to this property, cyclodextrins get into a broad range of use in many areas. The scope of this article is designing a textile substance which can adsorb undesirable odours by help of cyclodextrins complex generation capability with sources of these odours. In this paper, 100% cotton fabrics have been treated to aniline and cyclohexylamine those are having unpleasant odour with vaporization property at room temperature. The structures of inclusion complex formation between β-CD and aniline, cyclohexylamine vapours have been evaluated by help of various characterization analysis methods. ToF-SIMS, DSC, TGA, FTIR, GC-MS analyses were applied to exposed fabrics.*

Keywords: *unpleasant odour, cyclodextrin, volatile amines, aniline, cyclohexylamine, gas phase*

1. INTRODUCTION

Cyclodextrins have been used for scent, cosmetic and dye applications in textiles [1]. Nowadays, filtrate fibers and fabrics incorporating cyclodextrins have been growing interest for researchers. Entrapping ability gives a unique filtration. Incorporating cyclodextrins into nanofibers shows filtration and separation effects at both liquid and gas phase [2-4]. The aim of this study is to give capturing ability of volatile organic compound vapours, which can cause unpleasant odors. Cyclohexylamine and aniline were selected as a suitable model compound because of their cyclic structures.

2. MATERIAL AND METHOD

Grafting of water-soluble cyclodextrins on cotton surfaces has received attention for textile applications. Cotton fabric samples were dipped into the padding liquor, which consist of water, β/CD and BTCA.

Cotton fabrics were tested for trapping aniline vapor. 1mL of aniline was placed on a watch glass and left in glass desiccators for 1 h. After that, cotton fabric/ β-CD was placed into the glass desiccators and the desiccators were sealed. The cotton fabric/ β-CD was kept in aniline atmosphere in the desiccators. Cyclohexylamine was applied with the same method. The treated fabrics were analyzed ToF-SIMS, DSC, TGA, FTIR and GC-MS. And also, for the 10 wash durability testing method, used BS EN 20105C06.

3. RESULT AND DISCUSSION

At lower mass range, a few differences are observed between ToF-SIMS spectra of cotton fabrics. Sample is even more clearly distinguished in the higher mass range. The presence of CD is clearly established by peaks that can be assigned because of the high mass resolution achievable. Cyclodextrin at atomic mass unit values 1158.46 [2].

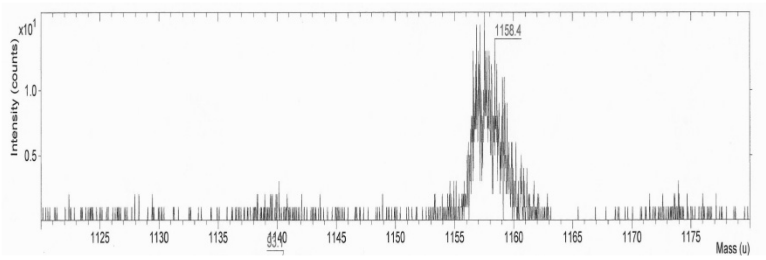

Figure 1. Positive ion static ToF-SIMS spectra from cotton/CD fabrics samples in the mass range 1120-1180 units showing molecular CD peak

CD host-guest inclusion complexes were investigated by TGA, DSC, FTIR-ATR and GC-MS analysis. TGA and DSC results show that host-guest inclusion complexes were observed in the case of both aniline and cyclohexylamine. GC-MS results show that treated fabrics have trapping ability for both aniline and cyclohexylamine.

4. CONCLUSION

In this investigation β-CD was grafted on to cotton fabric surfaces. We have shown that these cotton fabric/ β-CD entrap organic waste vapors such as aniline and cyclohexylamine from the environment. These findings are very promising and show the potential application for the cyclodextrin functionalized fabric which may be used as molecular filters or cotton fabrics for filtration/purification/separation purposes.

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POSTER PRESANTATIONS

A RAPID METHOD FOR FIBER CROSS-SECTIONS BY SEM AFTER MINIMAL SAMPLE PREPARATION

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Abstract: *Microscopy is the primary tool for fiber analysis and its application range includes from light microscopy to electron microscopy. In order to reduce sample preparation steps, samples were prepared by using a hardy microtome without any other treatment and any surface coating material for imaging. Especially, fibers which have high opacity were studied by scanning electron microscope and the results were compared with light microscope.*

Keywords*: SEM, sample preparation, fiber cross-section, microscopy, microtome.*

1. INTRODUCTION

Microscopy is the most discriminating method because most textile fibers can be excluded from a known sample by size, shape, color, or some other easily observable characteristics. The transparency/opacity of the fibers is a factor to be noted, as well as any coloration [1].

Scanning electron microscopy (SEM) can be used as an imaging and micro analytical tool in the characterization of fibers. Fiber surface morphology can be examined with great depth of field at continually variable magnifications [2]. SEM is used for investigations about textile fibers (bamboo, wool, silk, bagasse, PP, acrylic, angora wool, etc.) and provides more useful information on the results [3-9].

Although chemical bleaching is used to examine the dark-colored fibers, light microscopes may not be useful for these type fibers due to weak light transparencies. It is possible to reach a more effective result by using a SEM.

There are several developed techniques for preparation of cross-section such as plastic plate, brass plate, cork, hardy and rotary microtome methods [10]. Palenik and Fitzsimmons described a relatively simple method for preparing cross-sections. In their procedure, the fiber to be examined is sandwiched between two thin films of PE, the whole being mounted on a glass slide with a cover slip and placed on a microscope hot-plate. Additional methods, including fiber microtomes, fibers suspended in epoxy filled piped tips, and Teflon coated slides have been published [1].

The aim of this study is to develop a rapid method for studying of fiber cross-section.

2. MATERIAL AND METHOD

Fiber cross-sections are prepared by using a hardy microtome (Fig.1).The samples were directly mounted to microtome without any chemical as binder and examined by TESCAN-VEGA3 SBU-EasyProbe SEM-EDX without any coating material such as C or Au (Fig.2). During the observations, normal working modes of SEM were used. Several fiber samples, especially high opacity fibers were selected.

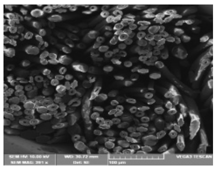
Figure 1: Sample preparation

Figure 2: Microtome in the chamber of SEM

3. RESULTS AND DISCUSSION

After same sample preparation process, for an opaque sample, the images are given in Fig.3. Image from light microscope is not appropriate due to the sample opacity. Information on fiber cross-sections obtained by SEM is more effective than light microscope.

(a)



(b)

Figure 3: Images for an opaque sample by light microscope (200x) (a) and SEM (391x) (b)

This study specifies a rapid method for fiber cross-sections, especially opaque types. According to this method, cross-sections are prepared by using a hardy microtome without any binder and coating material. Therefore, it can be reached to reliable results by consuming a time of thirty minutes approximately.
This method was found successful for overcoming of light microscope limitations.

Acknowledgements

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AN INFLUENCE OF THE HEAT TRANSFER MATERIAL TO THE SPORTSWEAR FABRICS EXTENSIBILITY

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Abstract: *The influence of heat transfer materials on the deformability of the knitted fabrics during their uniaxial extension was analyzed in this work. The results have shown that specimens strain depends not only on the bonded heat transfer material properties but also on the surface area covered by heat transfer material. Additionally, the experiment has shown that breaking of specimen may occur in the area of knitted single layer, covered with heat transfer material or in the zone of transfer edge. Visual and stress-strain curves analysis allowed observing some specimens which did not break simultaneously and determine cases of heat transfer materials cracking. The result indicated that extensibility of knitted fabrics after transfer usage may decrease till 27 per cent and judging by the gathered data this degree depends on the transfer material area.*

Keywords*: knitted fabrics, heat transfer material, extensibility*

1. INTRODUCTION

Knitted fabrics, which usually have softer handle, flexibility and elongation, are often used for sportswear, casual and leisure wears. One of the important properties of these fabrics is their easy deformability which is very important for wearing comfort [1]. Very often heat transfer materials are being used in these clothes for decoration and special effects [2]. Though many of heat transfer materials are characterized as soft and stretchable, sometimes they may crack during wear and overmuch stabilize some clothes parts. As a rule, the materials that have an additional polymer are more rigid [3].

The aim of this work was to determine the influence of the heat transfer material on the extensibility of knitted fabrics.

2. MATERIALS AND METHODS

Four knitted fabrics with basic characteristics that are presented in Table 1 were used in this work. As a heat transfer the PVC material *Firstmark* with self-adhesive and transparent polyester carrier was used. The thickness of this monocoloured material was 0.21mm and thickness of tested fabrics ranged from 0.46 till 0.68 mm. The heat seal press *Insta* MS728T was used for PVC layer transferring onto knitted fabrics specimens. The bonding conditions were: temperature 150^{o}C, duration 15s and 3 bar pressure. The polyester backing was removed after transfer material became cool. The rectangular specimens of knitted fabrics with width of 50 mm and working zone of 100 mm were cut in wale, course and bias directions. The square heat transfer material (50x50mm) was bound in the middle of the specimen.

Table 1. Properties of tested fabrics

Fabric's symbols	Composition	Density, cm^{-1}		Mass per square meter, g/m^2	Thickness, mm
		Wale	Course		
M1	96 % CO, 4% Lycra	20	15	160	0.60
M2	71 % PES, 29 % PU	15	17	127	0.46
M6	94 % PA, 6 % EL	35	20	147	0.60
M7	100 % PES	25	17	146	0.68

On purpose to investigate the coated area influence on the knitted fabrics extensibility three types of transfer material shapes were used in this work: entire square (2500 mm^2), perforated with nine circular holes (1645 mm^2) and perforated with six rectangular holes (124 mm^2). Uniaxial tensile tests were carried out using a *Tinius Olsen HT10* tension machine. The cross – head speed was kept at 50 mm/s. Fabrics deformation properties during their extension till breaking were investigated using such characteristics as maximal force F_{max}, strain at maximal force ε_{max} , force at break F_n, strain at break ε_n and strain ε_1 at F_1=20N/cm. Three repeats per specimen were carried out and the average was calculated. The strain-stress curves analysis and visual evaluation of specimen break types was also fulfilled in this work.

3. RESULTS AND DISCUSSION

The results have shown that during extension the breaking of most specimens occurred almost instantaneously, i.e. the maximal force F_{max} was equal to force at break F_n. The distortion which lasted for a period of time was determined for some specimens of fabrics M1 and M7 in wale direction and for all specimens of fabric M6 in course direction. The degree of extensibility was determined using the ε_1 characteristic. The received results have shown that heat transfer element decreased the extensibility more in the course than in other tested directions. The minimal decrease of characteristic ε_1 was determined for specimens with perforated transfer material of lesser area.

4. CONCLUSION

The results have shown that knitted fabrics' strain depends not only on the bonded heat transfer material properties but also on the surface area covered by heat transfer material and on the structural characteristics of knitted fabrics.

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APPLICATION OF DIFFERENT TYPES OF FLAME RETARDANT AGENTS ON COTTON FABRICS

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Abstract: *This study presents the use of natural structured and conventional flame retardant (FR) agents in padding treatment to provide fire-resistant cotton fabrics. Whereas the natural structured flame retardant agent was obtained from limestone and consisted of any industrial additives, the conventional flame retardant agent was phosphonate-based. In order to determine the flame retardant effects of these agents, vertical burning tests were carried out. According to the results, it was observed that all types of flame retardant agents improved the flame retardant effect of cotton fabrics but the space between two edges of burned cotton fabrics which treated with natural structured flame retardant agent was almost non existing.*

Keywords*: cotton fabric, flame retardant agent, padding, natural structured*

1. INTRODUCTION

Although cotton is the most commonly used textile fiber in domestic applications (clothes, beddings, furnitures, wall-hangings, etc) it is also one of the most flammable materials (LOI 18.4%) [1-6]. Most of flame retardant (FR) treatments, formulations and additives have been developed since 1950-1980 but increasing concerns over the toxicological and environmental consequences of using such chemical species on textile substrates have created new chemistry and applications [7-9]. The FR agent used for cotton fabric must be halogen-free, inexpensive, wash-resistant stable and non-toxic [10]. However, durable flame retardants are more complex, more than the nondurable type [11]. FR cotton fabrics are generally prepared by treating the fabric chemically in a finishing process by using different flame retarding agents. Recently, there has been interest to develop FR cotton fabrics by using halogen-free phosphorus-based compounds which act as flame retarding agents in condensed phase by increasing the amount of carbonaceous residues or by increased char formation [3,12,13].

2. MATERIAL AND METHOD

2.1. Material

% 100 woven cotton fabrics (35 warp/cm x19 weft/cm) were used as a material in flame retardant finishing treatment. Both the finenesses of warp and weft yarns were 28.4 Ne.

2.2 Finishing Process

600 g/L flame retardant agents were used in padding system. The pick-up ratio was 90 % during the study. After padding process, fabrics were dried at 110 ^{0}C for 2 min and cured at 170 ^{0}C for 1 min.

3. RESULTS AND DISCUSSION

Increase of 14,714 % was occurred in weights of cotton fabric treated with natural structured FR agent waiting 30 days after cure process whereas this increase was 6,66 % in weights of cotton fabric treated with phosphonate-based FR agent. The color of fabric padded with natural structured FR agent was 2.8 % more dark when compared with untreated fabric whereas this darkness was 0.5 % more in the cotton fabric treated with phosphonate-based FR agent. According to vertical burning test (to IMO A471 standard) the flame retardant effect of natural structured FR agent was better than the conventional one.

4. CONCLUSION

As mentioned in the previous study [14], it is considered that the property of moisture adsorption of natural structured FR agent which consisted of crystal forms of calcium carbonate ($CaCO_3$) caused increases in weight and darkness of treated cotton fabric.

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DEPOSITION OF NANOPARTICLE MULTILAYERS TO IMPROVE MECHANICAL PROPERTIES OF DENIM FABRICS

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Abstract: *Al_2O_3 nanoparticles were used for fabrication of multilayer nanocomposite film deposition on cationic denim fabrics by electrostatic self-assembly to improve the mechanical properties. Denim fabrics were pre-treated with 2,3- epoxypropyltrimethylammonium chloride (EP3MAC) by a pad-batch method for cationic surface charge. Scanning electron microscopy (SEM) was used to verify the presence of deposit nanolayers. CIElab analysis was performed on the fabrics before and after the treatment with Al_2O_3 nanoparticles by the layer-by-layer deposition method. After aging processes, the effect of layer-by-layer deposition method on the some of the physical properties of denim fabrics were also investigated.*

Keywords*: electrostatic self-assembly, Al_2O_3 nanoparticles, mechanical properties*

1. INTRODUCTION

Polymer-based multilayer films created by electrostatic self assembly (ESA) or layer-by-layer (LbL) deposition are currently used to modify the surface properties of materials used in various fields of science. Most types of charged molecules, nanoparticles, dyes, proteins and other supramolecular species seemed to be suitable for deposition by the LbL method, but generally polyelectrolytes have been employed. The LbL process is based on the alternating adsorption of charged cationic and anionic species [1, 3].

2. MATERIAL AND METHOD

The cationic denim fabric was prepared by using EP3MAC. EP3MAC solution was applied to the denim specimens at 100% wet pick-up and fabric samples kept for 24 h at ambient conditions in Ziploc bags. Aluminum oxide nanoparticles (particle size < 50 nm, specific surface area 40 m^2/g) were purchased from Aldrich and 0,1 wt % Al_2O_3 nanoparticle suspension was prepared at 40 W for 1 h by Sonics Vibra-Cell Ultrasonic Homogenizer. The pH of nanoparticle suspension was adjusted to 2,5 by using HCl. Poly(sodium 4-styrene sulfonate) (PSS, Mw=70.000) was purchased from Aldrich and aqueous solution of PSS was prepared at concentrations of 3 mM/l using deionized water.

For the Al_2O_3 nanoparticle/PSS multilayer film deposition process, the positively charged denim fabrics were applied in the following solutions alternately: (a) the anionic Al_2O_3 colloid solution, (b) the deionized water, (c) the cationic PSS solution, and (d) the deionized water. This deposition cycle was repeated until 8, 12 and 16 multilayer films were deposited on the denim fabrics. Multilayer film coated denim fabrics were dried at 60 °C and cured at 105 °C for 5 min. SEM measurements were used to examine the surfaces of denim fabric samples. The mechanical tests were performed on a Lloyd LR5K Plus electronic tensile strength machine according to TS EN ISO 13934-1 (Textiles- Tensile properties of fabrics- Part 1: Determination of maximum force and elongation at maximum force using the strip method) Standard. The breaking strength of the untreated, cationized and multilayer films deposited fabrics was tested at fracture. Denim fabrics were kept for 24 h at ambient conditions (20 °C and 65 % RH) before the mechanical test.

3. RESULTS AND DISCUSSION

The presence of Al_2O_3 nanoparticles in the denim fabric after the LbL process is verified with SEM analysis. For fabrics with 8, 12 and 16 layers Al_2O_3 nanoparticles deposited denim fabrics; cationized denim fabric and untreated denim fabric breaking strength values were measured. After cationization process for warp and weft direction fabrics breaking strength values decreased. The breaking strength test results clearly demonstrate that higher Al_2O_3 nanoparticles content with the increase in layer numbers leads to higher breaking strength.

Samples	Breaking strength (warp, N)	Difference (%)	Breaking strength (weft, N)	Difference (%)
Samples before washing*				
Untreated	1791,127	-	1147,361	-
Cationized	1722,12	% -3,9	1070,153	% -6,7
Samples after washing*				
Untreated	1636,467	-	1072,29	-
Cationized	1574,067	% -3,8	998,9033	% -6,8
PSS/Al_2O_3 8 layer	1706,233	% 4,3	1100,433	% 2,6
PSS/Al_2O_3 12 layer	1719,832	% 5,1	1136,623	% 5,9
PSS/Al_2O_3 16 layer	1719, 802	% 5,1	1130,4	% 5,4

* washing: desizing, pumice and enzyme washing processes

4. CONCLUSION

In conclusion, we have demonstrated and characterized the possible deposition of Al_2O_3 nanoparticle based films assembly onto denim fabrics. With Al_2O_3 nanoparticles multilayer deposition, weft and warp direction tensile strength values were increased. Al_2O_3 nanoparticles enhanced mechanical stability of the fabrics. The effect of aging methods on the Al_2O_3 nanoparticle based films deposited denim fabrics will be investigated.

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DISPERSION QUALITY OF COATED CALCIUM CARBONATE IN POLYETHYLENE MATRIX POLYMER

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Abstract: *This work reports dispersion properties of coated calcium carbonate in polymeric materials. Firstly, ground calcium carbonate was coated with different coating agents and then incorporated into polyethylene matrix polymer using different processing types (melt extrusion and high shear mixing). It was revealed that independent upon the type of coating agent and coating amount dispersion quality was not changed. However, dispersion quality was changed dependent upon the processing type used.*

Keywords: *calcium carbonate, stearic acid, compounding, particle size*

1. INTRODUCTION

Calcium carbonate being one of the most abundant minerals in nature has been produced according to two methods, i.e., ground (GCC) and precipitated calcium carbonate (PCC) and used frequently in a wide range of applications including paper, paint, food, ceramic, construction, ink, adhesive, drug, cable, and plastic industries. Calcium carbonate is traditionally used in plastics as bulking agent to substitute the expensive polymers. It is difficult to distribute calcium carbonate homogeneously in plastic materials since it has a hydrophilic and a lyophilic character. Therefore, calcium carbonate to be used in plastic industry is coated generally with stearic acid and its salts [1-4]

2. MATERIAL AND METHOD

Uncoated and coated calcium carbonate, technical grade stearic acid, and linear low density polyethylene (LLDPE, $MFI_{2.16kg/190oC}$ = 2 g/10 min) were provided from Mikron's A.Ş. Calcium carbonate was coated with stearic acid in dry state using Cyclomix 5 dry coater and then compounded with LLDPE using a co-rotating twin screw extruder (diameter: 27 mm, L/D = 44, PTLE 2744, Polimer Technics Bursa) and high shear mixer (Gelimat, Draiswerke Inc.). Five different processing aids were used for ease of dispersion. Morphologies of the cryo-fractured samples were studied using Scanning Electron Microscopy (SEM).

3. CONCLUSION

In this study, we have shown that coating amount didn't change the dispersion quality but processing type affected the dispersion quality considerably. The best results were obtained when used the twin screw extruder. And using processing aids were determined to have no effect in terms of particle size and particle size distribution.

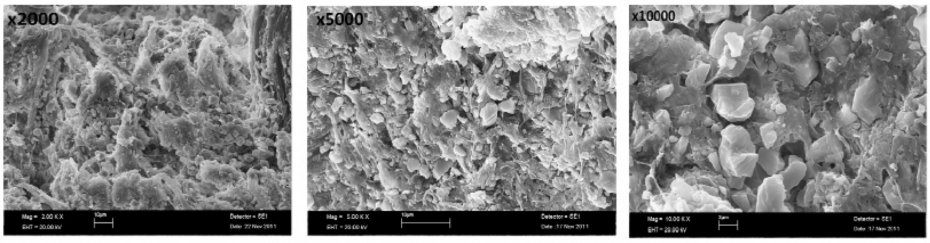

Figure 1. LLDPE/$CaCO_3$ (60/40 w/w) compound prepared on twin screw extruder

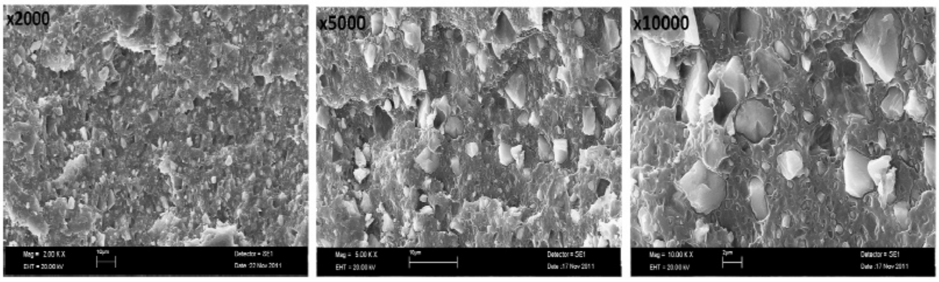

Figure 2. LLDPE/$CaCO_3$ (60/40 w/w) compound prepared on high shear mixer

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FACTORS THAT AFFECT THE INTERACTION OF BRAIDED COLON AND PLASTIC PARTS OF LOAD TRANSFER THREAD

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***Abstract:**. Load transfer threads are produced by generally braided colon and plastic end points. In this study, the affect of surface properties and rigidity of the braided colons on the blocking resistance was investigated. More roughly surface and less rigidity of the colon results in higher blocking resistance.*

***Key Words:**braided colon, load transfer thread, blocking resistance, technical textiles*

1. INTRODUCTION

Load transfer threads are used between the driving and drive units. The mounting of these threads are made by using plastic parts of the colon. The size and form of the plastic parts of the colon are designed according to the mounting areas. These types of threads are produced by using injection machines with appropriate mould [1]. During usage, the load transfer from driving unit to the braided colon [2] and plastic parts of the thread and then transfer to the drive unit. This load results stress between colon and plastic parts. Due to this stress shearing force is occurred between plastic parts and colon. The damage is depending on the interaction of the colon and plastic part. The interaction is effected by many factors especially injection process parameters such as the density of the plastics, cure processes and void amount, and surface properties and rigidity of the braided colon [3]. In this study, surface properties and rigidity of the braided colon affect on the blocking resistance was investigated.

2. MATERIAL AND METHOD

In this study 4 types of braided colon were used. The properties of these colons were given in Table 1. The plastics end points of all load transfer threads are made of same material and are POM (polyasetal).

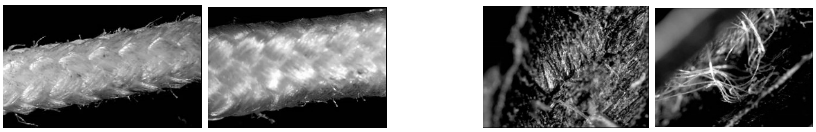
Table 1: The properties of braided colons

	A sample	B sample	C sample	D sample
Material type Filling and Braided yarn	PET	PET	PET	PET
Colon linear density (tex)	188	-	123	176
Filling yarn diameter(mm) Braided colon diametere (mm)	1,91 2,92	2,22 3,04	2,51 2,95	2,36 2,93
The amount of yarn in per unit on the braided surface (amount/cm)	6,8	5,1	7,0	5,8
Cross-section of filament	distorted round	distorted round	distorted round	distorted round
Filament diameter (micron)	22	22	22	22
Filling material	Filament yarn	Filament yarn	Braided colon	Filament yarn

For determining interaction behavior between plastics and braided colons, 5 parameters were investigated. Surface properties of colons and inner surface of plastics, blocking resistance between colons and plastic parts, rigidity of braided colons, filling material properties and surface appearance of both colons and inert surface of plastics after shearing test. Material properties were identified by using FT-IR analysis and DSC analysis.

3. RESULTS AND DISCUSSION

According to the FT-IR and DSC analysis, there is not any meaningful difference between all plastic parts of molecular structure and molecule chain length. Yarns which were used as filling or braided yarn molecular structure similar to each other. As seen Figure1-4 and Table 2, the separation behavior of the plastic parts from the braiding colon was changed according to surface properties and rigidity of the braiding colons. More roughly surface and less rigidity increase the blocking resistance. Due to higher blocking resistance the usage time of the thread will be longer. Roughly surface and less rigidity of the colon permit the plastic melt in to the filament yarns on the surface of the colon, because of that, the interaction between plastic and colon surface get be closely and blocking resistance get be higher.



-a- -b- -c- -d-

Figure 1. The surface appearance of a: A, B and D braided colons, b: C braided colon, c: A, B and D's inner surface of plastic and d: C's inner surface of plastic after blocking resistance test

Table 2: The results

	A sample	B sample	C sample	D sample
Colon rigidity (cm)	7,8	7,2	13,5	8,4
Blocking resistance (N)	642	757	514	702
Surface appearance of colon	high fuzzy level	high fuzzy level	low fuzzy level	high fuzzy level
Surface appearance of inner surface of plastics	filament breakage - colon surface shape observed	filament breakage - colon surface shape observed	no filament breakage -only colon surface shape observed	filament breakage - colon surface shape observed

4. CONCLUSION

The load transfer thread performance not depends on the tensile strength of the braided colon, depends on the blocking resistance between colon and plastic parts. The higher blocking resistance can be obtained by using less rigidity and roughly surface colon, if the other parameters are constant.

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INVESTIGATION OF LAYER-BY-LAYER DEPOSITION METHOD FOR FUNCTIONALIZATION OF COTTON FABRICS

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Abstract: *Multilayer nanocomposite films composed of anatase TiO_2, ZnO and Al_2O_3 nanoparticles were fabricated on cationically modified woven cotton fabrics by the layer-by-layer molecular self-assembly technique. For a cationic surface charge, cotton fabrics were pre-treated with 2,3-epoxypropyltrimethylammonium chloride (EP3MAC) by a pad-batch method. X-ray photoelectron spectroscopy (XPS) and scanning electron microscopy (SEM) were used to verify the presence of deposit nanolayers. Nano-TiO_2 deposition enhanced the protection of cotton fabrics against UV radiation, ZnO deposition enhanced the antibacterial protection and Al_2O_3 deposition enhanced flame retardancy properties of cotton fabrics in comparison with the untreated cotton fabrics.*

Keywords*: electrostatic self-assembly, TiO_2, ZnO and Al_2O_3 nanoparticles, UV protection, antibacterial activity, flame retardancy*

1. INTRODUCTION

The sequential adsorption of oppositely charged colloids was reported in a seminar paper in 1966 by R Iler. Starting in the early 1990s, Decher's group rediscovered layer-by-layer (LbL) processing to fabricate multilayer thin films from oppositely charged polyelectrolytes [1]. The LbL process is based on the alternating adsorption of charged cationic and anionic species. The oppositely charged species are held together by strong ionic bonds and form long-lasting, uniform and stable films, which are often impervious to a solvent. [1–4].

2. MATERIAL AND METHOD

Cationic cotton was prepared by using EP3MAC. EP3MAC solution was impregnated to the cotton specimens at 100% wet pick-up and fabric samples kept for 24 h at ambient conditions in Ziploc bags. 0.1 wt% nanoparticle suspensions were prepared at 40 W for 1 h by Sonics Vibra-Cell Ultrasonic Homogenizer. In the deposition process, the pre-treated cotton fabrics were immersed in the following solutions alternately for 5 min periods; (a) the anionic nanoparticle colloid solution, (b) the deionized water, (c) the cationic nanoparticle colloid solution, and (d) the deionized water. This deposition cycle was repeated until 10 and 16 multilayer nanoparticle films were deposited on the cotton fibers. Multilayer film coated cotton fabrics were dried at 60 °C and cured at 130 °C for 3 min.

XPS and SEM measurements were used to examine the surfaces of woven cotton samples. A UV Penetration and Protection Measurement System (SDL/ATLAS) was used to obtain the UPF value of the TiO_2 multilayered cotton fabrics according to Australian–New Zealand Standard AS/NZS 4399:1996. ISO 20645 Textile Fabrics-Determination of Antibacterial Activity-Agar Diffusion Plate Test Method was used to obtain the antibacterial activity of the ZnO multilayer film–deposited cotton fabrics against *Staphylococcus aureus* (Gram positive) bacteria. LOI was measured for

Al_2O_3 nanoparticle multilayer deposited cotton fabrics according to ASTM D 2863-77 by using the LOI instrument.

3. RESULTS AND DISCUSSION

The presence of TiO_2, ZnO and Al_2O_3 nanoparticles on the cotton fabric after the LbL process is verified with SEM and XPS analysis. For fabrics with 10- and 16-layer TiO_2 nanoparticle deposited cotton fabrics the UPF value is obtained as 50+. According to the AS/NZS 4399:1996 standard test method the value of UPF > 40 shows excellent protection against UV. Cotton fabrics deposited with 10 and 16 layers of ZnO nanoparticle films were dipped in a bacteria containing solution by following ISO 20645 test method Nano-ZnO 10 and 16 multilayer film–deposited cotton fabrics showed 1.5-cm and 1.8-cm inhibition zone, respectively. The antibacterial activity test results clearly demonstrate that higher ZnO nanoparticles content with the increase in layer numbers leads to higher antibacterial activity. LOI values of Al_2O_3 nanoparticle deposited cotton fabrics were analyzed after LbL process. The results show that the LOI values of the Al_2O_3 nanoparticle deposited cotton fabrics are increased, thus an improved flame retardancy of the compositions.

4. CONCLUSION

In conclusion, we have demonstrated and characterized the possible deposition of TiO_2, ZnO and Al_2O_3 nanoparticle based films assembly onto woven cotton fabrics.

ACKNOWLEDGMENTS

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INVESTIGATION OF PROPERTIES OF SMART HYBRID YARNS HAVING SHAPE MEMORY ALLOYS

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Abstract: *Applications of smart materials into textiles attrack considerable great attention of academic and industrial sectors due to functional and interesting usage fields of smart textiles. In this study, properties of different hybrid yarns produced by using shape memory alloy wires in a yarn spinning machine are presented in terms of wire type and yarn parameters. Such these yarns can be woven or knitted to develop smart fabrics to be used for medical aims.*

Keywords: *hybrid yarn, smart textile, shape memory effect, shape memory alloy*

1. INTRODUCTION

The ability of smart materials to respond external stimuli such as temperature, light, pH, etc. is of high scientific and technological significance [1]. The thermally induced shape memory effect is the capability of material to change its shape (see Figure1) in a predefined way in response to heat. Because of the high technological significance, shape memory materials possess many interesting applications in the fields of textiles, defence aerospace and biomedical. Shape memory alloys are the well known and oldest shape memory materials among others including polymers, gels and ceramic [2].

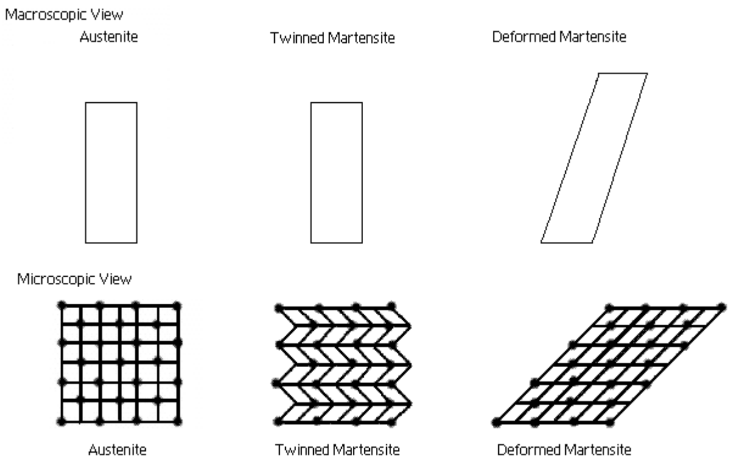

Figure 1. Microscopic and macroscopic views of the two phases of shape memory alloy [3]

The hybrid yarns were produced by using core spinning technique and yarns made of shape memory Ni-Ti alloys wires and textile rovings were investigated in terms of shape memory effect and yarn mechanical properties.

2. MATERIAL AND METHOD

Regarding the Nickel-Titanium (Ni-Ti) alloy characteristics, alloy is 54.8 ±0.5 wt% Ni -balance Ti while the melting point is at 1300°C. Ni-Ti wires have two different diameters (0.025 mm and 0.050 mm). Firstly, shape memory alloy wiress were trained according to its martensitic transformation temperatures (see Figure 2). Then, yarn formation was realized by using textile rovings in the sheat and these treated shape memory alloy wires in the core.

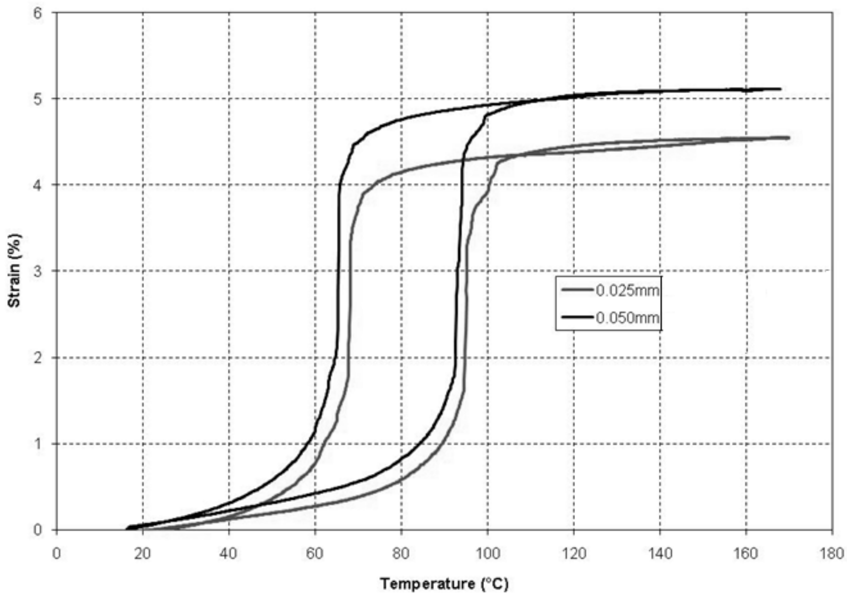

Figure 2. The hysteresis curves on both wires under a tensile load of 200MPa.

3. CONCLUSION

In this study, properties of yarns having shape memory effect were investigated in terms of wire content and yarn construction. These yarns can be used to produce smart fabrics by knitting or weaving for different aims.

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INVESTIGATION OF TEXTILE LAMINATES STRUCTURE AND PROPERTIES ON WORK SHOES COMFORTABILITY

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Abstract: *Textile laminates with breathable membranes are used extensively in protective footwear. The polymeric membrane acts as a barrier to liquid water and soil entry, but is sufficiently permeable to water vapour to allow significant amounts of sweat to evaporate. In this paper the influence of multifold water vapour resorption/desorption process on hygienic and electrical properties of textiles lining laminates for work shoes is presented. It was shown that equilibrium of water uptake increases with the increase of resorption/desorption process. Resorption/desorption process influences not only on the laminates absorption parameters but also changes the character of sorption kinetics and electrical resistance.*

Keywords*: textiles laminates, semi-permeable membrane, breathability, electrical resistance*

1. INTRODUCTION

During wet working conditions workers wear protective boots witch are resistant to moisture penetration. Commonly, the increase of water resistance reduces water vapour permeability of materials and increases vapour concentration due to the water vapour condensation [1]. Water vapour transfer through the footwear directly affects the comfort of foot. Because not all accumulated moisture is removed when footwear is dried and, as the result, the sensation of discomfort can increase. Recently new textile laminates with semi-permeable polymeric membranes in the footwear textile lining have been used. They are simultaneously permeable to water vapour from the inside, but waterproof from outside [2]. Not only breathability, but electrical properties of textile laminates also depend on the structure and can changes during foot perspiration [3].

2. MATERIAL AND METHOD

2.1. Preparation of Textile Laminates

Multilayer lining material Dryliner (L) that composed from PES knitting fabric, non-woven cotton fabric and foamed polyurethane layer was used for the investigation. In order to increase the lining resistance to water penetration the semi-permeable microporous polyurethane membrane Puratex (M) was hot laminated on the bottom of lining L at the temperature of (90 ± 5) °C and pressure of (35 ± 2) kPa for (20 ± 2) s.

2.2 Laminates Breathability Determination Methods

The water vapour permeability was measured when test piece was fixed over the opening of jar with solid desiccant. This unit is placed in a strong current of air in a conditioned atmosphere (23/50) and kept in movement by the rotation. The jar is weighted to determine the mass of the moisture that has passed through the test piece and has been absorbed by the desiccant. In the case of water vapour absorption determination an impermeable material and the test piece was clamped over the opening of container, which holds water, for duration of the test (ca. 8 h). Test piece is then weighted immediately and the water absorption is determined by

the mass difference before and after the test. Electrical resistance was measures at 100-200 V voltage.
Properties investigated materials are given in Table 1.

Table 1. Properties of investigated materials

Materials	Thickness, mm	Density, kg/m^3	WV permeability $P \cdot 10^{-6}$, $kg/m^2 \cdot s$	WV absorption $A \cdot 10^{-3}$, kg/m^2
Lining L	2.82	7.90	368.3	22.5
Membrane M	0.15	3.00	25.4	12.4
Laminate L+M	2.95	6.20	4.2	22.0

3. RESULTS AND DISCUSSION

Semi-permeable microporous membrane decreases ability of water vapour transfer, but not changes water vapour absorption in footwear textile linings. The water vapour absorption and diffusion depend on the vapour sorption and drying cycles. Absorption rate and equilibrium uptake increase with the increasing of resorption/desorption cycles number. During the resorption/desorption process the changes in the linings electrical properties are observed – the increase of treatment duration decreases electrical resistance of textile laminates.

4. CONCLUSION

1. Fickian behaviour is characteristic for water vapour absorption kinetics of textile linings.
2. The multifold resorption/desorption process of textiles laminates is history-dependent.
3. Semi-permeable microporous polymeric membrane decreases water vapour desorption rate and retard the drying process of footwear textile laminate.
4. The increase of water vapour resorption/desorption cycles number decrease electrical resistance of lining.

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KNITTED BIOMEDICAL TEXTILES

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Abstract: *Medical textiles have been used for various applications for improving the quality of life. They can be used as artificial organs, hygienic and protection products, implantable and non-implantable products such as compression bandages, sutures, artificial kidneys, cardiovascular implants etc. In this study the biomedical textiles, which is one of the application area of medical textiles are reviewed and the importance of biomedical textiles is mentioned. Knitted biomedical materials are also summarized.*

Keywords*: medical textiles, biomedical textiles, knitting.*

1. INTRODUCTION

Materials used in medical devices, particularly in those applications in which the device either contacts or is temporarily inserted or permanently implanted in the body, are typically described as biomaterials [1]. These biomaterials can be defined as any material used to make devices to replace a part or a function of the body in a safe, reliable, economic, and physiologically acceptable manner [2].

When selecting a material for use in a medical implant application, the functional requirements and the interaction between the material and the implant need to be taken into account (3). The success of a biomaterial or an implant is highly dependent on three major factors: the properties and biocompatibility of the implant, the health condition of the recipient and the competency of the surgeon who implants and monitors its progress [2].

Biomedical textiles are produced using synthetic and natural fibres such as synthetic fibers (polyethylene terephthalate, polyamide and polyethylene), natural fibers (silk, collagen and chitin), regenerated fibers (viscose rayon), carbon fibers and resorbable fibers. These fibers are used to produce woven, knitted, braided, non-woven and embroidered implants. Woven fabrics are dimensionally the most stable products, but during surgery if they cut, they may fray. Of the knitted fabrics the warp knitted fabrics, which are stable and versatile are most extensively used [4].

2. KNITTED BIOMEDICAL MATERIALS

Knitted textiles have been used in medical applications due to their high flexibility and low tendency to fray. Their mechanics have, however, received limited attention [5].They are used in many implantable products.

Many studies are investigated about knitted biomedical fabrics. The most studied subjects are about knitted mesh structures and the knitted fabrics used for cardiovascular implants.

Knitted mesh fabric structures are used for tissue engineered scaffolds. These meshes provide sufficient internal connective space for tissue ingrowth. The meshes produced from synthetic polylactide-co-glycolide (PLGA) and silk have unique mechanical properties and have been used to provide improved physical support, either alone to strengthen materials for the patching of soft tissues, or in combination with other types of biomaterials, for the construction of knitted mesh scaffolds[6].

Knitted fabrics are also used in cardiovascular devices such as vascular grafts, heart valve sewing cuffs etc. These fabrics are well suited for soft tissue and areas with complex anatomies commonly found in cardiovascular applications because of the knitted fabric structure [7].

4. CONCLUSION

Materials have been used for medical implant applications for centuries. Humans have attempted to use materials from biological and inorganic sources to replace diseased or damaged tissues. Since the twentieth century, as knowledge of the biological mechanisms behind the interactions of implanted materials and tissues has increased, the selection of materials for medical implants has been based on progressive improvements and experimental evidence [3]. So biomedical textiles are getting more and more importance every day. Different types of biomaterials have been produced and tested to support and help the patients. Also further investigations are needed to develop new implantable textiles.

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NATURAL HEAT RASH ADDITIVES TO THE BABY DIAPER

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Abstract: One of *the most common skin problems in babies relates to baby diaper obstruction, which is also termed nappy dermatitis.The drug is used for the treatment of skin injuries in the form of a topical preparation of external application. But this skin cream contains chemical subctances like methylparaben, propylparaben, antimicrobial agents and alcohol. These substances are harmfull for sensitive baby skin. Therefore; in this study, it is aimed to apply natural oil (centuary oil, almond oil and aloe vera oil) which is extracted from plant by spraying to the baby diaper surface with different concentration. As a result; the concentration of low dose centuary oil group samples is enough to prevent heat rash.*

Keywords*: nonwoven, baby diaper, heat rash, centuary oil,*

1. INTRODUCTION

Textile materials have an important part in many sectors; medical field is one of the them and nowadays various type of materials can be used such as fibres, mono and multiflament yarns, woven and knitted fabrics, nonwoven and composites in this field. Every ohter day more research is being completed and therefore textiles have been seen in every aspects of medical applications. The leargest use of textiles is for hygiene applications e.g. wipes, nappies, incontinence products. Manufacturers and converters now seek to develop these further by adding value to increasingly sophisticated products. Nonwoven dominate the use of these applications for over 23 % within the material type [1-2-3].

2. MATERIAL AND METHOD

In this study, 100% polyester nonwoven fabric specimens produced with spunlace technique have been used as testing material (Table 1). Properties of natural additives to the baby diaper is given in Table 2.

These fabrics have been used as a disposable diaper, make-up cleaning pad, hygiene sanitary napkin, operating gown and also furniture and bedspeads, carpet back, geotextile, agriculture products and industrial protective cloth.

Table 1. Physical properties of nonwoven fabric samples

Fabric Weight (g/m^2)	Thickness (mm)	Tensile Strength (N/5 cm)		Elongation (%)	
		MD	CD	MD	CD
30	0.25	112.2	135.1	19.7	17.1
50	0.32	123.5	153.7	25.0	26.6
70	0.45	154.9	180.8	39.5	32.7
100	0.66	163.4	214.6	58.5	42.3
120	0.74	284.5	225.1	60.4	45.0

Table 2. Properties of Natural Additives

Sample	Natural Additives	Concentration (%)	Method
1	Centuary Oil	0.2	Spray
2		0.5	
3		0.8	
4	Almond Oil	0.2	
5		0.5	
6		0.8	
7	Aloe Vera Oil	0.2	
8		0.5	
9		0.8	

3. RESULTS AND DISCUSSION

Among the components of a disposable diaper, the top layer comes into direct contact with the baby's skin is usually made of nonwoven fabric. Therefore, the surface characteristics of nonwovens are important for the health of the baby's skin. Therefore; centuary oil is spread on sufficiently thick over the affected area to allow a good coating of the area to be protected. By supporting this natural product, you can help to provide less toxic environment for your baby to grow up in. Centuary oil which is not only an antiseptic and stop bleeding, heal the wounds and burns prevents infection but also has a lot of healing capabilities.

4. CONCLUSION

Summarising, due to recent advancements in medical procedures and both in textile technology and engineering, the use of textile materials in healthcare and hygiene application is growing faster. By applying this natural oil, there is no need drug, alcohol and chemical products to prevent your sensitive baby skin.

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POLY(N-METHYL PYRROLE)- POLY(ACRYLONITRILE-CO-VINYL ACETATE) COMPOSITE NANOFIBERS

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Abstract: *Oxidative polymerization of N-Methyl Pyrrole (NMPy) by cerium(IV) on Poly(Acrylonitrile-co-Vinyl Acetate) matrix in N,N-dimethylformamide (DMF) was performed. Electrospinning method was introduced to preparation of P(AN-co-VAc) solutions with uniformly distributed PNMPy nanoparticles. The composite nanofiber SEM images showed that the PNMPy nanoparticles with the dimensions of 20-40 nm were distributed homogeneously.*

Keywords*: composite nanofiber, N-Methyl pyrrole, electrospinning*

1. INTRODUCTION

Micro and nano structures of functional conducting polymeric structures have received great attention due to technological applications in electrical and optical materials. Conjugated polymers exhibit excellent electrical properties and good chemical stability however, the common usage of these materials has been restricted due to their poor processability and poor mechanical properties. These limitations can be overcome by making composites of textile structures with conjugated polymers and it is possible to produce conductive textile structures. This approach enables unlimited possibilities on the designing of conductive composites [1-5].

2. MATERIAL AND METHOD

2.1. Preparation of PNMPy/P(AN-co-VAc) Composite Nanofibers

Poly(Acrylonitrile-co-Vinyl Acetate) [P(AN-co-VAc)] was dissolved in dimethyl formamide (DMF) at 25°C. Then NMPy was oxidatively polymerized on a P(AN-*co*-VAc) matrix in the presence of ammonium cerium (IV) nitrate [Ce(IV)] to obtain PNMPy/P(AN-*co*-VAc) composite solutions. The electrospinning conditions are as following, Solution concentration: 10%; applied voltage: 17 kV, tip-to-collector distance: 10 cm, Feed Rate: 0.02 mL/h.

3. RESULTS AND DISCUSSION

Figure 1 presents the FTIR spectrums of P(AN-co-VAc) nanofiber film and PNMPy-P(AN-co-VAc) composite nanofibers.The bands at 2243cm^{-1} and 1736cm^{-1} correspond to CN stretching and C=O stretching vibrations of P(AN-co-VAc), respectively. In composite nanofiber a new absorption band appeared at 1317cm^{-1}, corresponding to CH in plane vibration peak of PNMPy.

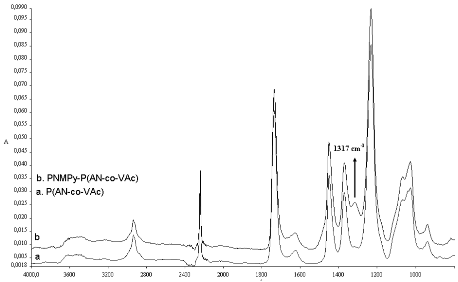

Figure 1.FTIR-ATR specta of (a) P(AN-co-VAc) nanofiber and (b) PNMPy-P(AN-co-VAc) composite nanofiber

The absorption band at 1453 cm^{-1} has been assigned to CN ring stretching vibration of PNMPy. An increase was observed in the absorbances of 1453 cm^{-1} by introducing PNMPy in composite nanofibers (Figure1).

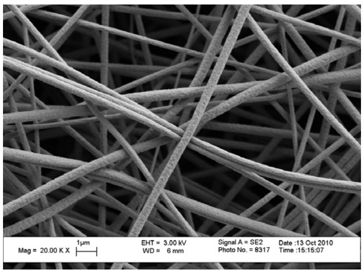

Figure 2. SEM image of PNMPy-P(AN-co-VAc) composite nanofibers

Figure 2 shows the PNMPy-P(AN-co-VAc) composite nanofibers have a surface randomly and homogeneously distributed nanosized conductive grains.

4. CONCLUSION

A well-dispersed reaction medium and a homogeneous PNMPy distribution was obtained due to the high oxidation potential of Ce(IV). A new absorption band appeared at 1317cm^{-1}, corresponding to CH in plane vibration peak of PNMPy in composite nanofibers. It is possible to produce composite nanofibers by electrospinning in the presence of conjugated polymers for smart textile applications.

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QUASI-STATIC BEHAVIOUR OF A NON-CRIMP 3D ORTHOGONAL WOVEN CARBON FABRIC COMPOSITE

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Abstract: *This paper reports results of study of mechanical behaviour of a non-crimp 3D woven carbon/epoxy composite it's quasi-static tension results: elastic constants and strength for tension in warp, fill and bias direction. Considerable stiffening of the carbon fibre reinforced material loaded in fibre direction was detected.*

Keywords: *3-dimensional reinforcements, mechanical properties, strength.*

1. INTRODUCTION

Three-dimensional (3D) fabrics, like 3D Orthogonal Non-Crimp Weaves (3DONCW) and 3D Braids (3DB), are under a scrupulous consideration by the aircraft manufacturers. Among important benefits offered by 3DONCW preforms is, that this type of textile reinforcement can be made in a single ply at much larger thicknesses than single-ply 3DWK preforms. Similar to the latter ones, 3DONCW preforms are characterized with practically straight in-plane fibers and, owed to the absence of fibre waviness, they show exceptional conformability even at relatively large thicknesses. Like in the case of 3DWK, the in-plane fibre straightness in 3DONCW ensures higher in-plane moduli and, especially, in-plane strengths of their composites in comparison with 3D Interlock Weave (3DIW) composites or 2D Plain Weave (2DPW) laminates. The reader is referred to the recent review paper of one of the present authors [1] for the detailed comparison of 3DONCW composites, which are the subject of the present study, with other types of 3D composites and for extensive bibliography.
The present paper aims to study of the mechanical behaviour of 3DONCW composites under static tensile loading, performed for glass/epoxy 3DONCW composites in [2-6]. The same testing methodology [2, 3] is applied here to a carbon/epoxy 3DONCW composite.

2. MATERIALS AND EXPERIMENTAL TECHNIQUES

The material under study is carbon/epoxy 3DONCW composite. The internal structure of the composite is studied in detail in [7]. The epoxy resin used was West System 105 with 209 Extra Slow Hardener and was cured at room temperature. The test methodology is outlined briefly here. The reader is referred to [2, 3] for details of the experimental technique. Tensile tests were done on a standard testing machine Instron 4505 with test speed 5 mm/min. The samples, 30x250 mm size, were cut out of the composite plates in three directions: (1) warp, (2) weft/fill and (3) bias $\pm 45°$.

3. RESULTS AND DISCUSSION

The measured stress-strain diagrams are not ideally linear. When the applied strain increases from zero up to 10000 $\mu\varepsilon$, the tangential Young modulus increases by 3.8 GPa (6.7%) for loading in warp direction and by 9.9 GPa (17%) for loading in fill direction. The increase of the modulus can be explained by the inherent stiffening of carbon fibres during tension. The stiffening effect for cross-ply carbon/epoxy laminate was measured by Toyama and Takatsubo [8] using Lamb wave technique; the increase of Young modulus of 6…17%, observed in our measurements, lies within the interval of the stiffening reported in [8], where a decrease of Young modulus in the later stages of loading was also noted, which was explained by the cracking in the transverse plies of the laminate. The measured strength and ultimate elongation of the composite in the warp direction (942 GPa) is higher then in the fill direction (893 GPa). With the standard deviation of 42 GPa (warp) and 47 GPa (fill) in 6 tests this difference is statistically significant with the confidence level above 99%.

Tension diagram in bias direction exhibits typical features common for loading of a woven composite in bias direction: fast decrease of the sample stiffness, with the low stiffness regime for strains more then about 2%. The latter is linked to the extensive damage inside the composite and the enabled ability of "scissoring" for the reinforcing yarns.

4. CONCLUSION

Behaviour of a non-crimp 3D woven carbon/epoxy composite has been studied during tensile loading in warp, fill and bias directions. The following phenomena have been registered: *Stiffening of the composite loaded in warp/fill direction*. The limited amount of damage in the yarns, transversal to the loading direction, does not stop increase of the composite Young modulus, which continues up to strain level of about 1.0…1.1%. The Young modulus increases by 7% for the loading in the warp direction and by 17% for the loading in the fill direction.

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SMART WRAP: ADVANCED MATRESS COVER TO MEASURE&MONITOR SEVERAL FEATURES

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1. INTRODUCTION

Bekaert Textiles is continuously investing in Sleep Science, in research into optimisation of sleep and comfort of sleep. Its own competence centre carries out scientific research on sleep in collaboration with universities, sleepcentres and various technology partners.
This innovation is an intelligent mattress cover that features integrated optical sensors. The optical sensor technology is already used for fire calls, protection against burglary, and the most different monitoring systems. In this case, it registers the breathing of the person lying on the mattress and sends an alarm to a mobile phone in case of respiratory arrest. The mattress cover can, for example, also measure the time of rest, sleeping positions, and pressure points making it very versatile. The accuracy of the technology makes it very suitable for use in health care. Since the solution is not based on electricity, the human body remains unaffected.

2. ANALYSES AND DISCUSSIONS

Smart Wrap® is a ready-made mattress cover with built-in sensors that measure / monitor several features that have an impact on the bed comfort of the end-user.
Applications will be possible in many fields and markets, both health & elder care, but also in the traditional market. For this **Smart Wrap®** project, Bekaert set up a partnership with Lightspeed Systems, a Dutch technology company that specializes in high-tech sensors that use light measurement and optical detection.
For now the products ;

- Only mattress covers
- 3 projects have been identified (see below)
- 3 projects = 3 concepts
- Control unit / interface will be standard
- Different fabrics for health care and for traditional market (different specs)

Project 1: Prevention of step/fall - out (un)intentionally (FP)

- For bedridden patients who nevertheless want to leave the bed
- Only for beds with siderails up
- Only for foam mattresses, other types have to be tested

Project 2: Absence/Presence (AP)

- Is person in bed or not ?
- Time a mattress has been 'used'
- Time slot for people leaving and not returning

Project 3: Breath Control (BC)

- Is person still breathing ?
- Is person still moving ?

This concept consist of;

- Mattress cover with built-in sensor (optical cable)
- Sensor connected to a control unit (interface)
- Connection to external device (= extra, not supplied by Bekaert)

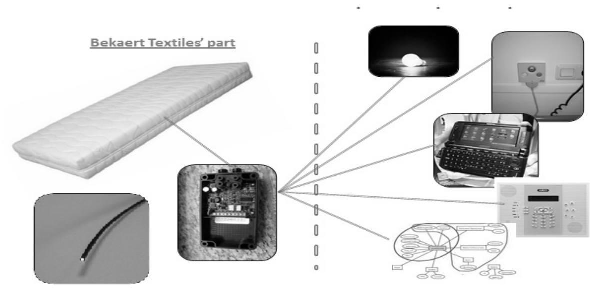
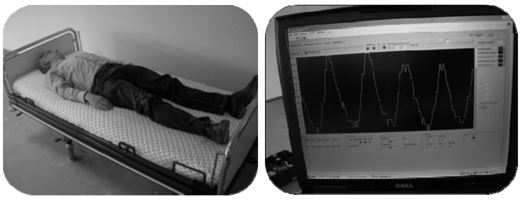


Figure 1. The **Smart Wrap®** consept.



a) b)

Figure 2. a) The matress cover with built-in sensors
b) The screen of the software you can follow the movement of the body

3. CONCLUSION

Smart Wrap® can be integrated into domotica systems, that is automation systems in houses, informatics and telematics were combined to support activities in the home. For ex. measure step/fall-out of the bed and warn the nurse in hospitals, you can follow the life of the matress, how much time it used, this gives the optimum follow up for replacing with the new matress. If the patient do not return to his/her bed for a defined time period, the system warns the nurse to check the patient. For people who are snoring, you can monitor it and if you define and connect it to the head part of bed, so bed moves, that will make person to move, change his/her position and stop snoring. For babies SIDS, Sudden Infant Death Syndrome, which we have seen the number of occurrence going down drastically over the last decade. They occur in infants, usually between 0 to 4 months, but also up to 1 year of age. **Smart Wrap®** allows to monitor babies breathing. This can easliy connected to babyphones, i-phone, automatic light-on/off, alarm, dial up to hospital, whoever necassary. There are many possiblities in market for different types of alarms. The scientific prove is very important and our real life tests ongoing. First results in hospitals are very promising. **Smart Wrap®** is also patent pending.

Key Words: Matress ticking, smart wrap, healthcare, babycare, monitoring, sensor, breathing,

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TEMPERATURE TREATMENT OPTIMIZATION IN THE APPLICATION BY BATH EXHAUST MICROCAPSULES ON FABRICS

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Abstract: *Microcapsules have been used for a long time in some fields such as chemist, pharmacy, cosmetics, etc. Some scientific papers from 90´s introduce them on textile fields, and some research has been done in order to encapsulate different kinds of active products with a wide variety of shell compositions.*
This work studies one application method of microcapsules on fabrics. The research is focused on optimizing the temperature treatment. Two experimental techniques, scanning electron microscopy and counter apparatus have been used to optimize this parameter. We conclude that temperature is an important parameter to consider in the microcapsules applications into fabrics.

Keywords: *fragrances microcapsules, bath exhaustion, size distribution, SEM, treatment temperature*

1. INTRODUCTION
Nowadays textiles are required to have extra properties, they should offer active functionality. Microencapsulation technology has been improved in recent years and there are a wide range application in food, cosmetics and other industrial sectors. The number of commercial applications of microencapsulation in the textile industry continues growing today. The application of microcapsules on fabrics provides unconventional finishes.
Microcapsules present an active core which is protected by means of an external polymer. The encapsulation in the textile sector is used to protect fragrances or other active agents from oxidation caused by heat, light, humidity, etc., and exposure to other substances over their lifetime [1]. The microcapsules composition will depend on the required effect. The major interest in microencapsulation focuses on durable fragrances and skin softeners, insect repellents, cosmetics, dyes, fire retardants, phase change materials, counterfeiting, etc [2].
The microcapsules can be applied on fabrics by impregnation, bath exhaustion, foam, spraying and coating. Although the most extended industrial application is by padding, commercial brands also suggest bath exhaustion as a possible procedure.
Previous works [3], have optimized the commercial products concentration and have studied the influence of temperature treatment in the application of fragrances microcapsules by bath exhaustion. This work is focused on optimizing the temperature treatment. Temperature can be affected by the stability of the commercial products.

2. MATERIAL AND METHOD
2.1. Materials
Fragrances microcapsules have been supplied by the Color Center (Tarrasa, Spain). In order to bond the microcapsules to the fabric, and acrylic resin has been applied, also supplied by the Color Center.
The fabrics used were a 100% cotton twill 210g/m^2, which has been chemically bleached with peroxide in an industrial process.

2.2 Methods

Commercial microcapsules have been applied to the surface of the fabric by bath exhaustion. The resin has been used as a binder. As a result thermal treatment in the form of hot air has been applied to cure the resin and to induce adhesion of the microcapsules to the fabric. Temperature influence has been studied (60ºC and 80ºC).

Different analysis techniques have been used in the study. Scanning electron microscopy (SEM) has been used in order to study the state of bath solution before and after treatment and microcapsules presence on fabrics. Multisizer Counter allowed us to counting the number of particles and their size contained in bath solutions before and after treatment.

3. RESULTS AND DISCUSSION

This study evaluates microcapsule behavior during bath exhaustion treatment. Microcapsules deflate when the bath temperature increases. When the temperature is over 80ºC, this effect is significantly noticeable on the microcapsules deposited on the fabric surface and in the number of particles contained in bath solutions.

4. CONCLUSION

We concluded that the temperature is an important factor to consider in the microcapsules application on fabrics by bath exhaustion. Temperature treatment should be controlled, because active products can be damaged.

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TENSION-TENSION FATIGUE BEHAVIOR OF A NON-CRIMP 3D ORTHOGONAL WOVEN CARBON FABRIC COMPOSITE

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Abstract: *This paper reports results of study of mechanical behavior of a non-crimp 3-dimensional (3D) woven carbon/epoxy composite in tension-tension fatigue: fatigue life diagram and fatigue damage development for loading in warp direction. Infinite fatigue life limit (more than 3 million cycles) corresponds to the stress of 450 MPa. This value is well above damage initiation threshold in quasi-static loading (250…350 MPa) and corresponds to the "second damage threshold" in quasi-static loading onset of local debondings and intensive transverse cracking. The damage under fatigue loading at the "infinite" fatigue life stress develops from transverse cracks inside the impregnated yarns and on their boundaries, with further development of micro-delaminations and local splitting of the yarns.*

Keywords: *3-dimensional reinforcements, mechanical properties, damage*

1. INTRODUCTION

The present paper continues comprehensive research program aimed at experimental determination of the mechanical behavior of polymeric matrix composites reinforced with non-crimp 3D orthogonal woven fabrics. Previously, E-glass fiber composites have been studied under static [1, 2] and fatigue [3] tensile loading. The carbon fiber composite under quasi-static tension was studied in [4], and the internal geometry of this material in [5]; the present paper reports results of investigation of tensile-tensile fatigue of the same carbon/epoxy material.
Fatigue data for non-crimp 3D woven composites are on a high demand by industry. At the same time, this topic has been barely touched for the 3D interlock weave composites, see [6] as one of rare publications, and, to the best of these authors' knowledge, no data of this kind are available in literature for carbon reinforced 3D composites. The present paper aims at closing this gap, reporting measurements of S-N fatigue life curves, relation between the "infinite" fatigue life (3 million cycles) load and quasi-static damage thresholds and damage development during fatigue.

2. MATERIALS AND EXPERIMENTAL TECHNIQUES

The material under study is carbon/epoxy 3D orthogonal non-crimp woven (3DONCW) composite. The internal structure of the composite is studied in detail in [5]. The epoxy resin used was West System 105 with 209 Extra Slow Hardener and was cured at room temperature. A hydraulic Schenk testing machine was used for the fatigue investigation. Tests were performed under constant stress amplitude, sinusoidal wave-form tensile-tensile loading with 6 Hz frequency and the ratio R = 0.1 (ratio of the minimum to the maximum stress in the cycle). The samples cut in the warp direction were tested. The post-fatigue damage state of the samples was studied using X-ray examination (four samples) and optical microscopy of cross sections of one of the samples.

3. RESULTS AND DISCUSSION

Fatigue life curve is well represented by a tri-linear diagram of Talreja [7]. The fatigue life limit, determined for the maximum of 3,000,000 cycles, is 450 MPa for warp direction. This value is about two times higher than the damage initiation threshold in quasi-static tests and is close to the "second damage threshold", corresponding to onset of local micro-debondings parallel to the sample surface.

The change (decrease) of the composite stiffness during fatigue does not exceed 5%. The initial stiffness in post-fatigue tensile test is close to the maximum values (which include effects of the deformation stiffening of carbon fibers) observed during quasi-tensile testing up to the maximum fatigue stress level.

The damage development during fatigue starts from the damaged state of the sample, characteristic for the quasi-static loading up to the maximum fatigue stress characterized by combination of transversal cracks in the fiber bundles, boundary debondings of the fiber bundles transversal to the loading and local micro-debondings parallel to the sample surface. This crack system develops during fatigue loading, appearing in each and every unit cell of the composite reinforcement inside the sample, increasing the length of the cracks and their opening. Splitting cracks appear at the later stages of the fatigue loading.

4. CONCLUSION

The fatigue life limit, determined for the maximum of 3,000,000 cycles, is 450 MPa for warp direction. The damage development during fatigue starts from the damaged state of the sample, characteristic for the quasi-static loading up to the maximum fatigue stress characterized by combination of transversal cracks in the fiber bundles, boundary debondings of the fiber bundles transversal to the loading and local micro-debondings parallel to the sample surface.

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TEXTILE BASED SENSORS, ACTUATORS AND ELECTRODES

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Abstract: *In general, an actuator refers to a device that converts energy or electrical signal into mechanical motion, but in the realm of smart clothing, the actuator may better be defined as a component capable of delivering senses, information, or energy through a wearable system or by the user's intention. Textile based sensors and electrodes integrated into a system are expected to be able to support the monitoring of personal activity during daily life and ensure the early detection of abnormal conditions and prevention of its serious consequences. In this study, the current technological status, recent developments and application fields of electronic textile based sensors and actuators are discussed and reviewed.*

Keywords*: textile based sensors, body signal monitoring, textile electrodes*

1. INTRODUCTION

Wearable sensors can be used to monitor the body's physiological response and also the kinematic aspects of performance. There is a need for integrated sensors that are comfortable, wearable and directly usable. Textile based sensors which are compatible with textile manufacturing processes are essential for such technology to become accessible. Making the fabric itself the sensor can increase the functionality of the smart garment while still supporting the normal tactile properties of the garment [1]. Smart fabrics especially focus on monitoring of patients in biomedicine, as well as in several health-focused disciplines, such as bio-monitoring, rehabilitation, telemedicine, tele-assistance, ergonomics and sport medicine fields.

2. TEXTILE BASED SENSORS, ACTUATORS AND ELECTRODES

Development of textile-based electrodes and motion sensors is one of the main issues of recent smart textile research, because individual health care is a growing global interest. However, conventional electronic sensors when applied on smart clothing probably cause discomfort and have interconnection problems with fabrics. Early stages of smart clothing development weren't capable of attaching existing electrodes or electrical devices to clothes, but now textile-based electrodes and sensors are being explored, focusing on increasing the user-friendliness and quality of smart clothing [2].

2.1. General Structures of Textile Based Sensors, Actuators and Electrodes

Conductive rubber, silver-coated polymer foam, metal-coated or sputtered fabrics, and woven metal fabrics can be used as electrodes in smart clothing Also use of narrow bands is the most common form. The narrow band is similar to the flat cable in the electronics industry and it's woven with conductive fibers placed in parallel for interconnection needs. Sewing and embroidery are also one of the readily available methods. Metal yarns or threads coated with metallic particles are used in this method. Also as for pressing sensors, Coating or printing the pressure sensing material on the surface of fabric is the easiest way to measure the pressure that applied to the fabric.

2.2 Signals Detected by Textile Based Sensors From The Human Body

Signals that are detected by textile based sensors most frequently are;

- Body temperature
- Respiration,
- Pulse,
- Electrocardiogram (ECG),
- Electromyogram (EMG),
- Electroencephalogram (EEG),
- Galvanic skin response (GSR),
- Gesture, etc.
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Figure 1 shows these biomedical signals that can be measured from the human body.

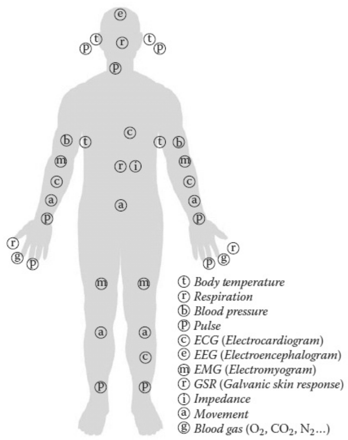

Figure 1. Biomedical signals that can be measured from the human body[3]

3. CONCLUSION

Development of textile-based electrodes and sensors is one of the main issues of recent smart textile research utilizing electronic textiles. In this study, some examples of textile-based sensors, electrodes and actuators applicable in the clothing environment are reviewed and described. Usability considerations for both clothing manufacturers and wearers should include the following topics:

- Ease of production for clothing manufacturers,
- Abrasion resistance,
- Stain resistance,
- Chemical resistance against secretions such as sweat, and
- Prevention of skin irritation for wearers.

As for the material characterization, it is possible to use any material or element as a sensor or actuator if it receives energy and transduces itself into other form or shape. This means that the physical, chemical, and electrical characteristics of all fibers, fabrics and accessories for clothing should be investigated.

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THE PERFORMANCE OF ENDOVASCULAR STENT GRAFTS AFTER IN SITU FENESTRATION

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Abstract: *Materials from different Endovascular Stent Grafts were fenestrated using an RF puncture technique then ballooned open and stented. Each material was tested for burst strength, tear strength, macroscopic and microscopic changes, warp and weft count, and pulsatile fatigue durability. The fabrics all behaved very differently. The Atex fabric had the best tear strength after being punctured and ballooned but it also did not increase in area as much as the other fabrics. All fabrics excepting the ePTFE showed melting around the edges of the fenestrated area. Further research is being done on accelerated fatigue testing in a realistic model.*

Keywords*: abdominal aortic aneurysm, cardiovascular, fenestration, endovascular stent grafts*

1. NTRODUCTION

An abdominal aortic aneurysm (AAA) is weakening of arterial wall in abdominal aortic region that results in a localized dilation. A number of factors are can cause this weakening, including age, smoking, hypertension, atherosclerosis, prior injury or surgery, spinal cord injury, genetic disorders and genetic collagen disorders [1]. A common treatment for this disease is the insertion of an endovascular stent graft. However if the aneurysm is located too close to renal arteries, this limits the use of current minimally invasive endovascular aneurysm repair (EVAR) procedures [2]. In such circumstances surgeons are looking at possibilities of using an *in situ* fenestration technique so as to allow continued blood flow to renal arteries. One such technique involves the use of *in situ* radiofrequency (RF) puncture of the endograft fabric and subsequent angioplasty ballooning of the fenestration to the desired diameter [3]. The primary goal of this initial study was to determine the effect of the post procedure effects on burst strength, tear strength, macroscopic and microscopic changes, changes in warp and weft count, and pulsatile fatigue durability.

2. MATERIALS AND METHOD

The five materials used in this study were: (1) a monofilament twill woven polyester fabric (Medifab) chosen to represent the Talent™ graft material, (2) a multifilament tubular woven polyester (Atex) representing the graft component of the Zenith device, (3) a multifilament plain woven tubular polyester used in the Endurant device, and (4 and 5) two types of ePTFE membranes, Standard and Next Generation (Zeus Inc, Orangeburg, SC).

The fabrics and membranes were first punctured using a radiofrequency puncture generator and were then gradually ballooned using a series of 2.5, 5, and 7 mm balloon catheters sequentially. Tests were performed on both fenestrated and unfenestrated control specimens to measure their microscopic appearance (SEM), fabric dimensions, woven fabric count, tearing strength, and probe bursting strength. The fenestrated specimens were also onitored for defects, fenestration measurements, and fatigue resistance testing.

3. RESULTS & DISCUSSION

For all of the woven fabrics there was fraying around the edges of the ballooned fenestrations. For both the Atex and the Endurant some of the yarns around the edges of the RF puncture site melted, fused together and encroached on the fenestration site (Figure 1). The Medifab did not show evidence of this, possibly because it was woven with a monofilament yarn instead of a multifilament yarn. The Atex fabric did not expand very much after ballooning, which correlated with its significantly higher bursting and tearing strength. It did show a 75% increase in the RF punctured fenestration area as a result of fatiguing. The Medifab fabric also showed a 30.7% increase in fenestration area after fatiguing and had the lowest tearing and bursting strength of all three woven fabrics. The Endurant showed no change in fenestration area. It performed at an intermediete level between the Atex and Medifab fabrics for tearing and bursting strength.

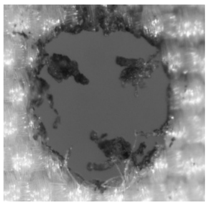

Figure 1. Endurant Fabric showing melted and fused yarnsencroaching after RF punture and ballooning

Both ePTFE fabrics (Standard and Next Generation) showed less melting around the edges of the ballooned fenestration, possibly because the melting point of PTFE had not been reached. The standard ePTFE had no change in tearing strength as a result of fenestration. The Next Generation ePTFE, however, had an increase in its longitudinal tearing strength after fenestration.

4. CONCLUSION

It was concluded from this initial study that the type of fabric and membrane and as well as their construction play a distinct role in the material's performance after fenestration. Additionally, the various materials exhibited significant changes in their dimensional, geometric and mechanical characteristics as a result of *in situ* radio frequency (RF) puncture and balloon expansion.

In order for this approach to have clinical application it will be necessary to install a stent into the fenestrated endografts. Research work on this approach is continuing with accelerated fatigue testing of fenestrated and stented stent grafts deployed in a flexible phantom of an abdominal aorta with a short necked aneurysm with flow to the two renal arteries.

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ANTIMICROBIAL ACTIVITIES OF SOME TEXTILE PRODUCTS WHICH IS USED ON MATTRESS TICKING

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Abstract: *In industrial practices, each decade brings into focus new technologies as a marketing strategy to boost the sale both in domestic and export markets. Textile industry is no exception to this [1].*

Microbial infestation has unpleasant consequences such as unpleasant odors, mold and mildew stains, discoloration and loss of functional properties (e.g. tensile strength and elasticity). Microbes can disrupt textile manufacturing processes like dyeing, printin and finishing operations through the reduction of viscosity, fermentation, and mold formation. Microbial infestation cannot be removed by the most frequent washing with the exception of washing at boiling temperature, which is not suitable for some textiles [2].

Antimicrobial textiles may cause skin irritation, allergic reactions and bacterial resistance on the human flora.

Several different types of antimicrobial agents, such as oxidizing agents, coagulants, diphenyl ether (bis-phenyl) derivatives, heavy metals and metallic compounds, chitosan, and quaternary ammonium compounds (QACs) are used in the textile industry to confer antimicrobial properties Imparting durable antimicrobial properties to cotton fabrics usingalginate–quaternary ammonium complex nanoparticles

In this study, some antibacterial textile products which belong to İstikbal Corporation and antibacterial active substances which used on these were investigated for antimicrobial activities against five microorganisms containing four bacteria an one yeast. Agar Diffusion Method AATCC 147 was used for determination of antimicrobial activities. Samples were provided by Istikbal Corporation.

***Key words**: Istikbal Corporation, antimicrobial activities, mattress ticking.*

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REFLECTION OF 3 D EFFECT WITH HEAT-SETTING TEXTILE SURFACES ON FASHION-TEXTILE AND ART

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Abstract: *The basic purpose of heat-setting technique that has* thus *far* evolved *using different methods, devices and material is to provide fabrics with permanent, flaxible and distinctive 3D forms.*

R&D Departments of textile businesses make considerable investments, presenting innovations for textile/fashion world. The fact that the state- of -the art or revolutionary synthetics, improved chemical methodologies and smart technologies have presented new possibilities of creativeness for designers and artists inevitably challenges limits of engineers, artists, designers and producers in this field as it brings interactive activities. The world of fashion and textile has been basically led by designing stylists and artists who carry high-tech innovations to their works with their unique approaches.

Heat-setting is one of the techniques which have been of great interest for designers. Many famous artists and designers have succesfully transferred fixation technique shaped by innovative technology to their own designes in a way to restructure fabrics which they work on. This communique will discuss how the above-mantioned designers interpret and perform heat-setting technique on their designings.

Keywords: *heat-setting, 3D, design-designer, synthetic fabric.*

THERMOPHYSIOLOGICAL COMFORT PROPERTIES of SILVER TREATED WOUND DRESSINGS

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***Abstract**: In recent years there has been a very noticeable increase in the interest and utilisation of smart and bioactive fibres and treatment for wound management. This paper focuses on the thermophysiological comfort properties of carboxymethylcellulose (CMC) nonwoven wound dressing and its silver treated form. Aquacel® and Aquacel® Ag were evaluated in order to compare their thermophysiological comfort properties including thermal conductivity, thermal resistance, thermal absorptivity, and thermal diffusion. The effect of silver treatment on the water vapour permeability was also studied. The results show some clear differences between the untreated and silver treated dressings. Statistically significant differences were observed in the thermal properties for all tested parameters.*

***Keywords**: in vitro, nonwoven dressings, carboxymethylcellulose, silver treatment.*

1. INTRODUCTION

Carboxymethylcellulose (CMC) is a water-soluble anionic polymer obtained by introducing carboxymethyl groups along the cellulose chain. Generally CMC is synthesised by the alkali-catalysed reaction of cellulose with chloroacetic acid. The functional properties of CMC depend on the degree of substitution of cellulose structure (i.e., how many of the hydroxyl groups have taken part in the substitution reaction) and also on the chain length of the cellulose backbone. The degree of substitution (DS) of CMC is usually in the range 0.6 to 0.95 derivatives per monomer unit. Some materials which have DS between 0.65 and 1.45 are also available commercially. The DS is a major factor in the water solubility of CMC, polymer down to DS 0.3. The fibres can absorb up to 20 times its weight of water and they are also capable of a high degree of swelling when wet in water. When the skin is broken, a significant number of micro-organisms may grow on and/or in the wound. Wound dressings which are made from CMC fibres have the ability of absorbing a significant amount of body fluid, thus, the removal of a large volume of exudates may lead to a decrease in the number of micro-organisms on the wound surface [1-3].

General applications of Aqucel® which include chronic wounds such as leg ulcers, pressure ulcers and acute wounds such as abrasion, laceration, incision, donor sites, and first and second degree burns. The dressing is also intended for use in the management of surgical or traumatic wounds that have been left to heal by secondary intent.

2. MATERIALS AND METHODS

The dressing specimens were purchased from the UK market, Aquacel® and Aquacel® Ag (ConvaTec, Skillman, NJ, USA). The thermo physiological properties of the dressings were determined using an Alambeta instrument (Sensora Instruments, Czech Republic). The Alambeta instrument provides values for thermal conductivity, thermal resistance (insulation) and thermal absorptivity (warmth-to-

touch), thickness and thermal diffusion. The test instrument was used to determine the transient and steady state thermo physical properties of nonwoven dressings. The tests were performed on dry and wet states which were wetted with 0.2mL of distilled water on the centre of the fabrics and allowed 4 minutes to thermal recovery of the fabric. Water vapour permeability and the resistance to evaporative heat loss of the dressings were tested using Permetest instrument (Sensora Instruments, Czech Republic). This instrument is based on a skin model, which simulates dry and wet human skin in terms of its thermal feeling.

3. RESULTS AND DISCUSSION

The test results of the specimens are given in Table 1. The mass per unit area and thickness of the silver treated dressing were slightly higher than the CMC dressing. The thermal resistance values of the dressings were found to be 55.6 and 60.2 W-1K m2×10-3 (dry state) and 15.4 and 17.0 W-1K m2×10-3 (wet state), for CMC and CMC Ag, respectively. In the wet state, the dressings had drastically decreased thermal resistance values. The differences between the Ag treated and untreated dressings are noteworthy. The significant differences in thermal absorptivity of the dressings were detected when the specimens were wetted. The CMC Ag obtained had higher thermal conductivity values in its dry and wet states compared to the CMC dressing.

Table 1 Test results of nonwoven dressings

	DRY		WET	
Dressings	**CMC**	**CMC Ag**	**CMC**	**CMC Ag**
Mass (g m^{-2})	125	132	-	-
Thickness (mm)	1.51	1.55	-	-
Thermal resistance ($W^{-1}K\ m^2 \times 10^{-3}$)	55.6	60.2	15.4	17.0
Thermal absorptivity ($Ws^{1/2}\ m^{-2}\ K^{-1}$)	48.7	49.0	589	611
Thermal conductivity ($Wm^{-1}\ K^{-1}$)	27.2	29.6	103	109
Water Vapour Permeability (%)	55.7	57.9	-	-
Resistance to evaporative heat (m^2PaW^{-1})	5.3	5.2	-	-

4. CONCLUSIONS

From the test results, it has been observed that the silver treatment affect thermophysiological comfort properties of CMC dressings. All the tested parameters were found to be increased significantly after the treatment. These preliminary results need an in-depth study to demonstrate how the changes may affect the wound healing process *in vivo*.

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SMART CLOTHES

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Whatever their religions, nations and races be, the prospering countries are meeting on one common ground; deceleration of population increase. Their population increase rate is almost non-existing. Rich European countries are solving their required population need by including skillful youth of other countries within their body.

They transferred production of cement, rubber, cable and such sectors which contaminate the environment to our countries, before seventies. Then they added textile paint to these sectors that they transferred from their lands. In eighties, they transferred industry branches such as white goods, iron-steel production and shipbuilding which they no longer wanted to produce and which required qualified personnel to countries like us which were close to their countries or to China who ignored environmental problems. In short, Europe was founded on sectors which contaminate the environment, which have high energy consumption and which require many workers. Increased time of life, increased patient care expenses and climate change increased the technological improvements used for treatment of old people regarding tools used for daily life, mainly in medical field.

Global warming caused clothes to become thinner. Then nano technologies became widespread and caused these technologies to enter into human lives fast.

After nineties, there were new applications for textile products such as stain and oil repellency, catching fire harder and being crease-proof. In time nano technologies became used for our clothes and daily life products. Researches about new products that could be applied on clothes for military uniforms and sports technologies gave positive result in short time.

As the result of these researches, especially clothes began to take part in our daily lives such as products used by soldiers and sporters (Water and heat resistant tents, clothes, anti-bacterial products, fireproof clothes), products produced by home textile sector, new stain and stainless products, comfortable products, medical clothes etc.

RESULT

Application used on fiber and painted fabric surfaces to be used for clothing production has these advantages:

- Application process can be carried out with current machine park for wet processes. No new investment is necessary.
- Used nano chemicals are environmentally friendly. Most of them can be disintegrated biologically.
- It reduces usage of environmentally hazardous chemicals to minimum.
- It protects fabric's breathing ability.

Surface application does not change basic properties of the product. Trousers are still trousers, but nano particles allow auto-cleaning for them against filth.

Fabrics to be used for nano technology applications are fabrics made of cotton, linen, Polyamide, rayon and polyester.

Bigness of the market created by clothes such as daily clothes, sportswear and uniforms; home textile fabrics such as curtains, pillows, bed linens and carpets; military uniforms and similar products is expected to be more than a hundred billion dollars in 2015 year.

USA, Russia, China and EU countries have invested billions of dollars in these researches. Obtained nano particles are taking part in each field of life.

SUGGESTION

In my opinion, the biggest reason of the current crisis of textile sector is getting stuck in production of classical products. First generation of industrialists in textile sector was the ones who employed engineers and who respected knowledge. Small and medium sized industrialists with artisan origin that entered into sector after nineties saw their company growth as the result of their own skills instead of conjuncture and continued production of products that require no engineering and research. When our rivals produced the same products with lower prices, sector came to a dead end. Sector's salvation depends on production of products with different qualities when compared to rivals, R&D and Product Development researches. In this subject my recommendation for companies in the sector will be having projects produced by high level technical people and getting support from TUBITAK-TEYDEB.