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XIVth INTERNATIONAL İZMİR TEXTILE AND APPAREL SYMPOSIUM

BOOK OF ABSTRACTS

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XIVTH INTERNATIONAL İZMİR TEXTILE & APPAREL SYMPOSIUM

IITAS 2017

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BOOK OF ABSTRACTS

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IITAS 2017
XIVTH INTERNATIONAL İZMİR TEXTILE & APPAREL SYMPOSIUM

BOOK OF ABSTRACTS

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OCTOBER 26, 2017

TECHNICAL TEXTILES - TRENDS FOR NEW OPPORTUNITIES WITH SMART SOLUTIONS!

Uwe Merklein
Ib M Consulting – Ingenieurbüro Merklein, Aachen, Germany
uwe.merklein@t-online.de

What are Technical Textiles? Just for industrial application?

Technical Textiles are advanced textiles know for their excellent functional properties and technical performance.

An exciting multidisciplinary field with exhaustive applications in various industries, technical textiles is poised to witness strong growth.

Market today and tomorrow?

The global market is projected to reach US$ 168,3 billion (other sources are talking about US$ 193 billion) by 2020, driven by a robust demand from the construction and automotive sectors. Compared to 2010 (127,2 billion), there is a growth of 32% in 10 Years.

Market for Technical Textiles (2015)

The market has been segmented on the basis of major regions such as North America, Europe, Asia-Pacific, and Rest of the World (RoW), wherein their value and volume has been projected.

The Asia-Pacific region accounted for around 33.13% of the total market share in terms of value in 2014, followed by the North American and European regions at 29.13% and 24.02 %, respectively.

Global Growth drivers?

- **Global growth (Population)** Agrotech, Clothtech,
- **Increasing urbanization** Buildtech, Geotech
- **Strong requirement in living space** Buildtech, Hometech

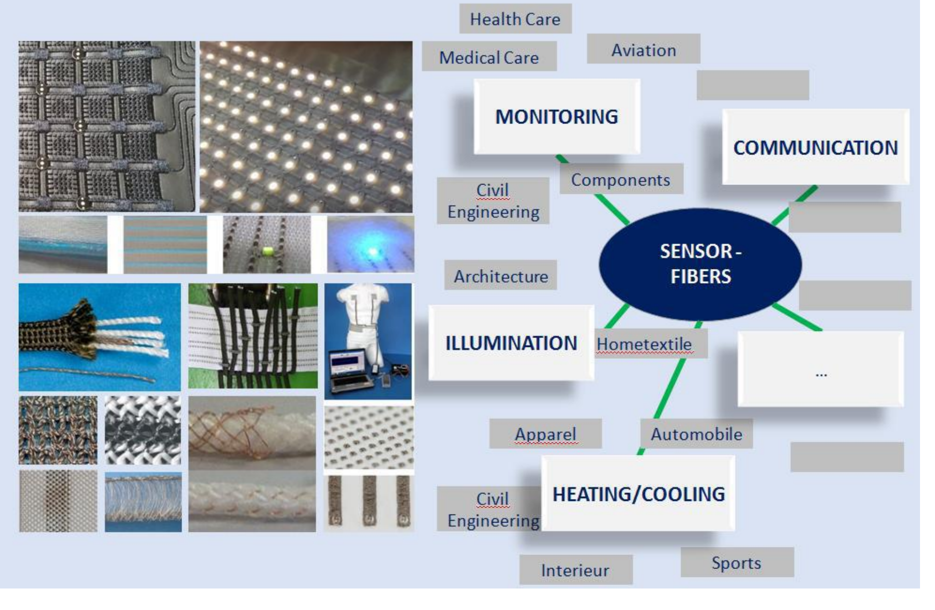
- **Expanding industrial production** Indutech
- **Roll out of medicare** (Emerging markets) Medtech
- **Increasing numbers of car manufacturing** Mobiltech
- I**ncreasing ecological damage -> environment protection** Oekotech
- **Expanding World trade**(Globalization) Packtech
- **Increasing requirement for security** Protech
- **Increasing expanses for sports and recreation** Sporttech

Key Trends (Future)

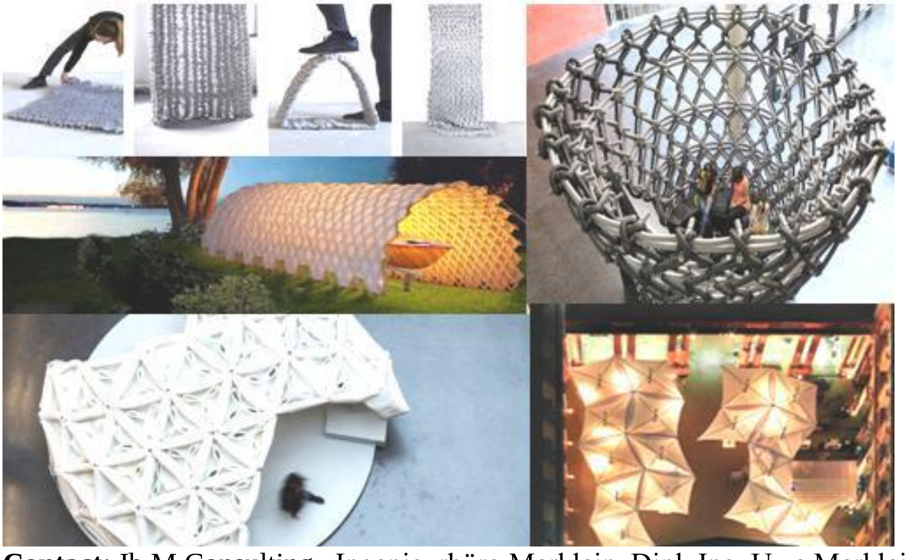
Functionality by material, finishing or in combination with:

- **SMART FUNCTIONS**
- New **APPLICATIONS** (for Apparels, Home textile, Architecture)
- Special **DESIGN** (Furniture, Outdoor, Architecture)
- Additional **SERVICES**
- **Digitalization**

Example for SENSOR FIBERS (Application/Smart Functions)



Just FANCY IDEAS?



Contact: Ib M Consulting –Ingenieurbüro Merklein, Dipl. Ing. Uwe Merklein
info@ib-m-consulting.de

Key Words: Technical textiles, smart, sensor fibers, safety textiles, health care

GLOBAL ORGANIC TEXTILE STANDARD ECOLOGY & SOCIAL RESPONSIBILITY

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elif@global-standard-org

GOTS is comprised of four reputed member organizations, namely OTA (USA), IVN (Germany), Soil Association (UK) and JOCA (Japan), which contribute to the GOTS, together with further international stakeholder organizations and experts, their respective expertise in organic farming and environmentally and socially responsible textile processing.

The Global Organic Textile Standard (GOTS) is recognized as the world's leading processing standard for textiles made from organic fibers. It defines high-level environmental criteria along the entire organic textiles supply chain and requires compliance with social criteria as well.

Key Words: GOTS, organic, process, ecology

OCTOBER 27, 2017

SESSION I

FROM RESEARCH TO IMPLEMENTED PRODUCT

Krste Dimitrovski[1], **Hüseyin Kadoğlu**[2], **Klara Kostajnšek**[1], **Pınar Çelik**[2] , **Güldemet Başal Bayraktar**[2], **Deniz Duran**[2], **Tuba Bedez Üte**[2], **Mustafa Ertekin and Matejka Bizjak**

[1]*University of Ljubljana, Faculty for Natural Sciences and Engineering, Department of Textiles, Graphics Art and Design, Snežniška 5, Ljubljana, Slovenia*

[2] *Ege University, Faculty of Engineering, Department of Textile Engineering, Bornova, İzmir, Turkey*

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In last 20 years the use of woven fabrics with extended elasticity increased enormously. Thanks to spandex yarns incorporated in woven fabric structure the woven fabrics got necessary increased elasticity for use. The problem was that incorporating not too expensive spandex yarn (mostly Lycra) into woven fabric structure in small quantities we could achieve desired stretching characteristics but they have some disadvantages like: non-ability of washing over 40°C, non-accepting colors, too big sensitivity (bad resistance) to chloral in the water and total control of dimension during weaving which results in at list lover productivity. It is certainly the possibility of using more expensive stretchable yarns but that makes the price of products not attractive.

In several years of research we tried to replace classic spandex yarns with so called potentially elastic yarns. That means that yarns can exists in two modifications: extended ones reached by texturing and shortened one reached afterword (after yarns are incorporated into fabric) by thermal treatment of the fabric itself. That approach has several advantages as are:

- No problems with controlling the tension of yarns during weaving since potentially elastic yarns act during weaving without extended elasticity.
- Possibility to use potentially elastic yarns in different construction as pure multifilament, as folded yarns and as core yarns in combination with natural yarns
- Possibility to wash fabric up to 100 or 110°C

- Possibility to regulate desired elasticity with the inserted quantity of potentially elastic yarns and constructional parameters of the fabric (weaves and densities)

We succeed to produce such woven fabrics under reasonable price and we could find the area of their use almost every field where products containing spandex yarns were used. However we asked our self is it possible to incorporate such potentially elastic yarns in the woven fabrics made product where improved elasticity is desired only on some part and not on all fabric. The fitted sheets and related products seemed ideal since the request is non-elastic upper side and elastic side and bottom side part of the fitted sheets. In that case elastic part should take the role of elastics on the back side of fitted sheets. The advantages of described approach comparing to fitted sheets containing elastic on the back side are:

- Better, faster and easier drying especially around the area near the elastic.
- Better folding and easier storing where take less space.
- In case of customized fitted sheet, meaning almost perfect fitting to the dimensions, there is no need for ironing which can results in significant sparing of time and energy. This is important in case of big user’s as are hospitals, homes for retired people, hotels where the costs of washing are an important factor.
- There is need for less material for the same matrass and there is almost no west.
- The manipulation setting and unsetting takes about the same time as fitted sheets with elastic but comparing to classic sheets much less time.
-

All this are benefits for potential individual and institutional users. Some of mentioned advantages are presented on the Figure 1.

Figure 1. The differences in use, folding and storing between fitted sheets with and without elastic

Considering all what was said we think that using potentially elastic yarns in the woven fabric structure can give real opportunity for production of fitted sheets without elastic and related products to compete on the market with classically produced product for that purpose of use. It means that without almost any investment in equipment, and problems in weaving process the product familiar and friendly for use can give customers good satisfactions and benefits.

Key Words: Basic research, potentially elastic yarns, fitted sheets

ACKNOWLEDGEMENT
This paper is a part of a bilateral project (Project number: 214M585) funded by Scientific and Technological Research Council of Turkey (TÜBİTAK) and Slovenian Research Agency (ARRS). We would like to present our thanks for their financial support.

RIETER MACHINES & SYSTEMS 2017: ALL SPINNING SYSTEMS FROM ONE SUPPLIER

Saygın Bayraktar
Erbel Mümessillik İhr. ve İth. A.Ş., Turkey
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“Rieter is the leading system supplier of installations for manufacturing yarns from short staple fibres. As a competent partner, Rieter makes customers’ lives easier. It provides advice and support from the initial investment discussions to the successful operation of their spinning mills. Rieter’s comprehensive know-how from fibre through yarn to the finished textile is the basis for innovative machines and consistent yarn quality.

Rieter is the only textile machine manufacturer to offer four spinning technologies and supports its customers worldwide with the most modern production installations in Europe, China, India and Uzbekistan as well as a professional sales and service network.

Rieter is the key to your success and offers you valuable systems, convincing technology and a supportive partnership.”

SAURER.SCHLAFHORST AND SAURER.ZINSER COMBINING FX-HIGH PERFORMANCE FEATURES IN RING SPINNING AND WINDING

Peter Gölden
SAURER.Schlafhorst GmbH & Co. KG, Germany

Zinser Impact FX compact spinning technology sets the benchmark for quality and economic efficiency. The self-cleaning and maintenance-free compacting system consistently ensures maximum compacting performance. Since it is electronically controlled and independent of the normal spinning vacuum, the compacting vacuum is guaranteed to be constant over the entire machine length. A high and constant yarn quality is therefore ensured at all times.

The Zinser Impact FX technology has the greatest possible area of application and gets the very best out of any raw material. The compacting zone and compact vacuum can be adjusted precisely to different raw materials and fibres. The settings are centrally managed here via the EasySpin touchscreen. All yarn counts from denim to fine yarn are possible.

The Impact FX makes it possible to get the best possible utilization of the raw material through adjustable compacting. The spinning limits can be extended for existing raw materials due to better utilization of the raw material. The individually adjustable compacting setting improves the running properties of the yarn and means that it is possible to achieve higher productivity as opposed to standard yarns. Even cotton qualities with reduced noil component and higher short fibre component give good yarn values – with significant raw material savings. It is also always possible with the Impact FX to react quickly to variations in the raw material.

Zinser Impact FX is the most economic compact spinning technology on the market.

The Autoconer package is the benchmark for quality and added value in downstream processing. This is true both for commodity applications and for the very sophisticated demands of high-end applications. Schlafhorst has the experience of many decades in automatic package winding, knows the market and process requirements. So we have developed intelligent systems to create process-optimized packages considering the most important package and process characteristics.

Perfect inner package structure

- even, uniform yarn tension: Autotense FX
- effective anti-pattering: Propack FX
- pattern-free, process-optimized inner structure: PreciFX

Process-oriented external package format

- formation of straight package flanks: Variotense FX, Variopack FX
- high-precision length measurement: Ecopack FX
- process-optimized, unique package shapes: PreciFX

First-class splice quality

- outstanding splice appearance and strength: SmartSplicer family

SUMMARY

The combination of both Saurer.Schlafhorst and Saurer.Zinser ring spinning FX technologies – your guarantee of success.

SIMULTANEOUS IMPROVEMENT OF ECONOMIC EFFICIENCY AND YARN QUALITY IN ROTOR SPINNING THROUGH INTEGRATED DRAW FRAMES

Hermann Selker
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Turkey has the most modern rotor spinning mills in the world. Of the current approx. 770,000 rotors in production, approx. half (343,400) are less than 10 years old. Today's spinning mills feature predominantly fully automatic rotor spinning machines.

THE INTEGRATED DRAW FRAME

An integrated draw frame is generally understood as an auto-leveller draw frame with a narrow drafting system for one individual sliver. This draw frame is directly coupled with the card. The 2-over-2 technology with one drafting zone has established itself as drafting system.
An input sensor measures the sliver mass to control the short-wave levelling. The sliver quality is permanently monitored by an output sensor.

LOWERING PRODUCTION COSTS

In spinning preparation there is still potential to lower production costs. Draw frame passages are completely eliminated due to the direct connection of card and integrated draw frame. This reduces operating costs by means of:

- Reduced space requirement
- Lower investment costs
- Lower electricity costs
- Fewer cans
- Fewer can transports
- Less personnel
- Increased efficiency of rotor spinning machines

IMPROVING YARN QUALITY

In contrast to ring spinning, parallel fibres in the sliver offers no advantages in rotor spinning. On the contrary, excessive parallelism is more likely to cause unevenness in the feed area. The sliver of a card, and thus also of the integrated draw frame, has the appropriate sliver structure and runs with much less interferences. This increases the efficiency of the machine.

However, evenness is often insufficient. For this reason, one or two draw frame passages were used in the past. These draw frames, in turn, have the disadvantage of impairing the yarn imperfection values.

An integrated draw frame works with a very low draft. It is high enough to allow sliver levelling, but low enough not to negatively impact sliver structure. Thus, the yarn has fewer thick places, thin places and neps. The improvement in yarn count variation is even more striking. Improved CV values in the range of 1-10 m cutting length significantly improve product quality. The fabrics appear to have less streaks and the knits exhibit an increased uniform coverage.

SAVINGS IN RAW MATERIALS

Until now, the field of application for integrated draw frames has mainly been in the cotton sector. Approx. 2,500 systems are globally in operation here. The respective raw material costs account for approx. 50 - 70% of the yarn production costs. That's why savings in this area make sense. Meanwhile it is common to add more or less waste, depending on yarn count. These card slivers, consisting of cotton and short-staple waste, do not tolerate a drafting process that is subject to high draft. The drafting systems must be set to the longer cotton and the shorter waste cannot be guided in a controlled manner with conventional draw frames. This results in floating fibres and the formation of fibre packs in the sliver. This in turn is the reason for the decrease in yarn evenness.

EXPANDING THE APPLICATION SPECTRUM

In recent years, the application spectrum for the integrated draw frame technology has been expanded.

Regenerated fibres

Regenerated fibres are often blended with 10 or 20% carrier fibers (usually polyester). Slivers with such huge differences in staple length cannot even be processed on regular draw frames.

Yarn counts

20 years ago, the first integrated draw frame was applied in the coarse yarn sector. Today, the technology is suitable for cotton in all yarn counts, even for Ne 30 and finer.

Man-made fibers

Currently the process is conquering the man-made fiber sector. First successes have been achieved - again in Turkey - with PES and CV ranging from 1.2 – 1.7 dtex and 32 – 40 mm, as well as blends with these fibers.

BOUNDARIES

Use of the integrated draw frame eliminates the blending effect of doubling in conventional draw frames. This aspect must therefore be considered during fibre preparation. This means a sufficiently high number of bales in the bale lay-down and the use of trunk mixers for a controlled blend.

The lower level of fibre parallelism in the sliver can result in lower yarn strength. In individual cases, the maximum tensile strength might be reduced by up to 0.4 cN/tex.

SUMMARY

The use of integrated draw frames in rotor spinning significantly improves the economic efficiency. The improved yarn quality has a positive impact on further processing in weaving and knitting.

Mönchengladbach, 26 April 2017

PIEZOELECTRIC FIBRES: POTENTIAL AND LIMITATIONS

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ABSTRACT
Piezoelectric materials have been used in many applications since the discovery of piezoelectricity in the late 1800s. Piezoelectric materials include single crystals, piezoceramics and piezoelectric polymers. While piezoceramics and specifically the most commonly used Lead Zirconate Titanates (PZTs) remain quite popular, piezoelectric polymers (mainly polyvinylidene fluoride (PVDF) films) are one of the fastest growing technologies for certain applications. Piezoelectric polymers exhibit low density and excellent sensitivity, and are mechanically tough. Since 2010 research has focused into the production of melt-spun piezoelectric textile fibres, with the aim of integrating sensing/ energy harvesting capabilities into smart textile structures. The electrical power efficiency and behavior characteristics of the fibres produced using the continuous method proposed and patented by Siores et al, has been investigated and this paper collates the results in an attempt to create a comprehensive profile of the fibres

Key Words: Piezoelectric fibres, polyvinylidene fluoride, Polyamide 11, polypropylene, energy harvesting

1. INTRODUCTION

Piezoelectric materials have been widely used as sensors, actuators and in energy harvesting applications. The materials are divided into four categories: ceramics, single crystals, polymers, and composites (the composite material is a combination of piezoelectric ceramics or single crystals with polymers). When considering the materials in a historic perspective, single crystals and ceramics were the oldest materials used for piezoelectric applications with quartz being one of the oldest materials used [1]. In 1969 Kawai [2] discovered large piezoelectricity in elongated and poled films of polyvinylidene fluoride (PVDF). Other polar polymers such as Polyamide 11 (PA-11) were also investigated [3].

Then around 2010 research was published into methods of producing melt spun, piezoelectric textile fibres [4, 5]. Multifunctional textile materials become increasingly important for combined applications. Piezoelectric fibres and yarns open a new field in the multifunctional textile area, especially for the energy harvesting applications, with a definite aim of integrating fabrics made of piezoelectric fibres into e.g. garments will be able to harvest the energy produced by the motion of the body to produce electrical power [6].

2. INVESTIGATION

This paper is concerned with melt-spun piezoelectric textile fibres and specifically the ones produced using the continuous production method developed by Siores et al [7]. The method integrates the polarization process with the fibre production process minimizing the numbers of steps required to produce piezoelectric fibres [8]. The method has been used to produce ribbon and monofilament yarns, comprising of pure PVDF, PP and PA-11 as well as composites of the pure polymers with multiwalled carbon nanotubes (CNTs) [9, 10]. Investigation into the electrical response of the fibres to mechanical simulation [8] highlighted the precise behavior of the fibres re voltage production with regards to the position of the maximum deformation [11]. The range of power produced by the fibres was investigated with [12] and without load [8] and the response to varied stimulating frequencies was determined. The paper attempts to present a broad profile of the electromechanical behavior of the fibres as a result of the aggregate of research carried out on the fibres produced and tested under various conditions in order to explore the benefits and the limitations of their use.

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DESIGN OF AN ELECTRO-TEXTILE BASED WEARABLE ANTENNA

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The electro-textile materials that have been developed by electronic, telecommunication and textile sciences have come into our daily lives in recent years. The emergence of the wearable electro-textile materials which constitute a new field of research, is the end of the nineties. The materials used in wearable antenna are conductive textiles and have resistant structures against bending. In this respect, they can be used in many areas such as the medical, military and mobile technologies.

There are many types of wearable antennas and they are used in various applications. Several types of wearable antennas have been proposed with different topologies, e.g., patch antennas [1], planar antennas [2] and monopole antennas. The monopole antenna design was preferred in this study. The Pure Copper Polyester Taffeta Fabric (PCPTF) is used as the electro-textile material. The electrical conductivity and sheet resistance of PCPTF is 2.5×10^5 S/m and 0.05 Ohm/sq, respectively. Felt textile materials were used as substrate. Materials used in design and their properties are given in Table 1.

Table 1. Properties of materials used in monopole antenna design

	Polyester	**Felt**
Loss Tangent	0.0044	0.016
Permittivity	1.748	1.22
Thickness	0.28 mm	2 mm

We have simulated wearable antenna design and made calculations by using a full-wave EM solver CST Microwave Studio. Firstly, the properties of electro-textile materials were defined in the program and then the design was created. The wearable monopole antenna design is shown in Figure 1.

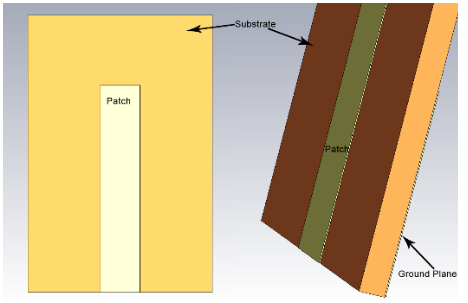

Figure 1. Electro-textile based monopole antenna design

Patch was made up with PCPTF, substrate and ground plane were made up with Felt materials in the design. The results obtained from the antenna simulations are given in Figure 2. The S_{11} parameter-frequency graphic is given in Fig.2(a). In this graphic, monopole antenna reflects at a frequency of 2.45 GHz and has a good propagation at this frequency. It means that, this antenna works efficiently at the frequency of 2.45 GHz. The surface current of antenna is given in Fig.2(b). Accordingly, the antenna propagation in the middle parts is adequate and well done.

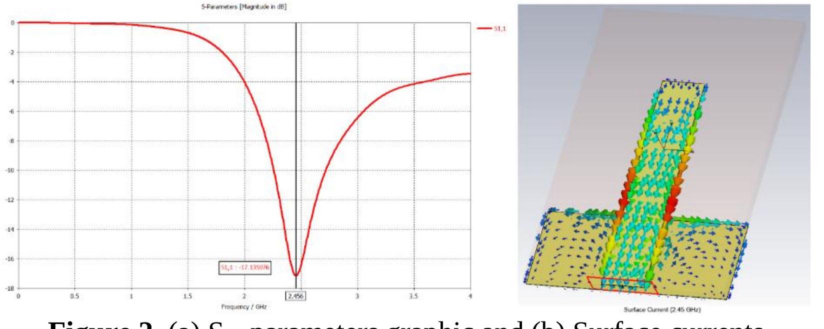

Figure 2. (a) S_{11} parameters graphic and (b) Surface currents

In the continuation of the study, Metamaterial (MTM) based structure that has Electromagnetic Band Gap (EBG) have been used. MTMs are defined as artificial electromagnetic materials. The dielectric permittivity (ε) and magnetic permittivity (μ) of traditional materials are positive. But for MTMs, these values are negative and can be modified [4]. MTMs have quite different features because of their unique property and this made them important topics in recent years. This study is distinct from others in terms of usage of electro-textile antenna with MTMs. Specific absorption ratio was obtained. Calculations were made by applying bending on structure. The results were observed in terms of bending formation when the antenna have been worn. The human body design formed in the study is given in Fig.3(a).

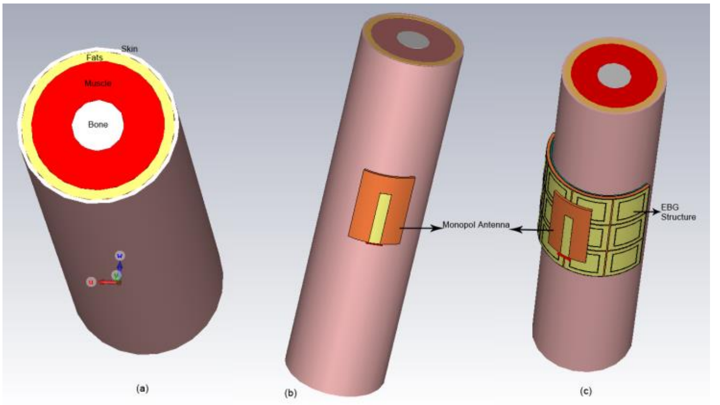

Figure 3. (a) Human body model, (b) A monopole antenna in direct contact with the human body and (c) Addition of EBG structure between the antenna and the human body

The monopole antenna is in direct contact in Fig.3(b), and there is an EBG structure between the antenna and human body in Fig.3(c). Bending was applied to both structures and the performances of the structures were obtained.

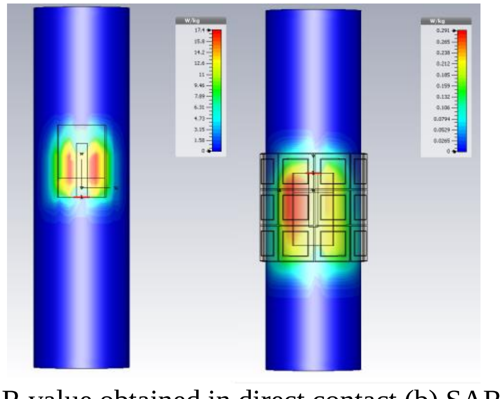

Figure 4. (a) SAR value obtained in direct contact (b) SAR value obtained when EBG structure was placed between human body and antenna

The SAR value was obtained as 17.4 W/kg when there is a direct contact between human bod and monopole antenna (Fig.4(a)). This value which is approximately the value of efficient antennas has detrimental effect on human body. If EBG structure is used between human body and monopole antenna, the SAR value decreases to 0.291 W/kg. Since, this value is lower than the European standard (2 W/kg), it can be said that the proposed structure is quite good. The other advantages of structure are low-cost and bendability. As a result, EBG based electro-textile antennas can be utilized in various applications where wearable antenna technologies are used.

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CORE-SPUN AND DOUBLE-CORE YARNS IN COMPARATIVE PERSPECTIVE

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For improving body movement comfort in denim jeans, 10-35% elasticity is needed. Elastic structures are preferred for improving the elasticity and also recovery of the fabrics [1]. Elastic core-spun yarns (soft-core yarns), having an elasthane core, mostly covered with cotton, are primarily used for this purpose. However, using soft-core warp yarns can be problematic during weaving processes. Therefore, desired fabric elasticity is generally provided by elastic-core-spun weft yarns. As mentioned before, core-spun yarns consist of at least two different components; a staple sheath and a filament core [2]. While, double-core (dual-core) yarns made of three components; an elastic polyurethane filament (such as Lycra®, Creora® or Inviya® I-300) and a multifilament (such as Lycra® T400®) are used in the core, covered by a staple sheath. Double-core yarns are used for high quality denim fabrics and they are advantageous regarding the spinning and weaving process [3].

In recent years, alternative to elasthane, using bi-component polyester fibres and poly butylene terephthalate is inspiring interest. They have some advantages such as higher strength due to better chemical resistance, better recovery and dimensional stability and elasticity properties [4].

Many researchers have been focused on core-spun and elastic yarn properties [5-7]. Sarıoğlu and Babaarslan investigated the fatigue behaviour of rigid core-spun yarn structure containing PET textured filament yarn (PET DTY) with respect to different filament fineness and yarn count [8]. Celik and Kaynak examined the effects of elasthane draw ratio on air permeability of denim woven fabrics [9]. Ertaş et al [10] analyzed the effect of the density changes in the use of the dual-core threads used in denim fabrics. Telli et al, focused on the usage of core and dual-core yarns containing tungsten for electromagnetic shielding [11].

In this study, the properties of core-spun and double-core yarns, spun with different core materials, were investigated. For this purpose, elasthane (EL), poly butylene terefthalate (PBT) and elastomultiester (EME) were used in the production of elastic yarns. Sheath material was cotton for all yarn types. Yarn samples were spun in the same yarn count and twist coefficient (Ne 18, α_e 4,2) on Pinter Merlin ring spinning frame. Filament draft ratio and other spinning parameters such as spindle speed were kept constant. Yarn samples were tested and evaluated for important physical and mechanical properties such as evenness, imperfections, tenacity, breaking elongation, hairiness and yarn liveness.

According to test results, intermingled PES/EL based core yarns have the lowest, whereas, PBT and EME based core spun yarns have the highest yarn unevenness values, respectively. In terms of yarn hairiness, IMG PES/EL based core yarns have the highest Uster H and sH values. The lowest yarn hairiness values were belonged to EME and EL core spun yarns. The snarling tendency, known as yarn liveness of the yarns were evaluated and it is found that EME based core spun yarns' yarn liveness were considerably lower, on the other hand, double-core spun yarns' liveness were higher than that of core-spun yarns. Breaking strength and elongation test results show that, dual core yarns have lower strength and higher breaking elongation, in general. EME based core spun yarns have the lowest elongation values. In conclusion, it is decided that, using dual-core-spun weft yarns for denim production will provide advantages.

Key Words: Core-spun yarns, dual-core yarns, duo-core, soft-core yarns, elastic yarns, denim

ACKNOWLEDGEMENT
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HOW DO TRAVELLER WEIGHT AND RUNNING PERIOD EFFECT PROPERTIES OF COMPACT SPUN YARNS FINER THAN NE 100?

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INTRODUCTION

Compact spinning is a time-tested spinning system for its high quality yarns. This spinning system allows producer to create yarns with higher tensile strength, lower unevenness and hairiness in comparison with conventional ring spinning system.

Compact system's main difference with ring spinning system is its drafting zone. In this zone, a compacting part is added, this part differentiates for each machine producer, and it forces fibers to align to a theoretical line which is at the center of cylinder surface. Thus, spinning triangle is minimized and producing yarns with higher quality features is enabled. Most of these systems use air guided compacting elements.

Twisting zone of compact spinning machines was kept the same with ring machines. Fiber bundle leaving nipping rollers cannot be presumed as yarn yet, it has to be twisted and formed as yarn. Spindle is mainly responsible for twisting. Ring and -its companion- traveler are as important as spindle for twisting. Ring constitutes a path for traveler during spinning. Their friction allows winding yarn to form a cop (1, 2).

Hairiness is an important feature of the yarn. It affects aspect, handle and performance characteristics of its end use product (3). For better handle of fabric, hairiness has a positive effect. However, for some aspect and performance properties of fabrics hairiness has negative effect, such as abrasion and pilling resistance (4). Moreover, hairiness has one important effect on traveler, which can be called as lubrication effect. Protruding fibers enhances traveler service time. This means by having lower hairiness, compact yarns have negative effect on travelers. In compact yarn production, traveler changing period is shorter compared to ring spinning system (5).

Traveler weight is an important parameter during spinning. Canoğlu and Usta stated that "traveler weight has a significant influence on reducing yarn hairiness" (6). However most of the studies do not include yarns finer than Ne 100. In this study, we produced Ne 100, Ne 110 and Ne 130 compact spun yarns using RIETER system. Our aim was to determine the effects of traveller weight and running period on yarn properties.

EXPERIMENTAL

In this study, Ne 100, Ne 110 and Ne 130 yarns were produced by using RIETER K44 compact spinning machine from combed cotton rovings. Three different ISO valued travelers were used in every yarn count. They were identified as light, medium and heavy. In these productions, same machine parameters were used such as spindle speed, apron/ cot types, spacers, and etc.

The effect of traveler running time on yarn properties was investigated by using three time intervals after replacing the traveler and testing yarns produced at the end of these intervals. For each yarn count we had 9 yarn types (3 different ISO and 3 intervals of traveler usage). For each yarn type we used 3 cops for tests.

Yarn samples were initially conditioned in laboratory. After that, tensile strength tests were carried out using Uster Tensorapid (?), and unevenness test by using Uster Tester (?). yarn to metal friction and yarn to yarn friction tests were done by using Lawson/Hemphil CTT yarn abrasion tester.

RESULTS

The test results indicated that heavier travelers enable producing yarns with higher tensile strength and lower hairiness. Hairiness and Tensile strength results of NE 30 yarns are given in figure 1. Additionally, it was determined that using new traveller does not always effect yarn properties positively.

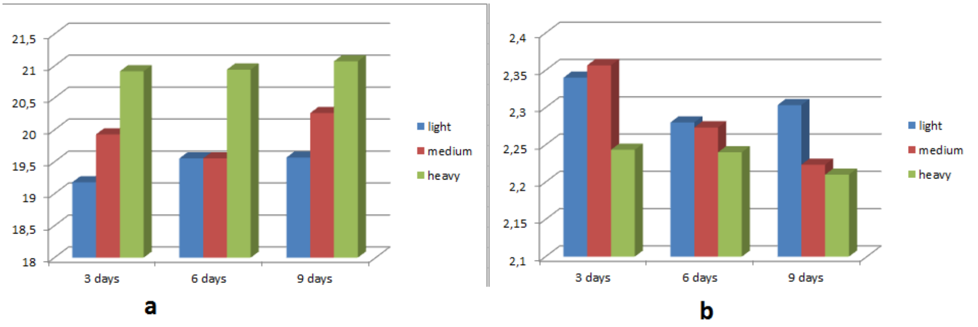

Figure 1. Tensile strength (a) and hairiness (b) comparison of Ne 130 yarns

Key Words: Compact spinning system, traveller weight, traveller running period, yarn physical properties

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PREDICTION OF THE CREASE RECOVERY PROPERTY OF LINEN WOVEN FABRICS WITH ARTIFICIAL NEURAL NETWORK TECHNIQUE

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Creasing is a bending deformation which causes an unwanted image on fabric surface, when the fabric subjected to external factors such as folding, bending and pressure. Crease resistance of fabrics variates due to type of raw material, except from this, creasing depends on the parameters such as yarn count, yarn twist, fabric density and fabric weight; and the fabric whether knitted or woven. In this study, 100% linen woven fabrics, from the cellulosic fibre group which has the most creasing problem, were chosen and the effect of basic physical properties of the fabrics on crease recovery were tried to estimate with artificial neural network technique. Parameters which stated as effective on creasing problem in literature were investigated with regression analysis primarily. According to the results of regression analysis, fabric thickness was found as the most effective parameter on creasing problem. The other parameters which were found statistically important are bending length for weft and yarn twist coefficient for warp directions. In the study artificial neural network models were created by using these parameters as input variables. The outputs obtained with ANN method compared with the experimental crease recovery angle results. According to the results, it is observed that ANN models make predictions closer to experimental results and it is revealed that ANN method could be used for prediction of physical properties of the fabrics successfully.

Key Words: Artificial neural network (ANN), crease recovery, linen, woven fabric.

AESTHETIC ANALYSIS OF THE RELIEF EFFECTS USING THERMOPLASTIC STRUCTURED YARNS TO DESIGN AND PRODUCTION OF WOVEN FABRICS

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AIM

It is seen that the woven fabric which has great significance within the textile products varies based on the effects of different production methods and raw materials. In woven fabrics, material and method are the two most important factors that lead to the occurrence of different surface appearances for physical and aesthetic purposes. The usage of thermoplastic structured yarns that shape permanently under thermal processing also enables the creation of aesthetically innovative and creative surfaces. The aim is to design and produce effective, functional, able to form aesthetics and taste shapes and innovative and creative woven fabrics with high added value within the industry-art cooperation in the 21th century in a modern, simple designing perspective. Within the thesis study, the relief effects acquired from the thermoplastic textured yarn used in the design and production of the woven fabric were analysed by considering the factors which effect the design in terms of aesthetics and it was aimed to get fabrics with innovative appearances in function-aesthetic sense.

Relief effects in woven fabrics occur by giving different volumes by considering the usage of the thermoplastic textured yarn and the factors effecting the design and production technically and aesthetically. Thermoplastic yarns -having permanent plasticity feature when applied thermal processing- as well as weave, weaving method, material, density and colour factors enable to design and produce relief-featured fabrics. The purpose of the relief effects formed on the fabrics woven by thermoplastic yarns are to increase the aesthetic value of the woven fabrics and design and produce innovative looking fabrics with function and aesthetic. Thermoplastic yarns are the ones that melt and can take form at different temperatures according to their raw materials and keep their shapes permanently when heat dies out. Being one of the visual effects in the design of the woven fabrics, relief effects are defined as partial shadow effects that highlight the impact of light on embossed surfaces. Structures with different effects, either genuine or artificial, are in every aspect of life and with the emergence of modern designing awareness, they have begun to shape simple, effective and functional designing ideas and aesthetics and taste forms. Designing a product which is already functional aesthetically or bringing function to an aesthetic product is only possible with a creative idea. Therefore, apart from design and creativeness, one of the features expected from the woven fabrics is to bring benefit in terms of aesthetics. Today, thermoplastic yarns are used widely in the woven fabric design and production. The conclusion aimed in this study is that when thermoplastic structured yarns, which are used in the design and production of woven fabrics, are applied thermal processing, they not only get functions but also have innovative surface appearances with relief effects in an aesthetic way.

METHOD

Not only the productions method but also yarns are significant in woven fabrics with relief appearances. Factors such as the type of the yarn, physical and chemical features of the fibre, yarn twist and the thickness and slimness of the yarn enable the occurrence of differences. Apart from yarn and latticing, relief effects can also be applied by density, finish and different methods. Applying all these factors together also diversify the relief effects in design and production of woven fabrics. During the process of design and production of relief effected woven fabrics, as a method, weave was fasten by using plain weave and 3/3 warping ribs was used as edge weave. Fabrics were woven on 2400 platinized Somet-Staubli jacquard loom in double layered circular weave.

RESULT

While evaluating woven fabrics in terms of aesthetics, the fabric feel, drape, brightness, colour, wrinkle recovery, bulkiness, transmittance, stiffness, softness and hairiness features as well as their care features and being dirt repellent feature are taken into consideration. It is seen that thermoplastic yarns and non-thermoplastic yarns and the design are significant when the images of 12 fabrics' relief effects before and after thermal processing are compared in terms of aesthetics. Considering the materials that are used, it is seen that fabrics have different relief effects as well as feel, volume and stiffness. Comparing the aesthetic features of all fabrics before and after thermal processing, the somewhat acquired volume of the fabric thanks to the double layered circular weave before thermal processing feels as if the pattern was weaved with yarns in different colour values. The reason of this perception is the shadow effect that is acquired by the areas with height difference based on light.

According to this information, it has been concluded that in order thermoplastic structured yarns to be effective on woven fabrics in terms of forming relief effects, they should be used together with non-thermoplastic yarns; features of non-thermoplastic yarns such as thickness- slimness, softness- stiffness and winding are effective on having a permanent form of thermoplastic yarns by being exposed to thermal processing; fabrics designed with double layered circular weave have better relief effects and all of the factors that have an impact on design should be considered by the designer inseparably. When evaluated in terms of aesthetics; it was observed that the features of digger yarn used with thermoplastic yarns increase or decrease the relief effects and change the aesthetic characteristics by changing the features such as feel, drape, brightness, wrinkle recovery, bulkiness, transmittance, stiffness-softness, slipperiness and hairiness. Furthermore, thermoplastic yarns enable fabrics to be used longer by preserving the appearance as they have a permanent form through thermal processing.

Key Words: Woven fabric design, thermoplastic yarn, heat-setting, relief effect, aesthetic

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OCTOBER 27, 2017

SESSION II

THE USE OF WASTE PUMICE IN THE TREATMENT OF DENIM PLANT WASTEWATER

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The elimination of the wastes from all industries is a requirement in terms of environmental regulations and welfare of all the creatures in the future. In this study, the use of the waste pumice stones of a denim washing mill was targeted to eliminate the pollutant by a waste material and obtain economic benefits by converting it to the adsorbent. The pollutants in the effluents obtained from chemical treatment unit of waste water treatment system of a denim plant were removed through the adsorption. The experimental studies were carried out in a pilot scale adsorption column. The change in color and chemical oxygen demand (COD) with time determined for the inlet and outlet streams of the column. In addition to the COD, the parameters such that total dissolved solid, turbity, the amount of chloride anion etc. were also measured. Although the color and other characteristics of the inlet stream changed depending on operation conditions, a 83% average color removal and a 8% reduction in COD value were obtained. The results showed that the waste pumice can be used as adsorbent for the treatment of waste water from denim plant.

Table 1. Water characteristics

Parameter	effluents obtained from chemical treatment unit of waste water treatment system	Treated waste water with pumice after chemical treatment	Fresh water	Waste water discharged into stream
Chloride (Cl^-)	307 mg/L	183 mg/L	75 mg/L	205 mg/L
Chemical oxygen demand (COD)	480 mg/L	416 mg/L	12 mg/L	16 mg/L
total dissolved Solid (TDS)	2000 mg/L	1640 mg/L	832 mg/L	1480 mg/L
Suspended solids	145 mg/L	71 mg/L	<2,95 mg/L	27 mg/L
Oil and grease	14,6 mg/L	13,6 mg/L	<4 mg/L	<4 mg/L
Sulphide (SO_3^{-2})	3 mg/L	1 mg/L	<1,45 mg/L	<1,45 mg/L
Sulfur (S^{-2})	2,4 mg/L	<0,79 mg/L	<0,79 mg/L	<0,79 mg/L
Ammonium (NH_4^{+1})	9,8 mg/L	7 mg/L	<0,24 mg/L	<0,24 mg/L
Turbity	77,2 NTU	66,6 NTU	<0,1 NTU	1,95 NTU
Biological oxygen demand (BOD_5)	350 mg/L	300 mg/L	7 mg/L	10 mg/L
Sodium (Na^+)	145 mg/L	234 mg/L	88 mg/L	187 mg/L
Adsorbable organic halides (AOX)	45 mg/L	23,5 mg/L	4,28 µg/L	40,06 µg/L
Colour	326 Pt-Co	35,6 Pt-Co	11,7 Pt-Co	122 Pt-Co

MANAGE THE CHALLENGE OF THE INDUSTRY BY DELIVERING ECONOMIC AND ENVIRONMENTAL SUSTAINABILITY

Oliver Gerlach
Hunstman, Singapore

In our industry we are facing constant changes. Environmental restrictions through new regulations and Economical pressure from brands and retailers to mills influence our business from many directions. The presentation will give examples of regulatory changes that are critical for the textile industry, like Oekotex, Reach, RSLs, MRSLs. The industry players will have to follow new restrictions, which may force them to adapt their processes and supply chain. A pro-active approach to EHS leads to a stronger competitive position.

It is the responsibility of every player in the industry – so all of us – to aim for better products.

Huntsman is working hard to be pro-active and to help the industry navigating through the complex landscape of requirements and fulfilling them.

Examples and solutions from Huntsman TE

PRETREATMENT
Ecological and economical benchmark concepts that help mills improving their environmental footprint and control their quality and costs for example phosphorus free surfactant formulations or biosoft cracking.

DURABLE WATER REPELLENTS

Our stance to the increasing challenge of PFOAs in repellency products is a responsible range pruning of Fluorochemicals by replacing C8 with newly developed C6. Moreover using non-fluorinated alternatives wherever possible to cover the market needs and engineering new high performing products.

The presentation will give an overview of comprehensive and diverse range of fluorinated and non-fluorinated technologies for all end use applications. We will ask the question „what do we really need?“

OPTICAL BRIGHTENERS / FWAS

Extending the life cycle of a textile contributes directly to its ecological footprint.

Optical brighteners allow the garment to stay white for longer and to retain its newness to prolong the use.

The presentation will introduce our concept and branding scheme of Lasting whiteness and give an example of a state of the art brightener that can be used together with effective stain release systems to achieve long lasting whites combined with effective stain management.

DYEING

Fresh water is very scarce and so is a top concern for the textile industry, which is one of the major water consuming industries. The presentation will review the success of award winning AVITERA SE in saving water, energy and CO_2 up to 50 % and more

USING PHOTONIC CRYSTALS FOR STRUCTURAL COLORATION OF TEXTILES

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Colours can easily two main categories: pigmentation and structural coloring. In textile fields, the main way to color textile is attaching colorants of dyes or pigments onto fibers, yarns and fabrics, which belongs to the pigmentation process (1).Traditional coloration relies on chemical means to achieve colour by selective absorption and reflection, and is generally used by creatures living in environments where light is plentiful. Dyes are subject to photo bleaching, so the animal's energy budget may need to include replacement of the pigments from time to time (2).

Structural coloration can be observed in natural life forms, for instance, in peacock feathers, outer shells of jewel beetles, wings of Morpho butterflies and many other insects. In nature, it is used for camouflage, intimidation (warning), display and communication (3-5). The formation of structural colors does not require any chemical colorants, by reason of coloration based on the principles of Bragg diffraction. It is, in fact, a visual perception to the selectively reflected light by a special physical structure interacting with incident light, such as dispersion, scattering, interference and diffraction. Structural color proposes several advantages, for instance, more bright colors, not fading, making reflection or transmission of selected wavelengths, permanent and reversible color changing.

Nowadays, photonic crystals (PCs) have attracted much interest since novel concepts, such as photonic band gap, have been theoretically deduced and various novel applications of photonic crystals have been proposed. Decoration applications perhaps first come to mind as they are closely related to the color effects of photonics crystals (6).

In recent years, structural colors by photonic crystals have encouraged a great number of potential applications: inkless printing, reflective flat display, gas sensing, paints, photonic papers and cosmetics (7-10). However, the research related to self-assembly of photonic crystals and its structural colors on textile were rarely reported (11). Most of these studies have focused on silk and polyester fabrics disregarding the application in cotton and other cellulosic substrate (12-14).

The main objective of this study is to perform structural color onto cotton fabrics. Colloidal PCs based on P(St-MMA-AA) composite nanospheres were deposited onto a black woven cotton fabric. Coated fabrics were evaluated for chemical properties and color variation by optical and SEM microscopy, ATR-FTIR and colour measurement.

Key Words: Photonics crystals, textile, structural coloration

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ENCAPSULATION OF PHOTOCHROMIC DYES FOR TEXTILE APPLICATIONS

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Smart textiles which perceive and respond to any effects in the environment attract attention in recent years. Photochromic materials which are one of the smart textile products can change color reversibly depending on the change of UV light intensity in the environment [1, 2]. Photochromic dyes that are of interest to textile industry have potential applications for fashion or functionality purposes. Industrial application and scientific researches on photochromic dyes for textiles have been attractive in recent years [1, 3-11]. In addition photochromic compounds have been widely used in optical industry and there are some problems on application of photochromic dye to the textile materials due to their sensitive structure as mentioned in the literature [12-14]. The molecular structure of these compounds deteriorates and photocromism properties of the compounds are decreased or disappear at high temperatures. These problems restrict the usage of the photochromic dyes in textile dyeing processes [1, 12-14]. In this context, encapsulation of photochromic dyes is a solution to eliminate the disadvantages on the application of photochromic dyes in textile industry.

Encapsulation is a process in which very small particles of solid or liquid material are coated with a continuous film of polymer. This process contributes to protect the photochromic dyes from environmental factors and develops the application and durability properties of these dyes [15]. There are several methods such as in-situ polymerization, interfacial polymerization, solvent evaporation, and spray drying to encapsulate of photochromic dye [1, 16-19]. In this study, encapsulation of photochromic dye by solvent evaporation and spray drying methods have been investigated. It was observed that ethyl cellulose has proved to be a useful polymer for formulating photochromic dye capsules using solvent evaporation and spray drying technology (Figure 1 and Figure 2).

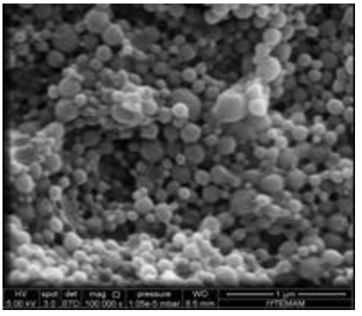	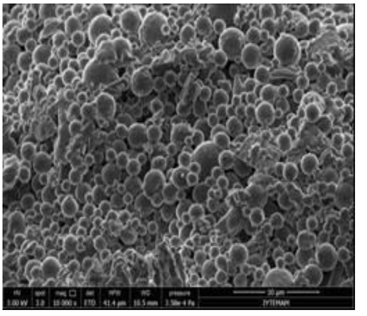
Figure 1. SEM image of the photochromic dye capsules obtained by solvent evaporation	**Figure 2.** SEM image of the photochromic dye capsules obtained by spray drying

Key Words: Photochromic dye, textile, encapsulation, solvent evaporation, spray drying, ethyl cellulose

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THE RESEARCH OF THE USAGE OF THERMOCHROMIC LEUCO DYES IN TEXTILE PRINTING

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INTRODUCTION

Chromic materials can change their colour reversibly as a response to changes in environmental condition (temperature, brightness, etc.) or by induced stimuli. Technically, colour change of a material can be explained by alteration in the equilibrium of electrons caused by the stimulus. This results in changes in optical properties such as reflection, absorption, emission and transmission. [1].

Chromic materials and textile applications, along with other technological developments and innovative material approaches, create new potentials in textile and fashion design fields and enable the development of creative products with the formation of new perspectives. Kooroshnia [3], Robertson [4, 5], Worbin [6] and other researchers and artists [7-10] have studied the chromic materials on textiles.

MATERIALS AND METHODS

Thermochromic dyes, which are by far the most popular chromatic dyes used in the textile industry, can change their colour by temperature changes. Two types of thermochromic dyes are “leuco” dyes (exhibit a single colour change with a molecular re-arrangement) and liquid crystals (have a spectrum of colour changes) [2] have been used in textile applications. In this study, three different leuco types thermochromic dyes (black, blue and red) that changing color at 31 °C and acrylic based printing paste (Inkuin-RB 2030) were obtained. Reactive printing dyes

(Procion Yellow PX-6GN, Procion Blue PX-5R, Procion Red PX-6B) were kindly donated by Dystar Company. Bleached 70 gsm 100% cotton woven fabric and 100% PES printed woven fabric samples were selected for printing applications.

Printing processes are explained below:

1. wt%30 thermochromic dye and wt%70 binder were mixed by mechanical stirring and printed to fabric samples. The printed samples dried at 130 °C by hot press or steam iron. Three different process time (60, 120 and 180 s) for hot press and two different process time (60 and 120 s) for steam iron were selected. Effect of drying time and drying method were investigated. 2. In this part of the work, black thermochromic dye mixed by weight with printing paste in three different ratios (wt%10, wt%20 and wt%30). Samples were printed on cotton and PES fabrics.
3. Thermochromic dyes were mixed with each other in different ratios to obtain different colour effects. Colour mixes were applied to cotton fabrics.
4. Thermochromic dyes were mixed with reactive printing dyes in different ratios. Applications details are given in Table 1. Printed fabric samples were heated over 31 °C for activation. After the sample temperature fell below 31 °C, the photographs of the samples were taken and colour changes were observed.

RESULTS

In the study, many results such as dye/binder rates, fixing methods and durations of the thermochromic dyes, application performances in different fabrics, color values of the blends with each other and behavior exhibited by their use together without thermochromic properties were tried to be exemplified.

The results of the applications are explained below:
1. The colours of the red samples return to original colour more quickly. It was found that printing paste on the samples dried at 60 seconds is not transparent (Table.2).

2. It can be seen that colour couldn’t be a completely transparent if the dye content increases (Table.3).
3. There is no difference in colour transition during heating application, the difference in colour reversion is that the colour transitions in the strips that were printed earlier in the printing application proceed faster (Table.4).
4. Reactive dyes and thermochromic dyes can be combined successfully. After the activation of thermochromic dyes, only the colour of reactive dyes can be seen on the fabric surfaces (Table 5).

CONCLUSIONS

Colour-changing textile would allow people to dynamically change the aesthetics of their clothing to suit their mood, their style, etc. allowing them to be creative and expressive in many ways. Due to the possibilities for developing new creative designs, colour-changing smart materials are generating intense interest among the artists and designers due to their interaction, responsiveness and ultimate functionality. Thus, colour changing technology offers unique and challenging design opportunities to the fashion and textile designers [11].

With a parallel approach to this point of view the intelligent textiles, which have a chromatic character, are a new original and exciting material group with the potential for their present and future uses. Therefore, in order to take advantage of new product design possibilities in new textile and garment design, material properties and usage areas need to be investigated and examined in detail. In this respect, this work carried out is a guideline for textile and fashion designers in terms of usage.

Table1. Application conditions of thermochromic dye and reactive printing dye mixtures

No	Dye type*	Color	Dye (%)	Printing paste (%)
1	-	Black	10	90
	-	Black	20	80
	-	Black	30	70
	+	Sarı	0.5	99.5
	+	Magenta	0.2	99.8

	+	Cyan	0.2	99.8
2	-	Red	10	90
	-	Red	20	80
	-	Red	30	70
	+	Yellow	0.5	99.5
	+	Magenta	0.2	99.8
	+	Cyan	0.2	99.8
3	-	Blue	10	90
	-	Blue	20	80
	-	Blue	30	70
	+	Yellow	0.5	99.5
	+	Magenta	0.2	99.8
	+	Cyan	0.2	99.8

* - thermochromic dye, + reactive dye

Table 2. Effect of drying method and drying time.

Drying method*	**Drying time (s)**	**< 31°C**	**>31°C**	**< 31°C**
-	0			
HP	60			
HP	120			
HP	180			
SI	60			
SI	120			

*HP: hot press, SI: steam iron.

Table 3. Effect of thermochromic dye/printing paste ratio

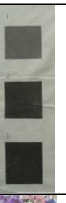
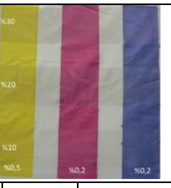
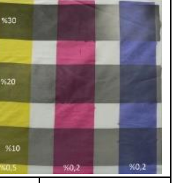
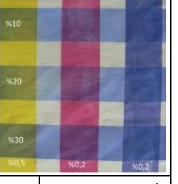
Fabric type	Thermochromic dye ratio (%)	< 31°C	>31°C	< 31°C
Cotton	10			
Cotton	20			
Cotton	30			
PES	10			
PES	20			
PES	30			

Table 4. Effect of thermochromic dye mixing.

Colour	Thermochromic dye ratio (%)	< 31°C	>31°C	< 31°C
Black & Red	10 20 30			
Blue & Black	10 20 30			
Red & Blue	10 20 30			

Table 5. Reactive dye and thermochromic dye applications test results.

o	**Colour**	**< 31 °C**			**>31 °C**			**< 31°C**		
	Black (Thermo chromic)									
		Y	M	C	*Y	M	C	Y	M	* C
	Blue (Thermo chromic)									
		Y	M	C	* Y	M	C	Y	M	* C
	Red (Thermo chromic)									
		Y	M	C	* Y	M	C	Y	M	* C

*Y:Yellow, *M: Magenta, *C: Cyan (Reactive dyes without thermochromic properties)

Key Words: Thermochromic dyes, Textile printing, Fashion design, Dynamic textile printing design, Intelligent textiles

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IMPROVEMENT OF WATER REPELLENCY PROPERTIES OF COTTON FABRICS WITH FOAM APPLICATION

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There are several studies performed with conventional methods on water repellent finishes. Beside conventional methods, there are some alternative application methods that allow low pick-up ratios as foaming technology. This study presents the improvement of water repellency characteristics of cotton fabrics via foam application. In order to carry out the experiments, fluorocarbon based water repellent chemicals were applied on cotton fabrics in a foam formed. Foam parameters were optimized for the requested water repellent effects on the fabric. After the application, repeated washing procedures were applied on the cotton fabrics to investigate the washing resistivity. In order to determine the effect of water repellency properties, contact angle test was performed beside other fabric performance tests. SEM micrographs and FTIR analysis were carried out as characterization tests. According to performance and characterization tests, significant improvement on water repellency effect of cotton fabrics was achieved and it was observed that improved water repellent effects could be performed on cotton fabrics with low wet-pick up ratios. The water repellency results of foam treated fabrics were compared with conventional method and it was determined that high contact angles were observed in foam application with low wet-pick up ratios. In addition to this, contrary to the conventional finishing, different water repellency effects were observed on face and back surfaces of cotton fabrics by using foam application.

Key Words: Water repellent, foam application, cotton

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SESSION III

VOCATIONAL AND HIGHER EDUCATION IN TEXTILE ENGINEERING USING THE MOODLE E-LEARNING PLATFORM

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ABSTRACT

E-learning is recognized today as a valuable tool in all grades and types of Education worldwide. The essential e-learning characteristic of relaxing time and space constraints allows for the delivery of educational programs to remote, highly dispersed or under-privileged communities of academia and enterprises. The reusability of learning material is another key advantage from the instructors' point of view. As a result, e-learning platforms have been progressively involved in the educational practice of teachers across primary, secondary and tertiary education grades, including vocational education and professional training. The special case of education in Textile Engineering, both at the vocational and the higher academic level is addressed in this paper. The educational model proposed and investigated is based on the flipped classroom scenario, supported by a structured e-learning platform allowing for extensive interaction and collaboration. An e-learning environment is designed and developed in the *moodle* open source platform in order to illustrate the advantages of the proposed approach.

Key Words: E-learning, moodle platform, Textile Engineering, Higher Education, Vocational Education, Blended learning, Flipped Classroom.

1. INTRODUCTION

The last decade of the 20th century has been characterized by the gradual transformation from the Industrial Society to the Post-Industrial or Knowledge Society. The generation, management and distribution of information and knowledge form the centerpiece of all production processes in this type of society. The aims and objectives of modern Education have been redefined accordingly to place the emphasis on the individual learner and on the development of 'horizontal' (across-subjects) or 'high-level' skills and competences rather than the accumulation of 'vertical' (in-subject) knowledge and specialization. Education should prepare individuals who 'learn how to learn' and who are eager to join forces and to collaborate in order to address the complex challenges of the new era. All grades of typical Education along with vocational education and training have been influenced by these trends. Technological advances in Information and Communication Technologies (ICT) have come to couple with this development and provide a solid technical basis for the needs of Knowledge Society. E-learning is an illustrative example: as the learning content becomes digitized, available over the Internet and accessible via a simple web browser from anywhere and at any time, the educational event and its benefits reach an ever-increasing audience; they satisfy diversified needs – and generate new needs in turn.

From another aspect, educational research has been seeking ways to condition the introduction and use of ICT in Education upon widely acceptable pedagogical and didactic principles, because the 'blind' or indiscriminate introduction and use of technologies has been seen to have negative results both on the parties and the outcomes of the educational process. Innovative methods and approaches, such as active learning, problem-based learning, personalized or adaptive learning, as well as innovative procedures, such as blended learning or flipped-classroom instruction, [1], have been extensively investigated in theory and practice, [2], [3]. As a result, the international community of educators has now access to a broader pallet of tools and methods to pick and choose from in order to provide education suited to a given target group of learners.

2. THE PROPOSED METHOD

This paper focuses on the target group of Textile Engineering students either in the Higher of the Vocational education level. Because of certain characteristics of the industrial production of textiles (materials, methods and products) that directly affect Textile Engineering Education, the introduction of modern approaches in education and training is expected to have a high impact on the learning outcomes, [4].

- Textile Engineering is an established and mature field of study; yet, not a core one in Engineering. Departments or Schools of

Textiles, therefore, are present neither in all academic institutions nor in all countries worldwide; rather, they form a highly dispersed community that relies largely on networking, physical and conceptual, for fruitful collaborations. A smaller population calls for saving strength while designing curricula and developing learning material; inevitably, reusability acquires a central role.

- From the point of view of the curricula, the broad, multidisciplinary nature of the field puts a pressure on the program structure and the depth of coverage of the various aspects in the Higher Education level. Vocational schools on the same field, on the other hand, face a considerable pressure due to the time parameter of the curriculum.

Both these characteristics prompt the proposal and investigation of the flipped-classroom instruction method, critically assisted and complemented by a structured e-learning environment. In a flipped-classroom scenario, the learning material is available in digital form through an e-learning platform and the students are expected to study remotely, accessing the material in time other than the time of classes. The instructor can then exploit the limited – therefore valuable – time of face-to-face meetings in class in order to answer questions, clarify obscure points, discuss details or bring to light unnoticed aspects of the material, encourage team work and collaboration and facilitate interaction. Student evaluation may or may not be accomplished through the platform; when lab practicum is included, the evaluation is usually face-to-face.

Flipped-classroom instruction is a form of blended learning, yet, a strictly structured one, as it includes alternating remote / e-learning and face-to-face instruction sessions, [5]. It incurs a high cost of preparation time and effort which is fully justified by the results. Along this line, we outline educational scenarios for the application of flipped classroom in Higher and in Vocational Textile Engineering Education, exemplified by an actual e-learning platform designed and implemented in the *moodle* open source e-learning platform, for the purposes of this research. Practical considerations are discussed and an implementation plan is proposed.

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KNOWLEDGE MATRIX OF INNOVATION FOR TEXTILE COMPANIES

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The intangible assets of a textile enterprise are of utmost importance for their innovation activity. Their evaluation and improvement contributes in bridging the weak points and consolidating the strong points of a textile enterprise. The concept of the Knowledge matrix for innovation (KMI) aims to create a comprehensive image of the intangible assets of an enterprise [1]. Examples of intangible assets are: innovation strategy / culture, informational resources, training methodology, relationships portfolio, IP rights etc.

The implementation of the Knowledge Matrix for Innovation (KMI) in textile enterprises, is carried out within the framework of the EU funded Erasmus Plus project, entitled "Matrix of knowledge for innovation and competitiveness in textile enterprises - TexMatrix", by a consortium of five partners with long-lasting tradition in the European textile domain: INCDTP – Bucharest, Romania (Coordinator), TecMinho – Portugal, Centrocot – Italy, University Maribor – Slovenia, Technical University "Gheorghe Asachi" – Iasi, Romania.

The main outputs of the project are [2]:

1. The Knowledge matrix for innovation
2. The Benchmarking study
3. The Guide with new solutions for textile enterprises 4. The e-learning Tool and work-based training.

The project is after the first year of implementation. The KMI was defined and the related Benchmarking matrix was established. The KMI includes 52 factors grouped in criteria and elements. The elements of the KMI represent the prerequisites a textile enterprise uses in order to fulfil its objectives. The conditions establish the resources, while both are conditioning the activities and the results. The KMI developed will be followed by a benchmarking study, which will establish the position of an enterprise on local/regional/national/European (consortium) level and statistical reports and charts upon the current situation of the textile industry on local /regional /national/European (consortium) level, will be done. Afterwards, a guide with new solutions for textile enterprises, containing new solutions based on the gap analysis of the benchmarking study, will be proposed by the project consortium, and its content will be transformed into one e-learning tool [3].

The e-learning tool will have the main aim of rendering solutions to the textile enterprises participating in the benchmarking study, based on the guide with new solutions. The solutions from the guide, including research results and new ideas for improving innovation capacity for textile enterprises, will be transformed in e-learning content, the e-learning content will have text, graphics and videos. The content will be scheduled interactively, in order to attract the young trainees in textiles [4].

The project partners support the enterprises by means of their latest research results and training methods. They are able to identify gaps in the innovation capacity of enterprises based on the benchmarking study and to enrich it with new solutions. Therefore, the relevant impact indicators on the target group are related to the improved training methods, better knowledge of innovation mechanisms in textile enterprises and increased implementation of the innovation. The target group of the e-learning content are young trainees in textiles, young employees, textile students and scholars, young unemployed workforce.

The Erasmus Plus project TexMatrix aims to improve the textile enterprise's competitiveness based on the instrument of the Knowledge matrix for innovation. The project's website is www.texmatrix.eu [2].

KeyWords: textile companies, knowledge matrix, innovation, e-learning.

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SUSTAINABLE TRANSFER OF TEXTILE AND FASHION IN VOCATIONAL EDUCATION

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StinFash is a strategic project cooperation between partners from different nationalities within the European sphere. The partners in this project have developed a flexible blended learning pathway with clusters of learning outcomes regarding; design (Lette Verein), development (Vitalis College) and production (Emel Akın Vocational School). The cooperation of international partners has a great impact on students and participating organizations. Beside the improvement of quality and attractiveness of the courses by implementing international learning mobility, The internationalization of the curricula allowed students to continue their study's at a higher level. In addition getting to know people from different nationalities will lead to a better friendships and build lifelong connections.

Key Words: Fashion design education, Erasmus+ project, international education, cultural development

DEVELOPING SMART BODY PROTECTOR FOR SPORTS KARATE

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Karate is a combat art which can be described as a weaponless self-defense system. The body is used for defense, and the physical contact between opponents is limited and subjected to rules (1). The word karate itself literally means "empty hand". Although many of the earlier origins of the art are traced to China, it owes its development to the inhabitants of Okinawa in the Ryukya islands, some 200 miles to the south-west of Japan (2). Even though karate was born as a martial art, which is a highly effective means of unarmed self-defense, it has survived and changed through the centuries to also become an exciting, challenging sport enjoyed by enthusiasts throughout the world (3). As reported by Kanazawa, today the training process in Karate encompasses four distinct areas: basic training (kihon), combat training (kumite), kata training (choreography of a series of movements and techniques) and competition itself (1).

According to the World Karate Federation (WKF) wearing a WKF approved body protector (Figure 1) is compulsory for all athletes in both Kumite and Kata competitions (4). The body protector consists of a three layered protective equipment (Figure 2), whose resistance to the compression is of up to 50%: 105 kPa and shock absorption: 45 % of the energy of impact (5).

Figure 1. WKF approved body protector (5).

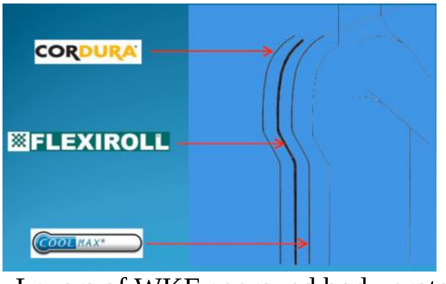

Figure 2. Layers of WKF approved body protector (5).

Karate, which is an art of unarmed self-defense, is the most violent of sports involving two opposing contestants. Nowadays, in tournaments the contestants either go through the motions without making contact with their opponent or they wear protective clothing to permit execution of their motions. In either case, a number of officials observe the contestants in combat and then determine the winner through their judgment (6). Dependent on subjective judgment, sometimes it results in improperly awarded points or missed points (7) and because of all these disadvantages, the necessity of using intelligent products in contests showed up in order to assist in scoring properly.

The integration of electronics into performance sports equipment has increased in recent years. Piezoresistive and piezoelectric force and pressure sensors have been used for some time in sports applications (impacts, skiing and golf) to gather data generated by human interactions (8). In piezoresistive materials, electrical resistance changes when pressure is applied. Piezoresistive semi-conductive polymers are sandwiched between two layers of highly conductive ripstop nylon fabric to form a flexible pressure sensor (9).

In this study, developing a smart body protector for sports karate was aimed. A piezoresistive material was used in order to prepare the impact sensors. Different conductive materials (such as conductive silicone, conductive fabric and conductive ink) and different assembling techniques (such as ultrasonic sewing, printing and press) were analyzed to achieve sandwiching the piezoresistive material. Afterwards, the most appropriate sensor was applied to the body protector.

Key Words: Karate body protector, impact sensors, smart garments, misjudgment

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EVALUATION OF E-TRADE FOR READY-TO-WEAR MARKET

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Technological developments lead usage of computers in various fields of daily life. One of these fields is electronic commerce. Usage of electronic commerce was also applied in Apparel Sector by the time. Customers often make purchases from the same sites by identifying companies that match their body structures as a result of shopping from various brands through trial and error to get rid of the problem of body size compatibility. Nowadays, customers have opportunity to design the textile pattern as well as the other features.

If clothes bought without pre-trial, many problems may occur since the human body sizes vary from person to person. This fact can cause problems in clothes that are bought without trial. In fact, the diversity of body sizes varies from firm to firm and people do not have body structure in similar proportions. In addition to physical comfort and appearance, garment should contribute to body harmony and physiological comfort. Some companies have developed various solutions to in order to increase e-shopping of clothes.

In this research, the product group incorporating men's suits and shirts were focused and internet sites of domestic and foreign brands were examined. For each site, the details and information those given besides the visuals related to the product and the features offered to the customer were investigated. In today's ready-to-wear market, the competition conditions are becoming increasingly greged. It has become compulsory for Turkish ready-to-wear companies to give importance to e-commerce applications which will provide a significant advantage in meeting customer demands quickly.

In parallel to past years, today's people tend to use computers in every field. With the increased opportunities offered by technology, many products, from food orders to household items, can be purchased online and delivered at the door. The consumer group who wants to enjoy this comfort tends to buy their clothes on this way. Lack of time especially for working people drive them to shop online. Products such as shoes and clothing, which have not been bought without pre-trial for a long time, even prefered to buy from internet since consumers could make comfortable decisions by the advantage of free return of today's companies. However, the opportunities offered by the companies that serve this field may vary. With this study, it was aimed to search the internet sites of domestic and foreign companies, for evaluating the opportunities offered by these sites and to determine the elements that would improve customer satisfaction.

Key Words: Electronic trade, garment industry, body size, measure, made to measure

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CIRCULAR ECONOMY AND APPAREL WASTE MANAGEMENT

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Circular economy is one of the topics, which is becoming significant and popular among various industries. It is seen as the opposite of the linear economy which represents 'make-use-throw away' patterns. Circular economy, which reduces people's dependence on new materials, has the core aim to enable more progress with less resources.

According to Ellen MacArthur Foundation, "a circular economy is one that is restorative and regenerative by design, and which aims to keep products, components and materials at their highest utility and value at all times, distinguishing between technical and biological cycles" [1].

End-of-life terms are substituted by circular economy, which provides opportunity for regenerated energy, and also helps for waste prevention as well as having only non-hazardous chemicals in supply chain. Waste prevention is targeted by improving the materials', items', structures' as well as business concepts' styling, by implementing circular economy, waste is being eliminated. Within this framework, the styling of styling and also the make-the-best use approach allows for subsequent using as well as dismantling patterns [2]. Circular business model is shown in Figure 1.

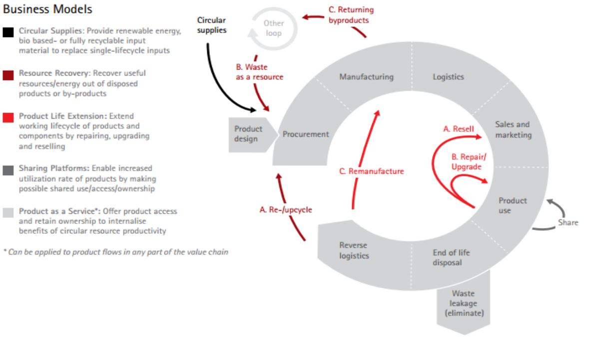

Figure 1. Circular business models [3]

As mentioned by Accenture, “in a circular economy, growth is decoupled from the use of scarce resources through disruptive technology and business models based on longevity, renewability, reuse, repair, upgrade, refurbishment, capacity sharing, and dematerialization” [4].

The theory of circular economy involves reconstruction and remodelling through styling. Furthermore, the goal is that materials, parts, items are always of their best service. Circular economy which can be applicable for all sizes, derives from constant progress patterns, and those patterns help maintain the available regular assets as well as making the best use of outcome and also by supply control [5].

Consumption is limited in circular economy and bio-cycle where the supply is renewed, is the cycle where utilization occurs. In the the technical-cycle supply is being revitalized [6].

Remodelling the assets is the focus of circular economy for a variety of categories including people, ecology etc.

APPAREL WASTE

For more than fifteen years, there has been noticeable changes in fashion apparel industry which affected the length of the cycles by shortening as well as the consumption habits of the consumers. With prices being decreased sharply and also having more alternatives in today’s fashion retail world, there has been a transformation to a disposing culture. These alterations in the society have yielded in increasing number of apparel waste. Fast-fashion market does not offer high quality; thus, it is generally very affordable prices, thus this results in higher consumption percentages [6].

In clothing industry waste is generated as pre-consumer waste and post-consumer waste. Pre-consumer waste occurs during manufacturing of materials and clothing in industry. Within the scope of this thesis, post-consumer waste is being focused on. Post-consumer apparel waste, in its simple term, is the apparel discarded by consumers after use for sometime. Apparel range consists of numerous articles such as trousers, skirts, shirts, outerwear, swimsuit, pyjamas, dress, formalwear as well as work uniforms.

This study aims to give insights to support sustainable directions in terms of defining the end-of-life cycles for clothing based on circular economy and it proposes to raise awareness in apparel market in terms of waste management and suggestions to establish closed loop systems for apparel. Consumers behaviours and motivations are studied based on primary research method. The results are evaluated to propose a model for waste management.

Key Words: Recycling, circular economy, apparel waste

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INVESTIGATION OF DEFECTS IN MALE SHIRT PRODUCTION WITH STATISTICAL CONTROLS AND DETERMINATION OF DEFECT COSTS

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There is a certain cost of poor quality despite the occurence of cost for quality. Becouse low quality causes an increase in the amount of discarded goods. Therefore, product cost increases(2). Prevention costs are defined as the costs of activities which are carried out for the prevention of faults at the first place (1). Prevention costs involves the cost of company resources for the design, installation and continuity of the total quality management system. Wasted materials due to false manufacturing and labor expenses are also included in the cost of prevention (3). The general elements that make up this cost can be listed as follows; Scrap, Reprocessing / Repair, Problem solving or defect / Deficiency analysis, Subcontracting mistakes Modification confirmation and negotiations and Product grading(4). The aim of this study is to reduce the sewing defects and to minimize the cost of defects. For this purposes, some of the 7 controls methods of Statistical Process Control (SPC) techniques are used (5). The study is carried out in a ready made factory producing mens's shirt.

Defects were detected using control charts, pareto analysis, control graphics, cause-effect diagram and grouping technique (5). The production data of the three consecutive months are sorted in accordance with the degree of importance on the basis of cuff attachment, skirt end, arm top stitch, shoulder edge stitch, side closure and apartra stitch. The cost of reprocessing / repair faults which is the main elements of quality costs is calculated by using the repair time, number of defects and minute production cost of the company (Table 1). Additionally, defect causes are analysed by means of cause-effect (fishbone) diagrams and proper solutions are proposed. A 15 % allowance was added to the standard repair time.

Key Words: Man shirt production defects, statistical process control, defect cost

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INITIATION OF A METHOD TO OBTAIN BODY MEASUREMENTS FROM 2D IMAGES

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ABSTRACT
Even there are several computer programs to obtain body measurements from a person and to prepare patterns, the main problem in web shopping is that the garment received is not made-to-fit. In a survey conveyed, it is deducted that if the garment fits well than web shopping would increase alot. A method is initiated to obtain body measurements from 2D images of a person aiming that if persons send their front and side photographs then their body measurements will be taken accurately and either will be sent back or patterns of a model of a garment will be processed immediately and sewn and sent back, so will be tailored specially for that person.

PROBLEM SEARCHED

The aim of this research is to obtain body measurements accurately from photographs taken front and back 2D images and process patterns for made-to-fit garments.

LITERATURE SURVEY

Body measurements are taken from the body by hand according to special standards [1] to prepare patterns in tailoring garments (Fig.1,2) [2]. This hand work is time consuming and prone to mistakes if try-on is not done on the person finally be using the garment. As the computer technology improved very fast, pattern preparetion was a main concern for this field and nowadays there are many computer programs both to acquire body measurements and to prepare patterns especially for ready-wear industry [3]. But, the main problem in this obligation is succeeding the made-to-fit garments since there are different body shapes. Web shopping is gaining speed but there are many complaints about the sizes of the garments.

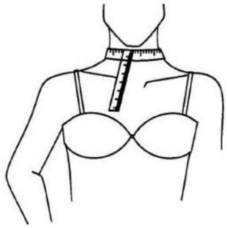

Figure 1. Neck circumference measurement by hand [2]

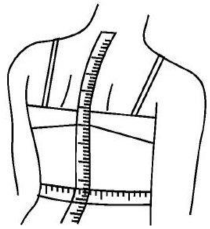

Figure 2. Back length measurement by hand [2]

ANALYSIS AND DISCUSSION

A survey among the students in Uşak University (100 female, 100 male who do web shopping for garments) is done to clarify if they were satisfied with the shopping and to gather information about the problems they encounter [4]. 24% of the ladies were satisfied with the shopping and 76% were not; 12% of the gentlemen were satisfied with the shopping and 88% were not. Their main complaint is that the garment did not fit well to their bodies. The rest stated their problems as follows: The size didn't match with the one written on the label; Seam lines were irregular; Demanded half sizes between size 34-38; Had difficulty in finding large sizes; Tall people received garments with insufficient long sleeves; Differences in the color of garment received with the one they ordered; Receiving faulty garments; and Deformations in the garment. They were also asked if these problems were corrected would they shop garments more on web and 54% of the ladies who were not satisfied answered yes, 28% answered no, and 18% didn't reply; 79% of the gentlemen who were not satisfied answered yes, 15% answered no, and 6% didn't reply [4].

With the information deduced from the survey, a method is initiated to acquire body measurements from 2D images of a person taken from the front and side. The method of taking the photographs is as follows

:Female students; Age range of 18-25; Weight range of 43-85 kg; All volunteers; Clothing fitting tight to their bodies when photographs are taken; From a distance of 3m.; Arms and legs slightly open; Camera focusing on waist and paralel to ground; Neck and knee included in the scene; One shot from front and one by turning 90^0 sideways [4]. Afterwards, the body measurements of all the 500 ladies studied are taken by hand according to standards with a non-stretching measuring tape. Some measurements are given as a sample in Table 1 [4].

Table 1: Sample of measurement taken by hand

Number of lady	1	84	123	235	251	313	328	329
Age	---	26	23	18	25	20	22	18
Height	176	165	155	165	170	167	155	161
Weight	52	52	51	45	85	54	47	51
Neck circumference	32	31	31	28,5	35	30	30	31
Back neck girth	15	14	16	13	15	12	14	15
Shoulder width	15,5	12	13	11,5	15	13	13	12
Shoulder circumference	93,2	94	91	90	121	98	93	92
Breast	82	84	89	77,5	109	85	82	85
Breast fall	26,5	23	23	26	27	26	23	25
Back width	36	36	33	35	43	37	35	36
Waist circumference	65,5	71	69	63	96	67	61	65
Back length	42	32	34	35	36	37	32	36
Front lenth	45,5	37	31	35	37	41	33	38
Side height	23,5	21	16	15	14	19	13	20
Arm length 1	76,4	67	61	69	73	68	63	65
Arm length 2	61,5	57	51	57	62	58	51	52
Inner arm length	49,5	42	39,5	46	45	48	41	43
Biceps circumference	24	25	25,5	21,3	33	25	24	22
Belly circumference	84,5	77	76	74	107	80	73	82
Hip circumference	96	94	92	87	114	91	90	90
Outer leg height	104	87	81	91	104	96	88	93
Inner leg height	77,5	62	62	68	65	69	64	65

CONCLUSION

The survey about the problems encountered in web shopping of garments have supplied valuable information to initiate a method to obtain body measurements from 2D images. Photographs are taken from front and side and body measurements are taken by hand. The values are studied if they have normal distributions and some statistical examination is done. In the succeeding part of this research, work will be done in means to connect the 2D images with the measurements taken. This work seems promising in obtaining body measurements from 2D images.

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GEOMETRIC MODELING OF THE PRODUCT UNIT FABRIC QUANTITY IN THE APPAREL SECTOR

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The share of knitted and woven ready-made garments among the top 20 exporting sectors in Turkish ready-to-wear sector is the most important according to product groups. In today's tough competition conditions, garment enterprises are having difficulty in the market due to the increase of input costs. Businesses must be well-controlled and rigorous in planning product unit costs to gain a competitive edge.

Due to Shortening of collection time intervals during the season, model selection and changes in the implementation process and shortening of product production cycle, businesses need to provide faster feedback than the old one and this leads to a considerably shortened cost calculation period. The difference between the preliminary cost and the actual cost, which is important for business profitability, is the minimum. For this purpose, organizations are made so that the cost after production is equal to or lower than the target pre-estimated cost. Fabric cost is the most important component of ready-made product cost components. The most important factor affecting the product unit cost is the minimum difference between the estimated fabric unit quantity calculated in the preliminary cost process and the fabric unit quantity after production. In the pre-estimated unit fabric counting process in the garment enterprises, the data and estimated fabric costs of the previous products similar to the planned product are utilized. By using these estimated data, product unit cost is calculated, order pricing is made to the customers and purchase order to the business is provided.

Başer and Bulgun (2000) have prepared a program that can create new products' data quickly and consciously by using the data of similar models previously produced in case of a new product design and production in order to help clothing companies in design and order acceptance process. Öztürk (2005) pointed out the changes in the production structure and their effects on costs. Dayanıklı (2009) has developed a method to calculate the fabric unit metric with the aid of metrics on the size charts sent by the customer for the fabric pants and skirt product group and metrics on the sample sent together with the size chart. Özdemir, Utkun and Yeşil (2015) prepared a program to calculate the unit cost of the products produced by small-scale textile enterprises and used them in a sample application.

During the calculation of the product unit fabric amount, the enterprises generally require information from the pattern design departman section to determine the collection needs of the collection or single product. In an environment where rapid advance of the production flow, to make pattern and marker works of the pricing stages without order approval yet, especially on many numbers, adversely affect the work flow. With this research, to minimize the need for marketing and purchasing employees who make the cost calculations of the business, during order pricing to take necessary data from the pattern design departman for pattern and marker informations or remove it entirely if possible, as a result of this, it is aimed that the customer will be given quick feedback and pricing information will be given to the nearest real values. In this context, the factors affecting the calculation of the product unit fabric amount required in calculating the fabric cost are determined and analyzed. Formulations have been created that allow the amount of unit fabric to be obtained quickly in a computer environment without requiring any CAD (Computer Aided Design) program. A model was designed to calculate the product fabric unit amount after the product technical information, model pattern properties, number of pattern parts, basic and auxiliary measuremnets, stitching ratios and efficiency components are entered in the system respectively. The main principle of the created fabric estimation model is to calculate the geometric areas of the pattern parts forming the product and to find the unit product total area according to the number of parts; to calculate the approximate unit fabric metric / grammage according to the woven / knitted product group by adding parameters such as fabric width, lacquer productivity, fabric weight, etc. to the total area.

The designed formulas were applied on shirts and T-Shirt products selected from weaving and knitted garments firms operating in Izmir. Unit fabric values were calculated with the designed model and compared with actual values. The model provided improved the estimate of the firm by not exceeding the acceptable deviation of 15%.

Key Words: Unit fabric, fabric cost, estimated fabric quantity, garment modeling

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CONTRACT MANUFACTURER SELECTION FOR APPAREL SECTOR BY USING KEY PERFORMANCE INDICATORS-KPI

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KPI-Key Performance Indicators are common and inclusive values that can be used today in any industry for performance measuring. These values are measurable terms to evaluate the effectiveness of the businesses in reaching their core business goals. It is obvious that one of the most critical points for evaluating the businesses' performance is correct definition of the success. In general, the success can be thought as steps taken in the direction of strategic objectives, but this depends on the businesses. It can be explained as simpler targets for smaller businesses. For instance, the customer satisfaction ratio, the percentage of defective products and so on, can be taken as the targets.

It is frequent case that in the apparel sector, bigger enterprises can operate their production activities with smaller scale enterprises which is called "contract manufacturer". In this sense, the "contract manufacturing" method has become an indispensable part of the industry in order to ensure that the production process can be completed in a healthy and timely manner. While it is extremely important to select a contract manufacturer for the production activities, it is also a difficult process.

In this study, the selection processes of a "contract manufacturer" for an enterprise which is operating in Izmir was handled. After the observations made at the smaller enterprises, the KPIs of each of them were determined and these enterprises were compared with each other. At the last step in the selection of contract manufacturer enterprise, the Dematel method which is one of the multi criteria decision making methods was used to determine the most suitable one.

Key Words: Selection of contract manufacturer enterprise, KPI, Dematel

"LIFE CYCLE ASSESSMENT" MILESTONE OF TEXTILE INDUSTRY

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Environmental issues are playing an increasingly important role in all industries, both from the point of view of government regulation and consumer expectations [1]. Therefore, many industries has manifested the sustainability movement and environmentally sustainable consumption has been broadly studied in relation to a variety of product categories such as electricity, textiles, apparel, food and other products [1,2].

The textile industry, as one of the biggest polluters, is a diverse and heterogeneous sector which covers the entire production chain of transforming natural and chemical fibres (such as cotton, wool, etc.) to end-user goods, including garments, household goods, and industrial textiles [4]. In textile processing, new emerging cleaner technologies are in a key position when striving towards zero emissions, best available techniques and eco-efficiency concepts aim to decrease emissions and to intensify the use of energy and material resources [3]. The number of regulations related to textiles and environment increased consequently in the past few years (Intergovernmental Panel on Climate Change (IPCC) and Registration, Evaluation, Authorization and restriction of Chemicals (REACH)).

In this concept, LCA methodology has been started to use for the assessment of environmental impacts during manufacturing and use phase in the textile sector as a standardized method to evaluate the environmental impact of their products [5,6], Life-Cycle Assessment (LCA) is also used to set up criteria for an environmental product declaration for textile products [3].

LCA is a method in which the energy and raw material consumption, different types of emissions, and other important factors related to a specific product's environmental impact are measured, analyzed, and aggregated for the entire life cycle of the product, attempting to include all impacts from raw material to disposal ('cradle-to-grave') or at least from raw material to the point of sale ('cradle-to-gate'), since, in many cases, the individual consumers are either not known or not traceable[7]. It is used to give a better assessment of environmental impact by identifying total energy use, material inputs, and waste generated from the point that the raw materials are obtained to final disposal of the product

The textile manufacturing chain starting on a raw material basis controlled by agricultural subsidies and trade agreements, goes on through a chain of quick-reacting, market-driven processes, and ends up at a customer and consumer who is manipulated by the branding of wholesalers and the discounts offered by retailers. Therefore, LCA method is still immature in textile industry and it should be improved in all aspects in the future [8,9].

Key Words: Environment, textile, textile industry, life cycle assessment

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OCTOBER 28, 2017

SESSION I

PRODUCTION OF NAFION NANOFIBRES WITH VARIOUS CARRIER POLYMERS

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There has been an increasing interest in fuel cells due to their low CO2 emissions and their high density energy production. Among the various fuel cells, polymer electrolyte membrane (PEM) fuel cells become prominent in terms of high efficiency and applicability. One of the most important components of PEM fuel cells is the membrane with high proton conductivity. The standard membrane used today is the perfluorinated polyelectrolyte based commercial Nafion films. However, these membranes have problems such as high cost, reduced proton conductivity at high temperature and low humidity, and high methanol permeability [1]. Therefore, new methods of producing polymeric membranes have received much focus and within these polymeric membranes, nanofibrous membranes are thought to be a potential candidate for the production of economic and high performance proton exchange membranes.

In this contribution, an overview of the use of nanofibrous membranes in fuel cells is provided and the results of the study on the production of Nafion nanofibres by electrospinning were given. The electrospinning of pure Nafion is not possible since Nafion/solvent mixtures do not have adequate chain entanglement [2]. Thus a carrier polymer should be used. Poly(ethylene oxide), poly(vinyl alcohol) and thermoplastic polyurethane polymer were selected as carrier polymers in this study. Nafion/carrier polymer/solvent mixtures with different mixing ratios were electrospun. Morphology of the resultant nanofibres were characterised by SEM analysis. The study revealed that Nafion nanofibres were successfully electrospun using the selected carrier polymers. On the other hand, Nafion amount in the resultant nanofibres were dependent on the carrier polymer type. The highest concentration of Nafion in the nanofibres was

obtained by the electrospinning with poly(ethylene oxide). The finest bead-free nanofibres were obtained with poly(vinyl alcohol).

Key Words: Fuel cell, membrane, Nafion, nanofibre, electrospinning

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NANOFIBER SEPARATORS FOR ADVANCED LITHIUM-ION BATTERIES

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Separators are an important component to obtain safe lithium-ion batteries with high performance. The objective of this research is to design nanofiber based separator membranes for advanced lithium-ion batteries. Different nanofiber production techniques and polymers are used and the physical properties of the nanofiber based separators and the electrochemical performance of the cells prepared by using these nanofiber based separators are investigated.

Separator is important for lithium-ion batteries due to the fact that separator prevents physical contact between the electrodes while serving as the electrolyte reservoir to enable ionic transport [1]. The performance of lithium-ion batteries is greatly affected by the materials and structure of the separators [2, 3]. In this study, SiO_2/Polyvinylidene fluoride (PVDF) separators were prepared to evaluate the effect of SiO_2 nanoparticles on electrochemical performance and thermal stability of separators. Improved electrochemical properties were obtained by increasing nanoparticle content. In addition, electrospinning and electrospraying techniques were combined to further increase the content of nanoparticles in PVDF nanofibers. Cells using SiO_2/PVDF separators showed superior C-rate performance compared to those using commercial microporous PP membrane. In order to further improve the mechanical and thermal properties of nanofiber based separators, nylon 6,6 nanofibers were fabricated. Nylon 6,6 nanofibers with TiO_2 and SiO_2 nanoparticles were prepared with enhanced mechanical properties. Compared to TiO_2/nylon 6,6 nanofiber membranes, SiO_2/nylon 6,6 nanofiber membranes showed higher ionic conductivity and lower interfacial resistance with lithium owing to their higher porosity and well-dispersed nanoparticles. Furthermore, centrifugal spinning technique was introduced as a fast, cost-effective and safe technique to fabricate high-performance fiber-based separators for Li-ion batteries. PAN was used because of its high ionic conductivity, good thermal stability, high electrolyte uptake, good compatibility with Li metal and excellent resistance to oxidative degradation [4].

Table 1 shows the porosity, electrolyte uptake, ionic conductivity of the separators which are prepared by using different nanofiber production techniques and polymers. Discharge capacity values of the cells prepared by using these separators are also shown. SiO_2/nylon 6,6 nanofiber membranes have the highest porosity and ionic conductivity due to their thin fiber diameters. SiO_2/PVDF hybrid membranes show the highest electrolyte uptake because of high amount of SiO_2 nanoparticles on the membranes. The highest discharge capacity at 8 C is observed by using SiO_2/PVDF hybrid membranes due to the highest electrolyte uptakes of the separators.

Two different nanofiber production techniques and various polymers were used to fabricate high performance separators for lithium ion batteries. In order to improve electrochemical properties, different approaches were utilized including, nanofiber-coating on nonwoven membranes, electrospraying of nanoparticles on nanofibers, fabrication of ceramic nanoparticle-incorporated nanofibers, and blending of different polymers. The results show that electrochemical performance of the cells depends on the morphology of the separators.

Key Words: nanofibers, separator membranes, Li-ion batteries

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EMULSION ELECTROSPINNING OF PVP/CINNAMON ESSENTIAL OIL NANOFIBERS

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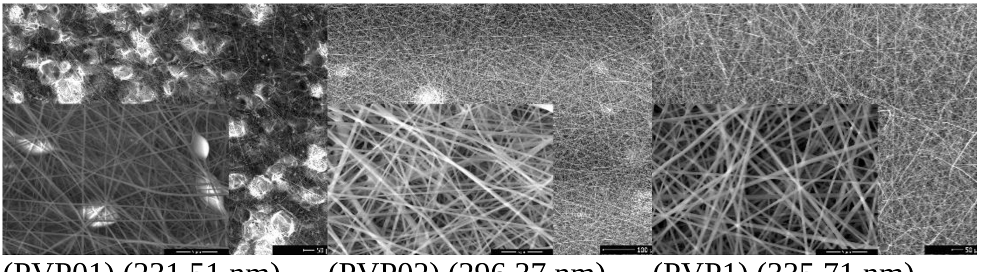
Polyvinylpyrrolidone (PVP) is a water-soluble and hydrophilic polymer. PVP nanofiber-based materials have important biomedical application areas such as; wound dressing, drug delivery, tissue engineering etc. [1-2]. Cinnamon (*Cinnamomun zeylancium*) essential oil (CEO) has antibacterial, antioxidant, antidiabetic and antifungal properties [3-4]. In literature, the studies about emulsion electrospinning process with oil or another water-immiscible phase are limited [5-6]. This study aimed to achieve antibacterial PVP nanofiber production by oil-in-water emulsion electrospinning and characterization was made using SEM (fiber morphology), FT-IR (chemical structure) and disc diffusion method (antibacterial properties) with *Staphylococcus aureus* (ATCC 25923), *Escherichia coli* (ATCC 25922), *Pseudomonas aeruginosa* (ATCC 27853) and *Candida albicans* (ATCC 10231). In this study; PVP polymer concentration was used as 10 wt % and surfactant concentration as 3 wt% for all solutions except PVP01. Distilled water was used as a solvent and various concentrations of CEO such as 0, 1, 2, 3, 4 wt % were used to provide antibacterial activity. First of all, solution properties such as, conductivity and pH values were determined. Then nanofiber production has been achieved with needle electrospinning method using optimum process parameters. During the spinning process, 13 kV voltage, 0,150 mL/h solution feed rate and 12 cm distance between the electrodes were applied for all solutions. Also, spinning experiments were achieved under room conditions.

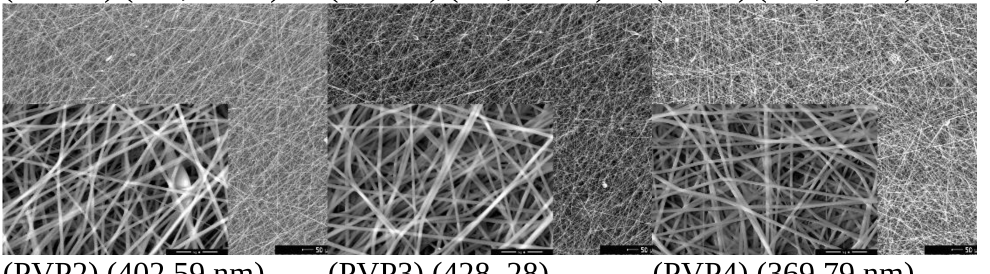
According to the results, PVP solution conductivity and pH values increased with CEO concentration. Optimum CEO and surfactant concentrations were determined from our preliminary studies. Addition of surfactant and CEO increased the fiber smoothness significantly (Figure 1). Also, there was a relationship between the solution properties and fiber diameter such as diameter increased with CEO concentration.

In the method of disc diffusion, all the nanofibers were cut in to 6x6 mm pieces. After this step, 100 µl 0.5 Mc Farland turbidity of *S.aureus*, *E.coli*, *C.albicans* and *P.aeruginosa* bacterial suspension spread on to petri dishes and incubated aerobically for 24 hours at 35±2^{o}C. . After incubation, inhibition zone diameters were measured with a ruler. Different diameters of the zones around the discs have demonstrated the antimicrobial effects of the substance.

Antibacterial test results, inhibition zones were measured as 0 mm, 0 mm, 0 mm, 6 mm, 5 mm and 10 mm for *S.aureus*, 0 mm, 0 mm, 0 mm, 10 mm, 8mm and 7 mm for *E.coli*, 0 mm, 0 mm, 0 mm, 9mm, 11 mm and 9 mm for *C.albicans* for PVP01, PVP02, PVP1, PVP2, PVP3, PVP4 respectively. There was no zone formation for *P.aeruginosa*. In addition, FTIR analyses result showed that CEO and PVP existed in the structure of nanofibers. SEM pictures of PVP nanofibers which include various concentrations of wt % CEO are given in Figure 1: PVP01: 10 wt % PVP, PVP02: 10 wt % PVP, 3 wt % surfactant, PVP1; 10 wt % PVP, 3 wt % surfactant, 1 wt % CEO, PVP2: 10 wt % PVP, 3 wt % surfactant, 2 wt % CEO, PVP3: 10 wt % PVP, 3 wt % surfactant, 3 wt % CEO, PVP4: 10 wt % PVP, 3 wt % surfactant, 4 wt % CEO.



(PVP01) (231,51 nm) (PVP02) (296,37 nm) (PVP1) (335,71 nm)



(PVP2) (402,59 nm) (PVP3) (428, 28) (PVP4) (369,79 nm)

Figure 1. SEM images (1.000x-15.000x) of PVP nanofiber samples produced with various CEO concentrations

Key Words: Emulsion electrospinning, nanofiber, essential oil, cinnamon, Polyvinylpyrrolidone

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ANALYZING THE DEPENDENCE OF EXPORTS ON IMPORTS IN TURKEY: CASE OF TEXTILE AND CLOTHING SECTORS

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Turkish textile and clothing sectors are one of the most significant sectors of Turkish economy in terms of employment and investments as well as international terms of trade. Both sectors are one of the leading exporters of Turkey for many years. However, the clothing sector, which possesses the leadership of exports, has been firstly outdistanced by automotive sector and then by chemical sector during the recent years. Both textile and clothing sectors are one of the remarkable sectors, which have net foreign trade surpluses. However, crucial developments have also occurred in this field. Therefore, net foreign trade surplus quantities have regressed by years. Textile and clothing foreign trades are negatively affected by the increments in production costs, which have negatively occurred in terms of global competitiveness; contradictory attitudes of government towards sectors and inadequacy of management quality within the sectors.

In this study, the decadal foreign trade activities of Turkish textile and clothing sectors are analyzed according to the international trade classifications at macro and micro levels and foreign trade suggestions are made towards sectors.

Key Words: International terms of trade, exports, imports, textile sector, clothing sector

DETERMINATION OF CONSUMER AWARENESS ABOUT SUSTAINABLE FASHION

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The sense of fashion in apparel consumers caused the increase in consumption and changes in demand patterns. Today's consumer is much more following the fashion trends and is showing more willingness to identify themselves with their dressing. In accordance with the change in the demand of consumers, the fast fashion concept became more popular, which responses quickly changing needs and tastes; but some threats have come presence in terms of reduction of world reserves and increase in industrial wastes recently. Therefore, the concept of sustainability has begun to gain importance in fashion industry, which enabled sustainable fashion idea to spread up. Actually, the concept of sustainability was first developed in 1972 at a United Nations conference. Conceptually, it encompassed three issues: (1) the interdependence of human beings and the natural environment; (2) the links between economic development, social development, and environmental protection; and (3) the need for a global vision and common principles [1]. Actually, these concepts were taken for granted by governments, retailers, producers and the environmental regulations and procedures became stricter and more compelling.

Sustainability concept was also adopted in fashion industry. In fashion, it refers to fair production and selling, which does not harm the environment and provide good working conditions, use of environmentally friendly raw materials as well as recycled materials in the products with a longer life time use and eco-labels [2,3]. The companies, which are acting in sustainable fashion, wants to gain recognition, inform the consumer about their products and services and generate a demand from the consumers. In their marketing programs, they use marketing claims to trigger especially the health concerns of the consumers and the sense of decreasing the harm given to the environment. Nevertheless, it is not clear whether the consumers are really aware of features of sustainable fashion products and what the sustainability term corresponds to. If the level of awareness and knowledge of consumers about sustainable fashion is known, it becomes possible to eliminate the confusion about sustainability, to enlighten the consumer market and to give the correct messages in marketing communications which will lead to conceive consumers for purchasing sustainable fashion products.

In this study, it was aimed to determine the level of awareness of consumers about sustainable fashion and understand various benefits, they are seeking for. To this aim, a survey was conducted among Turkish consumers including the following sections: (1) Socio-demographic characteristics of participants, (2) Awareness of sustainable fashion and (3) The relationship between socio demographic characteristics and awareness about sustainable fashion. The 16 questions under 8 criteria regarding the awareness of sustainability was adapted from the study established by Shen et al [1] and the socio demographic characteristics and its relation with the awareness level of sustainable fashion were analysed using statistical analysis and statistical charts. The eight criteria of sustainable fashion were defined to be recycling, usage of organic materials, reusing of products, giving no harm to animal, producing products in good working condition, producing products locally, custom made products with long life time, and fair production and selling [4]. The participants were asked to indicate which of the sixteen statements under eight criteria that were the examples of sustainable fashion by answering yes or no.

The data for this study was obtained from the survey conducted among 336 people living in Turkey. The results of the study showed that the awareness level is not so high for the participants covering all the aspects of sustainability. Some aspects of sustainability were much more favoured by the participants such as “Usage of organic material”, “Recycling”, “Fair production and selling” and “Reusing of products”. Thus the products made from organic materials seem to be more acceptable as sustainable fashion products. Moreover, the other two aspects related with recycling and re-usage of the products was perceived to be more related to sustainable fashion by the participants. The analysis of the relation between socio-demographic characteristics and awareness levels of consumers about sustainable fashion revealed that the male participants and the participants with high income level have higher degree of awareness. Nonetheless, the awareness level was not found to be associated with income linearly. Actually both relationship which are between awareness level and age groups and awareness level and education level showed that, the participants aged between 24-29 and the ones which had graduate and undergraduate degree were found to have higher level of awareness.

Based on these results, it can be said that the new generation which are well educated have higher level of awareness about sustainable fashion but some aspects of sustainable fashion is still not well known. Thus, the aspects of sustainable fashion should clearly be explained to these people to increase their level of awareness and to increase the positive approach towards sustainable fashion products.

Key Words: Sustainability, fashion, awareness, consumer, sociodemographic properties

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INNERSTRUCTURE CHARACTERIZATION OF PAN-co-VA, PAN-co-MA COPOLYMER FIBERS AND PAN HOMOPOLYMER FIBER

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Polymers based on acrylonitrile can be prepared by polymerization of acrylonitrile or other unsaturated monomers bearing nitrile groups in the presence of comonomers such as acrylamide and a cross-linker, e.g. divinyl benzene or bisacrylamide.

Since the PAN homopolymer fibers are so resistive to chemical applications and textile finishing operations, the crystallinity of the fibers should be deteriorated. To that end, different types of copolymers are added to PAN polymer structure in order to obtain more processable PAN fibers.

In this research 3 different types of PAN fibers (PAN-co-MA and PAN-co-VA copolymer fibers and PAN homopolymer fiber) were examined by FTIR, TGA, DSC and XRD analyses. And the impact of comonomer use and comonomer type to crystallinity, glass transition temperature (T_g) and decomposition temperature were investigated. Samples used in this study are given below as Table 1.

Table 1. Sample descriptions

SAMPLE CODE	PAN-VA	PAN-MA	PAN-Homopolymer
Description	Polyacrylonitrile (PAN) fibers with Vinyl acetate (VA) copolymer	Polyacrylonitrile (PAN) fibers with Methyl acrylate (MA) copolymer	Polyacrylonitrile (PAN) homopolymer fibers

According to the FTIR analysis graphics while 1196 cm^{-1} and 1168 cm^{-1} peak points can only be seen at PAN-co-MA sample, on the other side 1231 cm^{-1} peak point can only be seen at PAN-co-VA sample. Since they were characteristic special peak points and they were not seen on homopolymer fiber sample it was thought that those peak points should based on comonomer content. Farsani et al. (2009), revealed that, 1168-1196 cm^{-1} peaks are derived from methyl acrylate (MA) and 1231 cm^{-1} peaks are derived from vinylacetate (VA) which are presented as co-polymers in PAN fiber.

Table 2. XRD test results

	2Theta (°)	Crystallinity %	Crystal size (Å)
PAN-Homopolymer	16,9	28%	53,08
PAN-MA	16,8	21,3%	53,92
PAN-VA	16,5	21,2%	55,75

As the XRD results were evaluated, it was revealed that homopolymer PAN fiber has the most crystalline structure with 28% crystallinity ratio. Both MA and VA copolymer fibers demonstrate the similar crystalline characteristics and relative to Homopolymer PAN fiber both have amorphous structure. On the other side, it can be denoted that crystal size wasn't affected by change of crystallinity.

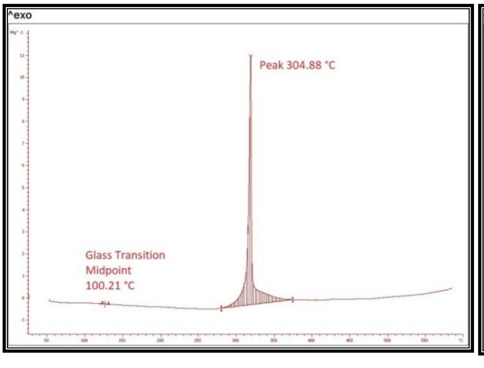

Figure 1. Homopolymer PAN fiber

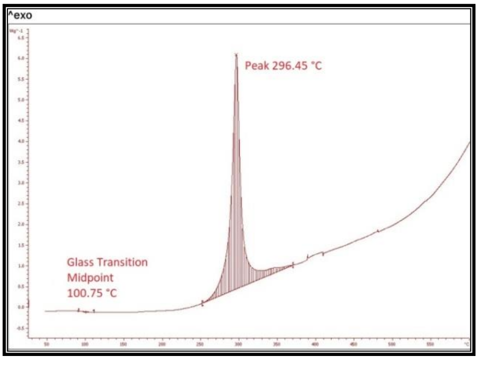

Figure 2. PAN-MA fiber

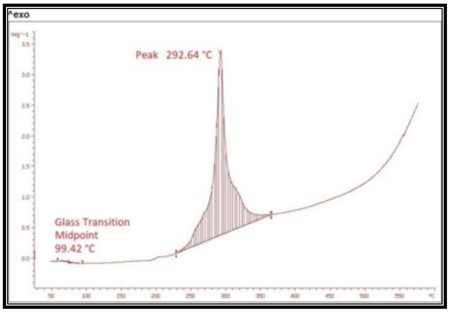

Figure 3. PAN-VA fiber

According to DSC curves it is clearly seen that Homopolymer PAN fiber exhibits a sharper and narrower peak curve. This situation indicates the difference of crystallinity of the fibers. The broadening of the DSC curve is attributed to the change in the mechanism of the cyclisation from the radical mechanism to the ionic one.

Both in DSC curves and TGA curves it can be clearly seen that decomposition temperature of Homopolymer fiber is also higher than copolymer fibers. According to DSC graphics; Homopolymer, PAN-MA and PAN-VA fibers have 304.88°C, 296.45°C and 292.64°C decomposition temperature, respectively. Moreover, TGA test results also demonstrate similar decomposition temperatures; 314.06°C, 298.27°C and 297.64°C for Homopolymer, PAN-MA and PAN-VA fibers, respectively. However, no change was detected on glass transition temperature (T_g) for all specimens.

In this study, it was seen that copolymer use came out drop in the crystallinity and drop in the decomposition temperature. But no significant structural difference was observed between PAN-MA and PAN-VA copolymer fibers.

Key Words: Poly(acrylonitrile-co-methyl acrylate) fibers, poly(acrylonitrile-co- vinylacetate) fibers, homopolymer fibers, PAN fibers, copolymer fibers, TGA, DSC, FTIR, XRD

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FUNCTIONAL FINISHING FOR ENHANCEMENT OF FLAME RETARDANCY AND ANTIBACTERIAL EFFECT OF COTTON FABRICS

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Functional textiles such as flame retardant, antibacterial or insect repellant textiles have attracted much attention nowadays. Phosphorous compounds have been widely in use for flame retardant applications while silver compounds, triclosan or chitosan based chemicals use generally in antibacterial processes. Beside these studies, researches have been more focused on getting these kinds of functionalities together on textiles under the term of multifunctional textiles via different kind of methods or processes. These methods could be either conventional methods or new generation production methods including one-step or multi-step processes. When the water and energy consumption is taken into consideration, one step finishing processes could be more cost-effective. In this study, flame retardant and antibacterial efficiencies of cotton fabrics were improved in one-step finishing processes. Vertical burning test was performed to determine the flame retardancy properties and burning behavior of cotton fabrics. As an antibacterial test, AATCC 100 method was carried out with gram positive and gram negative bacteria. Beside performance tests of fabrics, some characterization tests such as SEM and FTIR analyses were performed. According to testes carried out, cotton fabrics showed high-efficiency in antibacterial properties and improved flame retardant effects in a cost-effective manner.

Key Words: Flame retardant, antibacterial, finishing, cotton

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SESSION II

MULTIAXIAL TENSILE TESTING OF TEXTILES USING INDUCTIVE TYPE POSITION SENSORS

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Multiaxial tensile testing measurements of technical textile fabrics have shown to provide more information regarding the properties of real textile fabrics. Recently a multiaxial tensile testing device has been developed and evaluated for the simultaneously tensile measurement of four axis of a textile fabric [1]. This device is based on capacitive type sensors by measuring the deformation of one of the two planar electrodes of each capacitor, respectively positioned along the corresponding measurement axis (Fig.1). Although the proposed testing device gave excellent results after the necessary calibration procedure, a serious draw back has been noticed towards the design and development of a final product.

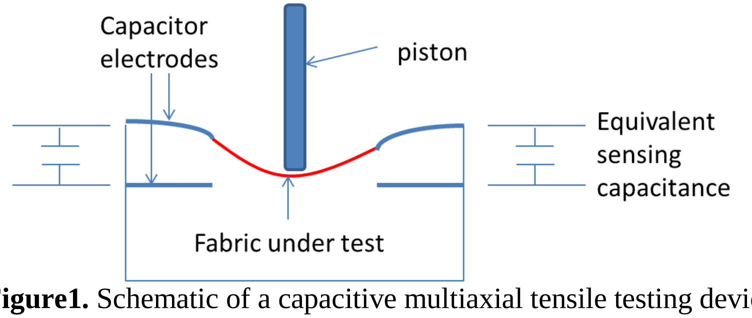

Figure1. Schematic of a capacitive multiaxial tensile testing device

The capacitive type sensor device suffers from the parasitic capacitances that are present due to electrostatic phenomena of the connection cables and the mutual influence from the neighboring capacitive sensing elements, as well as from any other metallic component. Although this problem may be tackled by a careful calibration, however it is a very tedious procedure and sensitive to any variation, even the smallest one.

An alternative method that may overcome this problem is based on the replacement of the capacitive sensor with an inductive one. In particular, instead of the two capacitive electrodes we use a metallic cantilever with a predefined elastic constant E, cross-section (w×d) and length L. As an inductive sensing element, a linear variable differential transformer (LVDT) is used (Fig.2) which is going to measure the cantilever's edge deflection Δy, due to the mechanical load that is transferred to the cantilever from the piston and through the fabric. The output of the LVDT is a DC voltage, proportional to Δy, that appears to have immunity over environmental influences. Additionally, the LVDT's movable core will follow variations at only one direction (i.e. only for negative Δy) and as a result, the necessary circuit for signal conditioning, will be less complicated and therefore more cost effective in comparison to a typical LVDT.
Furthermore, considering nonpermanent deformation of the cantilever, the edge deflection $\Delta y = \frac{4FL^3}{Ewd^3}$ is proportional to the equivalent force F applied at the edge of the cantilever in direction parallel to the y axis. Consequently, the LVDT's output DC voltage will be proportional to F and therefore, a comparative measurement between different tensile axis of the fabric is easily implemented.

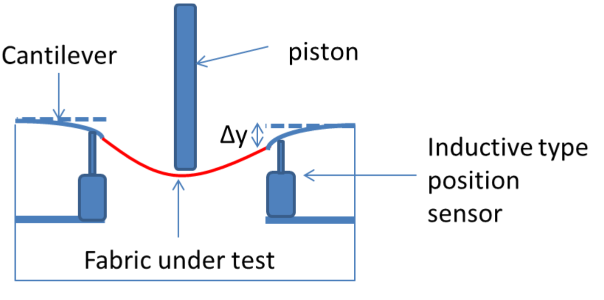

Figure2. Schematic of an inductive multiaxial tensile testing device

Another improvement of the proposed configuration has to do with the electronic unit that is going to implement the data acquisition task. This unit employs an ADC for each LVDT, while the final data may be transferred to a control unit for the monitoring and display of the measurements.

The final device, after the proposed modifications, will be more reliable and may be used either as a testing device for final inspection or as a testing device for in-process inspection, by the addition of rolling elements at all the cantilevers' edges and the piston edge as well. In the latter case, suitable software is required for a continuous recording of the measurements.

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NOVEL TECHNIQUES TO ANALYSE THE COMFORT OF CAR SEAT

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The car seat's comfort properties are analysed on the basis of permeability of top layer. This brings lot of error to the real breath ability of the car seat. The porosity of the material is important parameter affecting the thermal properties, also the porosity of the compressible materials changes with loading on the top. So that material can show different breathability under loading. Therefore it was important to develop measurement technique to measure car seat material under different load. On the other hand, experimental techniques should be developed to measure the comfort of the whole car seat. Commercial measurement techniques gives us the opportunity to measure the thermal properties of the car seat layer but there are also other parameter affecting thermal comfort of the car seats other than materials, such as heating and the ventilation of the car seat. With new experimental techniques it is possible to evaluate the car seat comfort with other effecting parameter that gives us more realistic values of car seat comfort and comparison of different car seats is possible.

In this research self fabricated sensor sheet is used to analyse the thermal field of the driver on the car seat, another improvement is made to the standard CUP METHOD to analyse the moisture permeability of the textile compressible layers under load.

The new methods are novel and can bring useful real time information about the permeability of the car seats.

Key Words: car seat, comfort, novel techniques, thermal field

PRODUCTION OF NONWOVEN FROM CHICKEN FEATHER FIBERS

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Studies show that chicken feathers have many valuable properties and the most important is that these fibers are porous. This feature transforms the fibers into a very valuable raw material for use in many areas, firstly for insulation purposes. Literature studies have shown that there are very few studies on the production of nonwoven surfaces from these fibers. This study presents the production of nonwoven that can be used for different purposes from chicken feather fibers and examining the properties of these surfaces.

Key Words: Chicken feather, chicken feather fibers, nonwoven surfaces, nonwoven surfaces from natural fibers.

APPLICATION OF TECHNICAL TEXTILES AS REINFORCEMENT IN CONCRETE STRUCTURES

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The rapidly increasing world population and the urbanization affect the needs of today`s building industry. Civil engineering applications require lightweight structural parts with high load-bearing capacity. One of the most innovative construction materials is the textile reinforced concrete (TRC), which offers different advantages in terms of sustainability and enables new types of construction for a sustainable future.

TRC can be used for fast and safe construction due to lightweight components with a high strength performance. Thin and lightweight TRC elements reduce the transport volume and thus the transport costs. Big sized TRC elements reduce the installation time and save personal costs.
High-performance rovings are used to produce biaxial warp knitted textiles. Due to their adequate mechanical performance and durability in alkali environments most common reinforcement materials used in construction are alkali resistant (AR) glass and carbon roving. These materials meet the growing requirements for corrosion-free and high-strength lightweight structures in the building industry.

The combination of technical textiles and concrete creates stability and a high durability in lightweight and thin walled building components with a lifetime of over 100 years (non-corrosive). TRC provides a high quality surface and a CO_2 reduction up to 80% in material, production, transport and mounting. It is adaptable to local standards (in terms of shapes, colors, architectural needs, etc.) The vertical extensions of cities are possible due to light weight.

TRC offers the opportunities to develop sustainable solutions for global needs. This paper will give an overview on the following projects about TRC researched at the Institut fuer Textiltechnik (ITA) of RWTH Aachen University:

- Strengthening of existing concrete structures with TRC and sensor-based warning systems
- Combination of photovoltaic and solar thermal absorber on basis of a TRC sandwich component
- Thin TRC-elements including a thermal insulation
- Development of recycling processes for TRC
- Development of an automated process (TRC production line)

Key Words: Textile reinforced concrete, lightweight structures, biaxial warp knitted textiles, sustainability

AN INVESTIGATION ON THE COMPRESSION PROPERTIES OF WARP KNITTED SPACER FABRIC/SILICONE RUBBER COMPOSITES

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Spacer fabrics are three-dimensional textile structures consisting of two parallel knitted fabric surfaces connected by a spacer yarn. The spacer yarn plays an important role on fabric's special characteristics. Thanks to these special features such as compression and impact resistance, high breathability, high elastic recovery characteristic, lightweight and durability, spacer fabrics offer a lot of possibilities in various application areas such as medical textiles, automotive textiles, geotextiles, protective textiles, sportswear and composites. It is possible to produce these fabrics by weaving or nonwoven techniques besides warp and weft knitting processes. Knitting technology especially warp knitting technique is the most commonly known and applied technology for the production of spacer fabrics [1].

Warp-knitted spacer fabrics are commonly used for the production of 3D-structure composites. These fabrics with better moisture transmission, better resilience and higher air permeability properties can be preferable as a reinforcement material [2-5]. Additionally, the spacer fabrics are regarded as environmentally friendly textile materials because unlike polyurethane foam, they can be recycled [6]. Moreover, by varying the fabric structural parameters, warp knitted spacer fabric composites exhibit superior mechanical performance such as tensile and flexural strength, and impact resistance properties compared to other textile-based composites [7-10]. Recently, a few researchers have investigated the mechanical characteristics of sandwich composites based on 3D warp knitted spacer fabrics by varying the matrices (i.e. magnetorheological fluid, flexible polyurethane foam, polyester resin, and epoxy resin) [2, 6, 11-12].

This study reports the compression properties of 3D-structure silicone matrix composites manufactured based on warp-knitted spacer fabrics. With an attempt to discuss the effect of fabric structural parameters on the compression characteristics, a series of warp-knitted spacer fabrics with different parameters (such as thickness and pore size on the outer layers) were used to manufacture the composites. For the production of outer layers, multifilament polyester textured yarns and as spacer yarn monofilament polyester yarn were used. Composite specimens were manufactured and their compression properties were investigated according to ASTM D575 standard. The characteristics of the spacer fabrics and properties of the silicone are given in Table 1 and 2, respectively.

Table 1. Basic characteristics of spacer fabrics used

	1	2	3
Yarn count of outer layer (dtex)		PTY 167f48 × 4 PTY 334f72 × 3	
Diameter of spacer yarn (mm)		0.243	
Surface structure (for both layers)		Two side open structure	
Courses/cm		5.25	
Distance between the needle bars (mm)	12.5	15.0	15.0
Finished width of the samples (cm)	160	110	160
Areal density (g/m^2)	521.02	721.76	553.28
Thickness (mm)	10.74	12.37	12.56

Table 2. Properties of the commercial silicone rubber

Viscosity (mPa.s)	Tensile Strength (mPa)	Elongation at Break (%)	Youngs Modulus (MPa)	Tear Strength (kN/m)	Hardness
96.000	5.4	330	1.88	22	40^{0}Shore A

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EFFECT OF DIFFERENT INTERACTION METHODS OF CNTS ON MECHANICAL PROPERTIES OF MULTI-LAYERED GLASS-CARBON HYBRID COMPOSITES

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Materials are combined in a way to minimize the effect of their deficiencies in a composite that enables to make better use of their properties. Tougher and lighter materials have made possible to fulfil particular design requirements in various applications such as automobiles, aircrafts and other impact protective equipment etc. They consist a bulk material called Matrix and a reinforcement of some kind and are characterized by high strength, better stiffness, cost, high performance, electrical properties and simple manufacturing techniques (Awan, Ali, Ghauri, Ramzan, & Ehsan, 2009) (Chapman & Hall, 1998). Carbon Nanotubes have been acknowledged widely for strengthening the mechanical properties of the composites (Kim, Shi, Majumdar, & Mceuen, 2001). There are several ways to accommodate the interaction of the CNTs within the composite materials, which differ with cost, time and resources. Most common method is chemical vapour deposition to grow CNTs on reinforcement but it requires higher temperatures and time (Romanov, Lomov, Verpoest, & Gorbatikh, 2015). The elevated temperature also affects the strength of the reinforcement (Kim, Kim, Yu, Youk, & Lee, 2013). It has been observed that addition of only 1% of CNTs by weight in a matrix material can result in the increase in stiffness of the composite film by 36–42% and the tensile strength by 25% (Qian, Dickey, Andrews, & Rantell, 2000). MWCNTs-g-carbon precursors using COOH functionalized MWCNTs with PAN resulted in an increased thermal stability up to 850^{o}C and also improved the UV absorption (Fares, Abu Al-Rub, & Massadeh, 2015).

Two simple cost effective methods for CNTs interaction have been investigated in this research. The first method was grafting of functionalized CNTs on primary reinforcements prior to composite manufacturing and the second one was dispersing functionalized CNTs in epoxy resin (matrix). Three layered composites using different stacking sequences of glass and carbon fabric with both methods were manufactured and compared for the improvement of mechanical properties. Previously grafting method has been applied for the improvement of single layered composites but its usage hasn't been investigated for multi-layered and hybrid composites. It was hypothesized that both methods will influence the mechanical properties of the resulting composites in entirely different manner. The results showed some significant improvements in different mechanical properties with respect to the method adapted for CNTs interaction. Tensile strength increased up to 12% by the grafting method whereas the dispersion method increased the flexural properties of the composite up to 70%. Grafting technique resulted to be more favorable for the presence of carbon fabric reinforcements in composites which can be attributed for the better bonding ability of carbon fabric. The second method showed best flexural results with the presence of glass fabric reinforcements which is attributed to better bending performance of glass fabric as compared to carbon fabric. The load transferring ability of the matrix was improved causing an increased flexural strength of the resultant composites. Impact performance of the composites was also measured which came out to be nearly in accordance with the flexural performance of the composites, showing the CNT-Epoxy dispersed matrix phase as the most favorable for absorbing an impact successfully.

Key Words: Carbon Nano Tubes (CNT), hybrid composites, carbon, glass, grafting method, dispersion method

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INTELLIGENT TEXTILES FOR MARTIAL ARTS

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Martial arts have become very popular among the young population and even children, especially over the past 10-15 years. There are many kinds of martial arts that are universally accepted. However, only boxing, judo, taekwondo, freestyle wrestling and Greco-roman wrestling take part in the Olympic games (1). There are also other martial art divisions which have federations and competitions around the world namely muaythai, karate, sumo wrestling, wushu, kickboxing, aikido, jiujitsu. In addition to this, participation in martial arts has many benefits like the development of discipline, respect, strength, coordination, balance, and flexibility (2).

As result of the rising interest in martial arts, intelligent textile applications in martial arts' equipments and clothing are emerging. Many academic/research institutions and also companies have carried out research and development of activities worldwide with noticeable outcomes either in the form of commercial products or research publications (3). Additionally, the development of intelligent products for martial arts provides more accurate judging, improves coaching and participant health monitoring and enhances the entertainment of spectators (4).

The World Taekwondo Federation (WTF) emphasized the requirement for an electronic scoring system in the game to assist the match officials (Figure 1) (4). The WTF began to promote the inclusion of electronic body protectors (EBP) in their competitions after the Athens Olympic Games in 2004 (5).

In Taekwondo, points are scored after a punch or kick to the thorax or head. These are recorded by four judges placed around the match arena, with decisions being made purely based on visual inspection and the officials' judgment (4). The EBP works with Bluetooth™ wireless technology and has some advantages, including: the possibility to register 5 hits per second, instantaneous presentation of the energy of the blow, electronic definition of minimal impact for a valid score, high amplitude and secure transmission (from more than 100 m and encrypted to prevent interference). Electronic sensors on footwear and gloves allow points to be scored when the body protectors are hit [5].

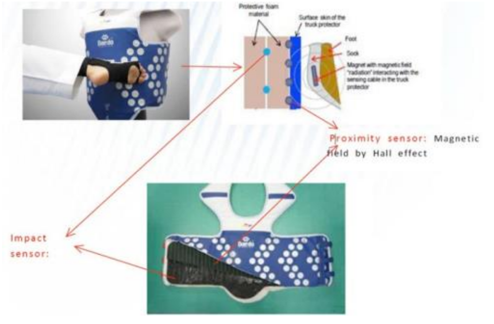

Figure 1. Electronic body protectors for Taekwondo (6)

Moreover, there are also products to track the training such as sensors attached to boxing gloves. The principle, patented by Victor Xavier Navas, uses accelerometers adapted to be worn on the hand or wrist of a user (Figure 2). The accelerometers are operatively coupled to a processor capable of calculating the user's hand position based on data from the accelerometers (7). Commercial systems using this principle are now on the market or in pre-order, such as the Hykso (8) and the Corner equipments (9), indicating several parameters related to the athlete’s performance.

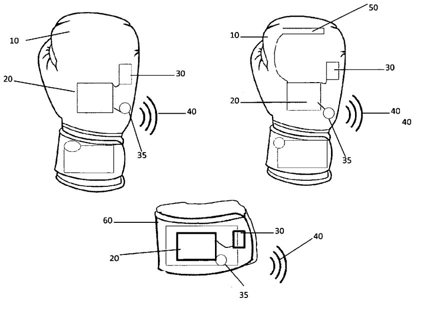

Figure 2. Boxing glove with accelerometers

This study has been conducted in order to present intelligent textile products for martial arts' equipments and clothing. For this purpose, we have analyzed different martial art divisions' equipments and clothes and the existing electronic systems, which will be presented.

Key Words: Martial arts, smart garments, intelligent textiles

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OCTOBER 28, 2017

SESSION III

INVESTIGATION OF THE EFFECT OF STRUCTURAL PROPERTIES OF DENIM WOVEN FABRICS ON THE MOISTURE MANAGEMENT PERFORMANCE

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In recent years clothing comfort in the garment industry has gained much importance. For this reason, advantageous fabric constructions are designed and developed in terms of comfort features for clothes. Heat, humidity and air movements are the most important parameters that provide thermo-physiological comfort. To make people comfortable, clothes must allow water vapor permeability from the body. Because of the wide use of the denim fabrics, it has caused importance of the comfort properties of denim fabrics. In this study, moisture transmission properties of denim fabrics with different structural parameters were investigated and effects of fabric structure on moisture permeability properties were tried to be analyzed.

The heat and moisture transmission properties of the fabric and the heat and moisture transmission ability of the body are important factors in determining the thermal comfort of the garment (1,2). The removal of moisture from the body in the form of vapor and liquid is defined as moisture management. The water absorbed by the textile material is transferred by diffusion through the textile structure and the transferred water is discharged from the textile surface to the external environment. This has been changes depending on the fiber type and the fabric structure (3,4).

In this study, the moisture management properties of denim woven fabrics with different structural parameters were tested with the SDL Atlas-Moisture Management (MMT) test device. The structural properties of the experimental fabrics were given in Table 1. Wetting time, absorption rate, spreading speed, accumulative one way transfer index and overall moisture management properties of the fabric samples were examined to determine the proper denim fabric structure for moisture transfer. Wetting time and overall moisture management values of the fabrics are shown in Figure 1-2. When the wetting times of denim fabrics with different structural parameters are examined in Figs. 1-2, it has been observed that the wetting times of denim fabrics vary depending on fabric weight, fabric thickness and weft yarn properties.

Table 1. Denim fabric properties

Fabric Code	Properties of Weft Yarns	Yarn Count [Nm]		Yarn Density [thread/cm]		Yarn Crimp [%]		Fabric Thickness [mm]	Fabric Cover Factor [Kf]	Fabric Weight [g/m^2]	Weave
		Warp	Weft	Warp	Weft	Warp	Weft				
F1	%97 OE Cotton / %3 Elastane	22	32	37	22	11	14	0,55	26,93	284	3/1 Twill
F2	%97 Textured Polyester / %3 Elastane	31	49	48	27	15	18	0,68	28,24	273,3	3/1 Twill
F3	%100 OE Cotton	39	41	41	24	10	18	0,37	24,46	190,1	3/1 Twill
F4	%97 OE Cotton / %3 Elastane	22	32	37	24	20	34	0,65	27,02	378	3/1 Twill
F5	%97 OE Cotton / %3 Elastane	14	18	31	19	18	20	0,76	27,69	388,6	3/1 Twill
F6	%97 Textured Polyester / %3 Elastane	14	17	31	20	15	27	0,75	27,72	412	3/1 Twill
F7	%97 Textured Polyester / %3 Elastane	34	67	59	33	14	34	0,63	30,83	279,1	3/1 Twill
F8	%97 OE Cotton / %3 Elastane	14	16	30	20	17	30	0,73	27,36	412,1	3/1 Twill
F9	%97 OE Cotton / %3 Elastane	14	12	26	18	18	19	0,78	26,03	423,5	3/1 Twill
F10	%97 OE Cotton / %3 Elastane	14	20	26	19	12	23	0,7	25,47	367,2	3/1 Twill
F11	%97 OE Cotton / %3 Elastane	14	18	29	20	15	28	0,75	26,92	411,5	3/1 Twill
F12	%97 OE Cotton / %3 Elastane	20	24	39	22	11	14	0,68	28,36	342	3/1 Twill

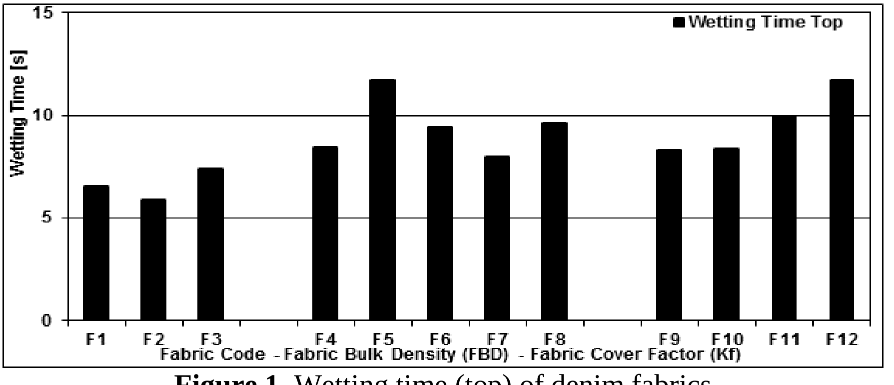

Figure 1. Wetting time (top) of denim fabrics

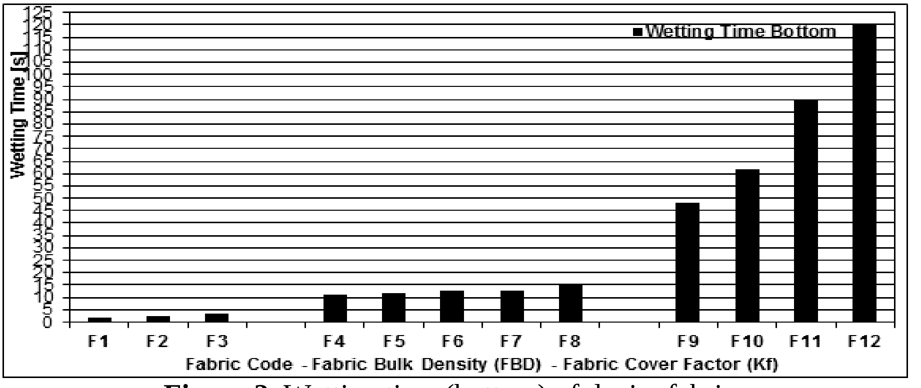

Figure 2. Wetting time (bottom) of denim fabrics

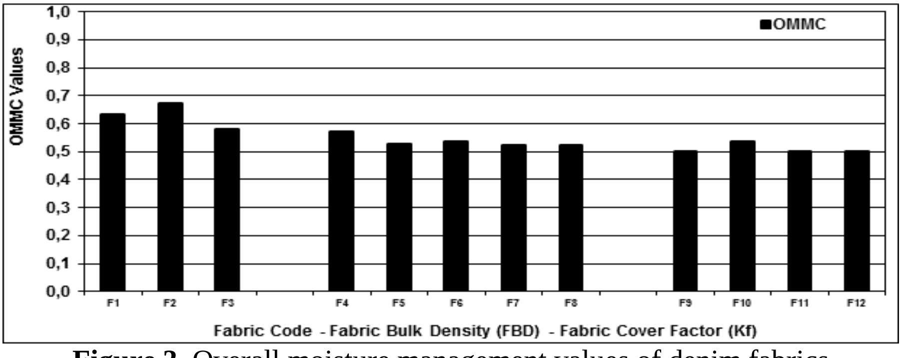

Figure 3. Overall moisture management values of denim fabrics

Key Words: Denim fabric, moisture management properties

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A STUDY ABOUT THE EVALUATION OF SEWING PERFORMANCE OF KNITTED AND WOVEN FABRICS

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Fabric quality is one of the primary requirements for production of high seam quality in apparel. However, fabric quality alone does not fulfill all the criteria for the production of high quality garment. The conversion of a two dimensional fabric into a three dimensional garment involves many other interactions, such as selection of suitable sewing thread, optimization of sewing parameters and ease of conversion of fabric into garment.

For achieving the desired seam performance and seam quality, the parameters like stitch type, seam type, sewing speed, needle size, shape of the needle, sewing thread, seam allowance, stitch density and tension should be chosen appropriately for the fabrics. The sewing machine parameters and settings of woven and knitted fabrics are different. As this situation is considered, it is clear that the correct selection of the parameters when sewing different fabric constructions together, becomes even more critical.

In this study, the effects of sewing different fabric structures on seam quality were investigated. For this purpose, 2 different knitted fabrics and 3 different woven fabrics were supplied. The samples were sewn due to the identified parameters, seam strength and seam pucker properties of the sewn samples were investigated. The data obtained from experimental studies were evaluated statistically. In the scope of the data, the effect of fabric construction and sewing parameters to the seam quality were examined.

Based on the results obtained, some suggestions were made for researchers and industrialists about the features that should be considered when sewing different fabric structures.

Key Words: Seam quality, seam strength, seam pucker, knitted fabric, woven fabric

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HIGH PRESSURE RESIN TRANSFER MOLDING (HP-RTM) PROCESS AND ITS FUTURE IN THE AUTOMOTIVE INDUSTRY

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ABSTRACT
Global automotive manufacturers are increasingly using carbon-fiber reinforced composite materials in the automotive industry, as they focus on lightening vehicles, reducing energy efficiency and CO_2 emissions. The automotive industry is working on the development of a new generation of electric and light vehicles and the RTM method for producing series of structural parts of these vehicles. The research has focused on the problem of long operation time and the automation of the process.
This study examines the high pressure RTM (HP-RTM) method, which will be used extensively for the production of structural parts such as body in new generation vehicles.

1. THE USE OF FIBER REINFORCED COMPOSITE MATERIALS IN THE AUTOMOTIVE INDUSTRY

Global warming and air pollution have been highly discussed after the Kyoto protocol adopted in Kyoto, Japan, in December 1997. It is emphasized that the greatest cause of air pollution is increased carbon dioxide (CO_2) emissions. In this context, European Union (EU) countries have developed various policies and they aimed to reduce CO_2 emissions by 80% by 2050 [1]. According to the legislation, in 2012 a CO_2 emission of a new car with a mass of 1289 kg should not exceed 130 g / km. Vehicles will have to be 26% lighter than in 2012 to reach the targeted 95 g / km emissions by 2020 [2]. If transport vehicles can be lightened, fuel efficiency can increase significantly and CO_2 emissions can be reduced, further reducing environmental impacts. A 100 kg reduction in automotive weights saves 0.35 liters of fuel and 8.4 g / km of CO_2 emissions at 100 km. That is a major environmental and economic gain [3].

2. HP-RTM METHOD AND USE IN AUTOMOTIVE NERVOUS WORK

Use of carbon fiber reinforced plastic (CFRP) is used materials by automotive manufacturers in this sector has focused on continuous vehicle mitigation, energy efficiency and CO_2 emission reduction.

The use of carbon fiber reinforced plastic (CFRP) materials in the automotive sector is increasing due to focus on vehicle mitigation, energy efficiency and CO_2 emissions reduction. In 2015, the amount of CFRP produced by the RTM process increased by 3% to 141.000 tons [4].

The conventional RTM process is limited by the problem such as low volume production capacity and long duration impregnation process. For this reason the HP-RTM method was developed and the processing time was reduced significantly. It is aimed to reduce the curing time of the complicated geometry (like the body of the BMW i3 model), which is generally required for automotive, to the size of the part and the complicated geometry to 3-7 minutes. In this process, the preform is placed in the mold cavity as in Figure 1 and a small gap is left between the mold and the surface. The resin is transferred from a suitable injection point to the leaving space and the preform is partially absorbed. High pressures (30-120 bars according to size and geometry of the part) are then applied so that the resin can be distributed quickly and homogeneously in the preform [5].

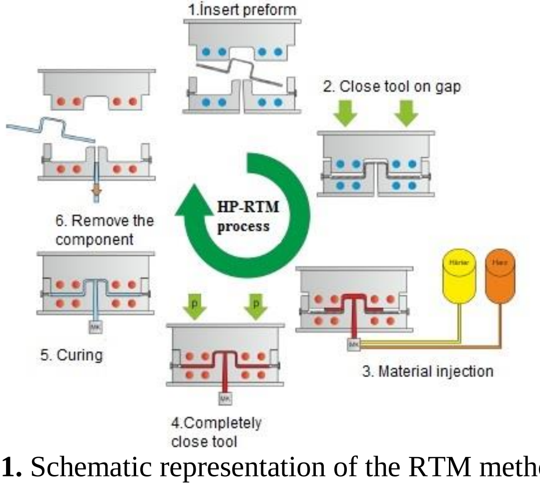

Figure 1. Schematic representation of the RTM method [6]

3. CONCLUSION AND EVALUATION

RTM process which has been used for many years in the production of vehicles with low production volume can be used in serial production in future. Therefore, abbreviation of process cycle, integrated production and adaption of them to carbon fiber are key issues. If the production volume is around 10.000 pieces per year, it may not be seen as a problem but if the production volume is over 100.000 pieces per year, preforming process can create a serious bottleneck.

The most important elements of reduction the process time in the RTM process are to shorten the injection and curing times. Low viscosity resins have been developed to reduce the injection period. But these can lead to problems such as leaking from mold. The most important method to reduce the injection time is the HP-RTM process. It takes time to fully transfer the R&D work carried out in the automotive sector to serial production. However, the HP-RTM method will take an important place in the production of the body and other parts of vehicles that are lightweight and will work with renewable energy systems after 2020.

Key Words: High pressure RTM, automotive industry, composite, carbon fiber, CO_2 emission

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A RESEARCH ON BIODEGRADABLE NONWOVEN AGRICULTURAL TEXTILES

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The purpose of this study is the production of nonwoven to be used in agricultural textile that is harmless to the environment and agricultural products, also without creating pollution after its usage and without the need to collect, self-destructive surfaces.

Increase in the world population and industrialization have brought environmental problems [1]. Petroleum-derived raw materials which last long time for decomposition are known to emmit harmful chemicals and pollute the food chain and also cause reduction of renewable energy in time when the decomposition is started [2]. These raw materials besides the environmental pollution they bring, are threat to all living creatures' life. In this context, biodegradable and environmentally harmless polymers are important.

In this study, by using PLA polymers obtained from self-destructive corn starch, nonwoven materials have been obtained with the method of melt blown to be used in agriculture [3].

In Turkish agriculture sector, when the increase in productivity of production and reduction in cost are considered, agrotextile field is a big potential for our country. Agrotextiles are used in many areas for different purposes such as, packing agricultural products, acceleration of plant growth process, protection the products against UV, disinfection of agricultural areas, inhibition of growth of weeds, control of drainage and erosion for agricultural purpose, protection of animals under bad weather conditions, fishery etc [4].

Using PLA granules and with melt blown method rate of output, DCD and collector drum speed have been changed to produce 36 different sample.

Repeated part of PLA composed of lactic acid is a polymer belongs aliphatic polyester group. Being compostable and biodegradable a thermoplastic polymer which is produced by at a high rate contained corn, sugar cane and wheat in vegetative sources is one of the most important properties [5]. PLA quickly absorbs the moisture in environment. Because of being condensation polymer, during melting containment of moisture even in a small rate can cause degradation of the polymer chain and property of mechanical with loss of molecular weight. For this reason the PLA granules were dried at 80 degrees centigrade for 4 hours.

Subsequently, surfaces were obtained by melt blown method. Melt blown is one step operation method of blowing the granules at high speed with melting by hot air through die to collector drum in extruder.

Physical test (air permeability, thickness, basis weight) have been applied to obtained samples and results of the tests have shown that, they are suitable to be used as agrotextile is comment able. Biodegradability tests are in progress and the test results will be given in full text.

Key Words: Agrotextile, nonwoven, melt blown method, polylactic acid, biodegredable

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FABRIC DESIGN FOR OUTDOOR SPORTS BY FLAT KNITTING TECHNOLOGY

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Enhancing standard of living quality and health trends in developed countries lead to positively growing for sport textiles. The expectations from these products are thermal comfort, stretchability, breathability, easy care, durability, tight fitting and lightness. There is a growing demand in sport textiles and equipment with especially high performance and thermal comfort.

Today's raw materials and production technologies take advantages of sport textiles to another level. There is a need of improved sport products in terms of safety and performance because of extreme sport conditions. During sport, human body is under the influence of environmental factors and sport activity risks. Environmental factors are weather conditions, cold and hot temperature changes and land shapes of sport area. Furthermore textile product should have impact absorbent ability in order to prevent the user from harms such as falling, hitting and crushing.

Comfort feeling is a pleasing situation between human body and environment with physiological, psychological and physical harmony. The most important factor about clothing comfort is thermal comfort. Clothes constitute a barrier effect for sustainable body temperature in different climate conditions. A high comfortable garment should generate a thermoregulation system for consistent average body temperature even if the environmental conditions and psychical activities change rapidly and enormously.

This study aims to product textile fabrics for technical purpose by using electronic flat weft knitting machines. For this aim various sandwich knitted structures (Figure 1) are designed to enable important comfort parameters such as protecting cold temperatures and breathability for all outdoor sport and skiing in particular. In design of structures, different fabric surfaces are created by considering of different usage (e.g. adding support pads for better impact resistance) and different products (e.g. cap, glove or mask).

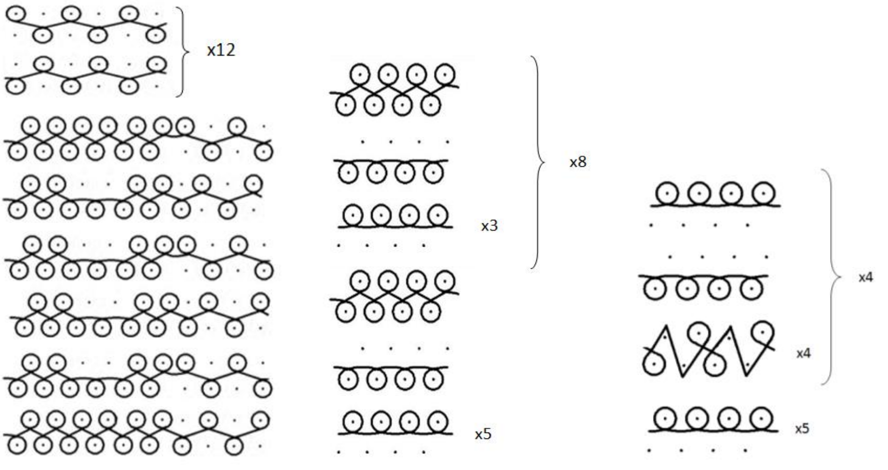

Figure 1. Stitch diagrams of designed sandwich knitted structures

In the scope of this study, the fabric samples were knitted by raw material 100% wool and 100% acrylic yarns (Nm 28/2) with same manufacturing parameters on Shima Seiki NSSG 122-SV electronic flat knitting machine. Thickness, mass per unit area, thermal conductivity, thermal resistance, thermal absorptivity, air and water vapor permeability of samples were tested in accordance with related standards and the results are statistically analyzed.

The results revealed that knitted structure and material type had significant effects on thermal comfort characteristics. The air permeability, water vapor permeability and thermal resistance of samples changed with related designed structures. Woolen fabrics reached higher values for air permeability, thermal conductivity and thermal resistance. In the light of these results, the acrylic fabrics consist of tuck loops presented ideal performance for cold climates.

Key Words: Thermal comfort, flat knitting technology, sanwich knitted fabric, sport textile, cold protection

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POSTER SESSION

THE ANALYSIS OF THE WORKING POSTURES FOR THE SEWING MACHINE REPAIR THROUGH ERGONOMIC RISK ASSESSMENT METHODS

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The rapid advancement of technology are accelerated and facilitated the work in many areas of life as well as changing the way of production. The place of mechanisation in production is increasing day by day and this makes things faster and also easier. On the other hand, labor intensive production still continues in many enterprises and workers are faced with physical difficulties. Musculoskeletal system disorders affecting areas such as back, leg, arm, neck, wrist are frequently seen in workers who require physical strength. Inappropriate working postures for works that require intensive labor force cause musculoskeletal disorders as well as inefficiency in production. The main objective of the ergonomics discipline is to reach the maximum performance with the least human cost (stress, strain, fatigue). Examination and evaluation of working postures, which is a very important issue in terms of management and employees, also has an important place in ergonomics. Reducing stress and fatigue of worker, increasing satisfaction and quality of life will provide great contributions to productivity and cost. There are many methods used for the analysis of working posture of workers. Rapid Entire Body Assessment (REBA) & Rapid Upper Limb Assessment (RULA) are the main of these methods. The REBA method is a process of assessing body posture factors by assigning points to the relevant region for every work that can be evaluated as critical task. The potential risk of a working posture or movement desired to be analyzed is stated as numerically. The RULA method is an observation-based method, categorizes working postures according to specific hazard levels and works with matrices. Upper extremity consisting of neck, body and arm is taken into account while analyzing a working position by RULA method and a general assessment of leg position is made. The aim of the study is to examine the working postures and the strained areas that lead to the muscular and skeletal system disorders experienced in the works in the clothing sector where labor intensive jobs are involved. For this purpose, various problems occurring in the sewing machines during the production and the adjustments to be made have been defined. The works to solve these problems were explained under the main headings and the working postures in the order of repair and adjustment were examined. Then, possible tasks that could be assessed and have harmful effects on musculoskeletal system were determined and analyzed with REBA and RULA methods using uMED Ergonomy package program. The ergonomic risks of employees' positions during the job have been determined and the results of these two methods have been compared.

Key Words: Ergonomics, Ergonomic Risk Assessment Methods, REBA, RULA, Working posture

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A NEW APPROACH FOR PIGMENT PRINTING

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The aim of this article is describing the ways of eliminating the common disadvantages related with the usage of end product and operating efficiency observed in various coloring processes. In our previous study in 2015, cotton fabric samples were printed with pigment printing paste added amorphous silica, pumice and colemanite and then its functional properties such as tensile strength, flame retardancy, water repellency, air permeability were investigated. Applying this production method with the usage of natural materials, it will be possible to obtain cotton fabric with high tensile strength, flame retardancy, water repellency, less air permeability and low cost (1, 2).

In this study, based on our previous work, pigment printing process was carried out printing paste in which added colemanite, pumice and amorphous silica and dyes. The fixation of paste was performed using sol-gel method instead of binder and fixerer and a new printing process was obtained.

Key Words: Pigment Printing, Sol Gel, Pumice, Amorphous Silica, Colemanite

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BIOLOGICAL APPLICATIONS OF ELECTROSPUN POLYURETHANE NANOFIBERS

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In this paper, chemical and performance properties of polyurethane was discussed accompanied with the polymerization process. Mostly emphasizing the polyurethane nanofibers, different types of polyurethanes were mentioned. Electrospinning process was explained with its parameters in order to produce polyurethane nanofibers and applications of polyurethane nanofibers were revelaed in detail mostly in biological field but also in the other fields like filtration, shape memory, electrical property etc.

INTRODUCTION

Polyurethanes are the synthetic, resourceful and biodegradable polymers, which were first discovered in 1937 by Otto Bayer and coworkers in Germany. Since having heterogeneous structure, polyurethanes can be divided into two groups as thermoplastic and thermoset polyurethanes. Thermoplastic polyurethanes are flexible and recycable materials that makes them preferred to be used in sports equipments whereas thermoset polyurethanes are neither very flexible due to the crosslinking in their structure nor recycable. In addition, conventional thermoplastic polyurethanes are referred as biomaterials which not degrade easily except oxidative or hydrolytic environment. Using polyurethane in the form of nanofiber come with a lot of advantages because nanofibers have many benefial properties in a wide range of applications [1-4].

This paper presents general information about polyurethane electrospun nanofiber applications and focuses mainly on biological usages. By the help of this overview, comparison of polyurethane nanofiber applications between each other could be made available. Moreover, dealing with studies made on biological applications about polyurethane nanofibers, a new perspective on the usage of polyurethane in biological field could be gained and finally, this paper could be a guideline for future works on polyurethane electrospun nanofibers.

EXPERIMENTAL

In this paper, the produced nanofibers produced by electrospinning process were summarized. Examples for used solution concentrations are 3, 5, 6, 7, 10, 12, 14, 20, 32 wt % ; solvents used for dissolving are polyurethane N,N Dimethyl formamide (DMF), Methylethylletone2butanona (MEK) , Dimethylsulfoxide (DMSO), Tetrahydrofuran (THF), Hexafloroisopropanol, 1,1,1,3,3,3-hexafluoro-2-propanol; voltages are 10, 12, 15, 18, 20, 24, 25, 26 kV; feed rates are 0.1, 0.3, 0.5, 0.8, 1.2, 1.80 kV, and finally distances from tip to needle are 5, 12, 13, 14, 15, 18, 20 cm.

APPLICATIONS

Polyurethane / collagen nanofibers were produced for tissue enginnering applications. It was seen that, the dimater, pore size and porosity of the obtained nanofibers were in the optimum range for representing tissue scaffolds [5]. Fibers were produced based on polyurethane composite for the cardiovascular system. By using natural polymers or physical or chemical modification of polyurethane chains boost this biodegradability and biocompatibility [6]. Graphene oxide was selected to make nanocomposite with polyurethane in order to come down with the low hydrophilicty, low stiffness and low tensile strength of the polyurethane. When graphene oxide sheets were incorporated in to the polyurethane nanofibers, coating layers with enhanced stability were achieved [7].

CONCLUSION

Electrospun polyurethane nanofibers were studied by many researchers for different applications like tissue engineering, wound dressing, bone implants, filtration, flexibility, shape memory, electrical conductivity etc. In this researches, pure polyurethane nanofibers were used or polyurethane was copolymerized or blended with other synthetic or natural polymers. All the researches supported that polyurethane nanofibers are good canditates to be applied in a wide range of applications.

Key Words: Polyurethane, nanofiber, electrospinning, tissue engineering, wound dressing

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EFFECT OF DIFFERENT STACKING SEQUENCES OF FABRIC PLIES ON THE THERMO-MECHANICAL PROPERTIES OF HYBRID COMPOSITES

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During the last two decades, fibre reinforced composites gained more importance owing to their excellent weight-saving and load-bearing capacites [1]. Natural fibers are mostly preferred reinforcement materials owing to their properties such as sufficient mechanical strength, low cost and lightweight [2-7]. However, instead of using natural fibers alone as reinforcement material, hybridizing these materials with higher strength fibers results in a good balance of mechanical property and cost for composite materials [8, 9].

In this study, three hybrid composites (GGJJJJGG, GJGJGJGJ, JJGGGGJJ) are produced with different stacking sequences of fabric plies to examine the effect of stacking sequence on the thermo-mechanical properties. Eight-plied fabric reinforced samples are manufactured by vacuum infusion process. While jute and E-glass fabrics are used as reinforcement material, polyester resin is preferred as matrix material. In sample codes G refers to E-glass fabric and J refers to jute fabric ply.

Thermo-mechanical properties of hybrid samples are investigated by dynamic mechnanical analysis (DMA), thermogravimetric analysis (TGA) and differential scanning calorimetry (DSC) test methods. DMA results show that samples which have two plies of E-glass fabric at the outer layers have higher storage and loss modulus values which indicates the elastic and viscous behaviours of material, respectively (Figure 1).

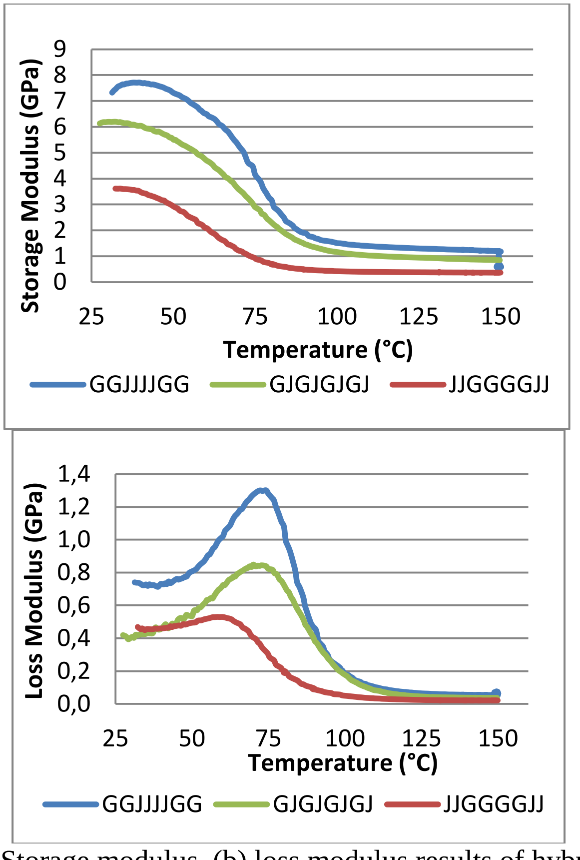

Figure 1. (a) Storage modulus, (b) loss modulus results of hybrid composite samples

When the TGA results of hybrid samples are studied, it is seen that samples onset temperatures of degradation are so close to each other (around 305°C). This shows that degradation temperature is not related to stacking sequences of fabric plies. However, it is observed that between 25°C to 600°C, the weight loss percentage of GGJJJJGG sample (81%) is higher than JJGGGGJJ (70%) and GJGJGJGJ (73%) samples. DSC analysis presents that all samples show endothermic reactions at the first cycle of heating but when the second cycle examined, it is observed that jute samples do not demonstrate any endothermic or exothermic reaction. This endothermic reaction can be due to the impurities that are located within the jute fiber.

Key Words: Composites, dynamic mechanical analysis, differential scanning calorimetry, thermogravimetric analysis

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THE PROPERTIES AND EVALUATION FACTORS OF ALPACA FIBERS

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Alpaca is a keratin fiber and is classified under luxurious fibers. To the touch, alpaca is soft and silky, with a rich handle and sensual drape. The alpaca fiber is hollow, which proves greater insulation and a wider comfort range with less weight. Compared to wool and cashmere, an alpaca garment is lighter, more breathable and far warmer (5). It is seven times warmer than wool thanks to microscopic pockets within the fibers that trap air (1). Precipitation does not readily penetrate an alpaca garment, allowing the wearer to remain warm and dry. This property also aids in wicking moisture away from the skin for better comfort and warmth. Alpaca fibres long is up to 150 mm. Fiber finesse is between 15 micron and 37 micron (8). Alpaca fibers comes in an extraordinary variety of 22 natural colours, contains no lanolin and requires no chemical scouring agents for processing. This, combined with its natural hypo-allergenic properties and softness, makes alpaca garments comfortable, even for sensitive skin (4). Those who wear alpaca garments choose them because of their thermal qualities and resistant features of the fiber, as well as some other attributes such as their impermeability and anti-inflammability (2). Alpaca's principal end-uses are in knitwear and lightweight suits.

In this study, alpaca fiber properties and the factors that are affacting to the alpaca fibers evaluation were examined. The evaluating factors were sorted as; staple length, fineness, external material rate, prickel factor, medulla grate, curve characteristics, fiber curvature, scale height, pressure resistance to force. The staple length defines the actual length of the fiber within a given time period. The weight of the Alpaca also affects the staple length and density values. Fineness is a very important factor in defining good quality fibers on the animal. Thin fibers are brighter, softer and more expensive. Fineness is measured in microns.