



# BOOK OF ABSTRACTS

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## 1<sup>ST</sup> INTERNATIONAL CONFERENCE EMERGING TRENDS IN KNITTING

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# National Textile University Faisalabad Pakistan

Faisalabad (فیصل آباد) is the third-most-populous city in Pakistan, and the second-largest in the eastern province of Punjab. Historically one of the first planned cities within British India, it has long since developed into a cosmopolitan metropolis. Faisalabad has grown to become a major industrial and distribution center because of its central location in the region and connecting roads, rails, and air transportation. It has been referred to as the "Manchester of Pakistan". The reason Faisalabad is called Manchester of Pakistan because it's the biggest textile city of Pakistan and all the industries here related to textiles and same is Manchester in UK so these cities are also named as Twin cities. Faisalabad is home to the National Textile University as well as the Ayub Agricultural Research Institute, and University of Agriculture.

National Textile University (NTU) is the premier institution of textile education in Pakistan. The campus is spread over an area of 62 acres. The National Textile University is affiliated with National Computing Education Accreditation Council (NCEAC), Pakistan Engineering Council (PEC) and Higher Education Commission of Pakistan (HEC). It has total seventeen departments that offer professional degrees including Textile Engineering, Polymer Engineering and Software Engineering. National Textile University aspires to have a transformative impact on the socio-economic development of the country in general and textile & clothing industry in particular, with outstanding education, research, and eco-friendly innovation. The mission of National Textile University is to contribute towards sustainable socio-economic development of society and welfare of humanity through pursuit of excellence in education, research and innovation in areas of National importance, with special emphasis on textile and clothing.

“He it is Who created for you all that is in the earth; then He turned towards the heavens, and He perfected them as seven heavens; and He knows all things.” Quran-Al-Baqarah [2:30]

## **Disclaimer**

The statements and the opinions published in this abstract book are solely those of the individual abstract authors and not of the Emerging trends in knitting (ETK) authority. The abstracts have been printed as submitted. For the consistency of this publication only a standard language spelling check was made on all abstracts; it is the decision of the ETK not to edit the abstracts in order not to change any contexts.



Sikander Abbas Basra

Conference Secretary ETK-2018

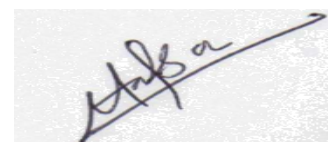
## Foreword

Textile Industry is backbone of Pakistan's economy and to strengthen the backbone it is necessary to develop a strong bond among academic personnel, industrialist, and policy makers. Conventional textile is transforming fast into technical textiles. The advancements in textile engineering are expanding due to technological advancements and innovations in raw materials. An international conference on the Emerging Trends in Knitting is being organized to discuss and share cutting edge techniques and state of the art technology in textile knitting and its associated processes. This conference will help to exchange research ideas and their impact through oral and poster presentations and question answers.

Objectives of the conference are to enhance interaction between researchers and professionals working in the field of knitting. This event will also pave ways to collaborate with international researches and scientists. Giving ample opportunities to bring innovative and creative ideas and to promote their viable ideas for commercialization is the foremost objective of this august gathering. For this purpose, a competition of innovative products from industry and academia is also being arranged.

We are thankful to all researchers and speakers from Pakistan and all around the world for their interest in presenting their research work and concern in publishing their research contributions through ETK platform. We believe that their contribution would entail a milestone in the textiles.

At the same time, we express our gratitude to all the members of the Event Organizing Committee from National Textile University for their support in arranging and organizing this event. We are grateful to the members of Technical and Steering Committee for their valuable and endeavor in the publication process of the ETK proceedings. But most of all, we truly indebted to sponsors for realizing the importance of the conference and financial support for this case. We hope the conference immense benefit for researchers, professionals, and other involved in the worldwide innovation in Knitting.



Dr. Hafsa Jamshed

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# Conference Objectives

Textile Industry is backbone of Pakistan's economy and to strengthen the backbone it is necessary to develop a strong bond among academia personnel, industrialist, and policy makers. Objectives of conference is to enhance interaction between researchers and professionals working in the field of Knitting. Many CEOs, machine manufacturers, government personages, industrialists and technical experts are attending this conference. Some international dignitaries are also joining .

Participants of this conference will get a podium to listen, share and invigorate applied research and recent advancement in Knitting. Knit to Achieve, a competition of innovative products from industry and academia is also part of the event.

## **TOPIC COVERED**

- Yarns
- Knitted Structures & Design
- Knitted Fabric Dyeing
- Knitted Fabric Finishing
- Garments
- Hosiery Products
- Computer Applications In Textiles
- Geotech
- Agrotech
- Smart & Interactive Textiles
- Protective Products
- Mobitech
- Sporttech
- Composites
- Simulation & Modelling
- Industrial Management
- Textile Management
- Machine Designing
- Environmental Textiles
- Sustainable Products
- Embroidery
- Recycling

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20. Development of Special Knitted Fabric Through Modification of Hand Flat Knitting Machine

# Oral Presentations Section

## **A Review of Advances in Warp Knitting**

Mumtaz Hasan Malik <sup>\*1</sup>

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### **Abstract**

Knitting is the second most frequently used technology for fabric formation after weaving. It is the technique of interlooping of one or more yarns. When loop formation takes place in horizontal direction by the use of one or more yarns, the technique is classified as weft knitting and when it occurs in vertical direction using a set of yarns, it is categorized as warp knitting. Although, both weft- and warp knitted fabrics have some merits and demerits, however stronger and dimensionally stable 2D and 3D structures can be constructed on warp knitting machines, which find applications in many types of technical textiles. This paper focuses on the recent developments in warp knitting, which enable this century's old technology with certain modifications for use in highly sensitive areas like health and human safety.

**Keywords:** Warp knitting, 2D structures, 3D structures, Human safety, Health monitoring

## **High-strength Nano-fibers for Lithium Ion Batteries**

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### **Abstract**

Lithium ion batteries have received great attention due to their high energy density, high operational voltage, long cycle life, and low self-discharge rate. In order to use lithium ion batteries in large-scale power sources, new battery components are needed to improve safety and performance of the batteries. In lithium ion batteries, separator is placed between two electrodes to prevent physical contact and allow ionic transport. Microporous membranes are commonly used in commercial lithium ion batteries however, their low wettability and thermal stability limits battery performance and cause safety concerns. In this study, thermally-stable nanofiber based separators with high mechanical strength have been produced and used in lithium ion batteries. Physical characterization results demonstrated that nanofiber based separators have high thermal stability (above 150 °C ) with the mechanical strength of above 20 MPa. In addition, better electrochemical performance was observed owing to high porosity and good electrolyte affinity of these separators.

**Keywords:** Lithium ion batteries, Nano fibers, Micro-porous membrane

## **Prevailing Trends in Knitted Fabric Dyeing Machines**

Muhammad Mushtaq Mangat\*<sup>1</sup>

<sup>1</sup> CEO, Moderno Fabrics Lahore-Pakistan

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### **Abstract**

There is a rapid change during the last decade in the technology of knitted fabric dyeing machines, mainly in the design and in automation. Latest technology addressed long time issues. For example, shade variation when different fabrics are dyed together e.g. fleece and rib , a huge amount of water was used in the dyeing process. It was due to high liquor to goods ratio (L: R) and conventional technology of continuous rinsing. Moreover, people were facing a serious issue of creases, dyeing of light weight fabric and fabric having spandex yarn, limitation of batch size. This article is to elaborate with the latest development in knitted fabric dyeing machines technology. The objective is to introduce the industry the latest technology and new ideas so that Pakistan Textile Industry may compete in the international market. With obsolete technology and abandoned machinery, remarkable share in international trade is not possible.

**Keywords:** Knitted fabric, Prevailing trends in knitting, Pakistan textile industry , Knitted fabric dyeing



## **Possibilities of Tubular Knitting in Design Developments for Pakistani Knitting Industry**

Mr. Allah dad <sup>\*1</sup>

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### **Abstract**

Textile industry has prominent position in economic structure of Pakistan. Textile industry is capable of making yarn to garment products. In Pakistan Fabric manufacturing sector is mainly divided into two main categories one is weaving and second is knitting goods. During September, 2016 the 9 selected commodities of Textile Manufactures contributed 59.55% of total exports in which the share of knitwear bed-wear, cotton fabrics, articles of apparel & clothing accessories (excl. knitwear), cotton yarn, and towels were 11.95%, 11.27%, 10.96%, 10.56% and 5.71% respectively. These value indicate that knitwear industry in flourishing day by day and putting its major role in export performance. Major type of knitted goods accounted as t-shirts, socks, and other apparel goods. For such industry which accounted important role in economy of country, needs more improvement and attention in terms of product development and also needed to be producing more fashion and design goods. Weft knitting technique is dominant in Pakistani textile industry over warp knitting technique, various small to large companies are operating in this sector. But mostly focused on export orders, very less companies are developing their own product and attracting European, American and other customers in the world. In the technique of weft knitting by using hand flatbed machine which is easy to operate and has ability to develop fabrics from 2 to 14 gauge fabrics with also many ease possibilities in product development. Various small to medium size factories of Pakistan can produce such products by consuming less cost in terms of technology investment. One of technique that can be used is tubular knit fabric on hand flatbed machine. Through developing tubular knit fabrics and by adding or stuffing digital print designs in it can give aesthetically good product which gives cost effectiveness as well. This paper will explain various possibilities of tubular knit fabric in Design development which will be suitable for coarser to finer fabric of various end uses such as tops, lowers. Knitted jackets etc. So by producing such value added products, Pakistani Textile Industry related to knitted goods can increase its overall competitiveness in terms of design developments.

**Keywords:** Tubular knitting, Knitting in Pakistan, Weft knitting , Warp knitting,, Pakistani industry 17

## **Synthesis of Silver Nanoparticles With Different Plant Extracts and Antibacterial Property of Undergarment Fabrics**

Samiyah Tasleem\*<sup>1</sup>

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### **Abstract**

Pakistan recorded one of the most astounding temperatures on the planet – 53.5 °C(128.3 °F) – on 26 May 2010, the most sweltering temperature at any point recorded in Pakistan, yet in addition the most blazing dependably estimated temperature at any point recorded on the mainland of Asia.

Three thousand seven hundred and ninety-seven skin cases were considered in Dermatology outpatient one tertiary medical care Center, Karachi more than one year. The rate of different ailments is contrasted and those from Bangkok, Shiraz, London, and Ibadan. Scabies, dermatitis, pyogenic and parasite diseases were the most widely recognized issues experienced.

Skin diseases are because of an abundance of organism on the skin. Minute estimated living beings called live regularly on everybody's skin without causing issues. On a few occasions, they become crazy and cause infectious diseases of the skin, hair, and nails. They are particularly among youngsters and adolescents yet can influence individuals of any age. We need an antimicrobial undergarment fabric to solve these problems. The object of study is to develop undergarment fabric that controls skin problems. First we synthesis of silver nanoparticles with different plant extracts, characterized the material via the standard protocol and determine the antibacterial property of undergarment fabrics treated with silver nanoparticles plant extracts mixture by Kirby Bauer Disk Diffusion Method. We obtain significant activity again different skin infection causing microorganisms.

**Keywords:** Nano particles, Silver Nano-particles, Undergarments, Skin diseases, Dermatology.

## **Current Snares and Imminent Sustainability Issues for Knitted Apparels**

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### **Abstract**

Majority of Pakistan's knitwear industry is producing the articles for lower to medium price ranges. The key reason for not hitting the higher value ceiling is shortage of skilled manpower in the field of design and development of knitted fabrics. The existing capabilities of product developments or fabrics produced in land are not to the level of quality that is obligatory for high-end products. This scenario is prone to be worsened due to the new requirement emerging from consumers in respect of environmental impact of apparel products. There is new drive in the world that fast fashion is putting negative impact on the environmental health of the globe and excessive product are being produced comparing to the number of consumers in the market. Environmentalist are pushing the concerns to put-up new laws to fight these impacts. These laws will bring more stringent requirements for the apparel production and focus will inevitably be shifted to high value-added products. This paper encompasses a snapshot of few of the current hindering factors and forthcoming requirement, those will impact adversely to the export of knitted product from Pakistan.

**Keywords:** Knitted Apparel, Pakistani industry, Knitting fashion, Value –added knitting product.

## **Thermal Absorptivity Model of Knitted Rib Fabric its Experimental and Theoretical Verification**

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### **Abstract**

Thermal absorptivity is an indicator of warm and cool feeling of textile materials. An equation based on thermal absorptivity of polyester in solid form, porosity of a fabric, and relative contact area of human skin and fabric surface has been developed to characterize thermal absorptivity of fabric. For verification of suggested model, 15 knitted rib fabrics were produced using 100% polyester yarn and having different surface profile. ALAMBETA semiautomatic non-destructive instrument has been used for measuring the effective thermal absorptivity of knitted rib fabric. It was found, that that the suggested simple theoretical model exhibits significant agreement with the measured thermal absorptivity values of knitted rib fabric, which endorsed the approach applied. Warm-cool feeling is one of the parameters, which play a vital role in thermo- physiological comfort. It is also known as thermal absorptivity. Thermal absorptivity is measured with the help of an instrument. Thermal absorptivity has a strong correlation with fabric structure and type of fibers. Surface profile determines the contact area between human skin and fabric. Many studies have proved that contact area between fabric and human skin controls the warm-cool feeling during initial touch. Keeping its importance in view, a physical model has been developed for the prediction of thermal absorptivity of any fabric. The suggested model has been used to predict thermal absorptivity values of 15 different knitted ribs produced using 100% polyester. For development of knitted rib fabric, double-knit rib knitting machine has been used. Samples were kept under standard conditions and were tested using Alambeta. Thermal absorptivity was measured and compared with predictive values of knitted rib using models. It was observed that significant correlations exist between thermal absorptivity observed and calculated, which show that suggested models could be used for prediction of thermal absorptivity of any material having distinct surface.

**Keywords:** Knitted Fabric, Rib knitted structure, Thermal absorptivity model, ALAMBETA

## **Improvements on Handling of Water Resources in the Textile Industry and Possible Role of Compliance for International Buyer**

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### **Abstract**

The water sector in Pakistan is going to be hit hard by the climate change. Thereby the textile industry is the largest industrial consumers of water and also polluter in Pakistan. Besides the consumption of water, the resulting volume of wastewater and pollution loads poses a problem. High amounts of untreated water are disposed in land and water bodies and are infiltrating the groundwater bodies. It has a high concentration of dyes, chemicals, and textile auxiliaries. Yet the textile industry is extremely important for the country's economy. The competitiveness of Pakistani textile products in the international market depends on efficient production and unit cost and therefore on resource efficiency but also on compliance. Many exporting companies therefore are eager to engage also in improving compliance with environmental standards. And likewise, the GSP+ (Generalized Scheme of Preference) status to Pakistan sets external conditions for improving on compliances topics.

In future suitable strategies and technical approaches for water-efficiency measures and reducing pollution loads to river systems and channels (e.g. by combined treatment plants, minimizing input of persistent substances, etc.) has to be elaborated for and with the textile industry. The WETI project is working on corresponding policies and stakeholder involvement, technical trainings, dissemination of efficiency-enhancing and pollution reducing technologies and standards and management systems in industry.

**Keywords:** Water source, Compliance, Textile water treatment, Pakistani export, Pakistani textile industry

## **Development of a Puncture Resistant Glove**

Muhammad Dawood Husain<sup>1</sup>, Bilal Zahid\*<sup>1</sup>, Fahad Mahboob<sup>2</sup>

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### **Abstract**

In this paper development of seam-less, knitted, non-coated puncture resistance liner has been discussed. Puncture Resistant Glove Liners comes under the category of Personal Protective Equipment (PPE) and could be used in various applications. The liner has been developed by the use of high performance fibers having high modulus and tensile strength, in order to achieve the level 4 of Standard EN388 2003. The motive of developed glove is to acquire protection against puncture or pointed sharp objects having diameter of more than 1mm. Along with technical fibres, conventional fibres were also embedded in the knitted structure to improve its comfort and flexibility. The results have demonstrated that the developed glove liner is capable of resisting puncture force up to 150 N i.e. level 4 of standard EN388 2003. This paper explains the details of whole development process (material selection, plying, knitting and testing) of glove making.

**Keywords:** Knitting, Glove, puncture resistance, Seam less,

## Spun Yarn Quality Requirements for Knitting Industry

Zulfiqar Ali Malik<sup>1</sup>, Amir Shahzad<sup>1</sup>, Ali Afzal<sup>1</sup>, Zubair Khaliq<sup>1</sup>, Muhammad Bilal Qadir<sup>\*1</sup>

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### Abstract

Yarns are the raw material for woven and knitting industry. These all yarns may be classified in spun yarns and filaments. Normally, there is no problem regarding the variation in the quality of filaments. However, variation in the quality of spun yarns is a vital problem. This variation in yarns could be due to the raw material, poor yarn formation process and negligence of workers in spinning mills. In knitting industry, lack of knowledge regarding the quality of yarns is another issue which increases the severity of this problem. Furthermore, there are no adequate facilities to investigate the yarn quality standard in the knitting industry. So it is need of the day to provide awareness regarding yarn quality and its investigation in order to reduce the rejection and improve the yield of knitting industry.

**Keywords:** Spun yarn, Knitting, yarn problems, quality

## **Removal of Acid Red from Aquous Media Using Activated Carbon from Acrylic Waste**

M. Salman Naeem\*<sup>1</sup>, Zafar Javed<sup>1</sup>, Abher Rasheed<sup>1</sup>, Babar Ramzan<sup>1</sup>, Zuhaib Ahmed<sup>1</sup>, Hafiz Affan Abid<sup>1</sup>

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### **Abstract**

Acrylic waste was converted into activated carbon by using physical activation at different temperatures in high temperature furnace. The carbonization was performed at different carbonization temperatures (800, 1000 and 1200 °C) with a heating rate of 300 °C. The activated carbon prepared at 1200 °C with heating rate 300 °C gives better results in terms of porosity and surface area and was used for checking adsorption performance of acid red 27 by varying different parameters like stirring speed, different concentration of dyes, adsorbent dosage and PH. The results were evaluated using non-linear forms of Langmuir and Freundlich isotherms. The Freundlich isotherm was found to describe the results more effectively because of non-homogenous surface of activated carbon web.

**Keywords:** Physical activation, Stabilization, Carbonization, Heating rate, Holding time



## **Investigation of Functional Properties of Different Blends of Bamboo/Acrylic Knitted Fabrics**

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### **Abstract**

Textile blends are produced to exploit the combined properties of different materials in the blends, although there are many textile apparels that give good mechanical and comfort properties. But due to increasing living standards, people are more concerned about comfort and protective fabrics. Also the product should be cost effective in order to meet the requirement of customers. In this research, two different fibers of Bamboo and Acrylic were used in blend. Three different blend ratio of Bamboo and Acrylic (70/30 %, 50/50 %, 30/70 %) were used to make ring spun yarn. Single knitted structures were produced. Aim of the present study is to reduce price and improve comfort properties of fabric. This study involves the comprehensive analysis of comfort properties of fabric like air permeability, moisture management and thermal resistance and antimicrobial properties.

**Keywords:** Bamboo, Knitted fabric, Acrylic, Textile blends, Antimicrobial, Moisture management, Thermal resistance.

## **Role, Essentials and Applied Medical Requirements of a Knitted Fabric as Compression Garments**

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### **Abstract**

Knitted structures are a favorable choice for compression therapy due to stretch and recovery properties when compared with the woven. Main areas of compression garments are to treat varicose vein and burn wounds. When dealing with the complex nature of burn wounds; compression garments play a vital role during the rehabilitation process. Hypertrophic scar inhibition is key for successful burn management as it can improve the aesthetic issues and build confidence in burn victims. The purpose of the present talk is to provide in-depth requirements and essential considerations with practical problems and issues required to be addressed when an innovative compression garment is to be fabricated. Special consideration for burn wounds regarding anatomy and healing mechanisms is described that could prove to be a focal point for textile researchers to develop the compression garments to the critical performance and commercialization mark.

**Keywords:** Knitted, Compression garments, Burn wounds, Hypertrophic scar

## **A Mobile Based Solution for Automation of Knitting Calculations**

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### **Abstract**

One of the main manufacturing industry in Pakistan is a textile industry. In Asia, Pakistan is the 8th prime exporter of textile supplies. With the advancement of science and technology, we have to introduce new applications in textile industry. It is the need of time to connect our textile industry with modern technology. Calculations of different things on different parameters are the basic step which plays a vital role in the textile industry. Knitting is a technique with the help of which yarn is operated to create a textile or fabric for use in numerous types of garments. Knitting Calculation's or service of performing different calculations of knitting with different parameters is the topmost problem of knitters. Furthermore, the creation of textile knitted fabric demands many calculations to be performed before fabric production or during production. During production or research work they have to face different problems in calculating yarn requirements, main calculation, Fabric Parameter and many other calculations.

Our work on Knitting calculations is based on the brief formulas of knitting with different variables and constants which covers all the solutions to the problems faced by the knitters. Our work provides the complete solution of all problems of knitters related to the calculations with mobility and data storage capacity. Our android application of knitting calculations provides the flexibility to the user that they can calculate different calculations at any time anywhere, while our desktop application provides the complete automate solution of most problems of knitters.

**Keywords:** Mobile software, Knitting calculation, Pakistani knitting industry, Knitted fabric, android application.

## **Environment Friendly Reactive Dyeing of Cotton Knitted Fabric by Exhaust Dye Bath Re-use**

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### **Abstract**

A novel approach of reuse of reactive dye residual dyebaths on modified cotton knitted fabric was examined. Cotton was chemically modified with a novel crosslinker to make it dyeable at acidic pH without the use of salt. Reactive dyes were saved from hydrolysis by dyeing at acidic pH on modified cotton knitted fabric. Thus, the residual dyebath contained reactive dyes capable of reacting with the cellulose substrate. Residual dyebaths were reconstituted to the required concentration of dyes and utilized for dyeing of modified cotton knitted fabric. The reutilization of reactive dyes in this way is repeated three times. Another unmodified cotton sample was dyed through conventional exhaust dyeing procedure and its residual dyebath was also re-utilized after re-makeup to initial dye concentration. The residual dyebath of conventional reactive dyeing was further reused after reconstitution three more times. The depth of shade after each dyeing was evaluated with the help of UV-Vis spectrophotometer and quality of dyeing was assessed by color fastness tests. The results revealed that reactive dyeing with acidic pH on modified cotton can be done and its residual dyebaths can be utilized repeatedly to get the same shade and quality of dyeing. Thus expensive dyestuffs, chemicals and water can be saved through this approach and effluent load of reactive dyeing will also be minimized.

**Keywords:** Knitted fabric, Cotton, Reactive dye, Exhaust dye bath, spectrophotometer,

## **Development of Mannequin by Recycling Paper Technique**

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### **Abstract**

The present study pertains to the process of development of mannequin by recycling of waste newspapers. Newspapers have one day life after the date it's discarded. With the varying lifestyles of human, the main issue of planet earth is the minimization of natural resources as human used these resources without thinking about future. If these resources vanished, human life cycle will not survive on man-made capitals. Sustainable and eco-friendly design and practices are the need of time. If it is possible to reduce extra production convince and convert people behaviour to adopt recycled products can really help to prevent the decline of natural assets. In this study recycling of paper will be carried out by the paper mache strip method technique using old newspapers which are ranked as lower grade and reused to make more newsprint, tissue and other products In Paper maché several thin coatings of paper and hardener are applied to the surface of an armature. The proper name for this technique papier-mâché ("chewed paper") was given by French.

**Keywords:** Mannequin, Recycling, Waste treatment, News paper recycling, Waste material  
Mannequin

## **Comparison of Mechanical and Comfort Properties of Dye-able Polypropylene and Cotton Blended and Conventional Polyester Cotton Blended Knitted Fabrics**

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### **Abstract**

In this work, dyeable polypropylene (DPP) fibres are used as an alternative to unsustainable polyester (PET) fibres. PET is generally used worldwide (57 %) in textiles that is increasing gradually, thus, increasing landfills. PP has proved to be more sustainable and eco-friendly than PET. So, different blends of DPP and cotton (DPPC) were prepared and compared with polyester cotton (PC) blend. 100 % DPP, DPPC (75:25), DPPC (52:48), DPPC (25:75) and PC (52:48) blends were prepared. The mechanical properties (bursting strength, bending length) and comfort properties (air permeability, moisture management properties and thermal resistance) of knitted fabrics were studied. DPPC (25:75) gives relatively lower mechanical properties than PC (52:48) however these are enough for clothing. Regarding, comfort properties, air permeability and moisture management properties are found similar to PC (52:48) knitted fabrics although DPP fibres in DPPC (25:75) were used one half of PET fibres. Similarly, DPPC (25:75) exhibits lower thermal resistance than the PC (52:48) knitted fabric, which is favourable for summer clothing. It is found that DPPC (25:75) blended knitted fabrics which are more eco-friendly and more sustainable can be used in summer clothing as a replacement to PC (52:48) knitted fabrics.

**Keywords:** Polypropylene, and cotton blend, Knitted fabric, Polyester cotton blend, knitted mechanical properties, knitted fabric comfort properties.

## The Potential of Knitting in Polymer Matrix Composites

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### Abstract

This paper highlights the potential of knitting in polymer matrix composites and investigates flexural and interlaminar shear characteristics of glass/carbon hybrid composites made of unidirectional warp knit preforms. Non-crimp unidirectional intra-layer hybrid preforms used in this research have been manufactured using warp knitting technique on tricot machine (tows were bound together at an angle of  $\pm 60^\circ$  using hot melt yarn of linear density 52.5 tex and an areal density of 7.2 g/m<sup>2</sup> as knitting yarn). Investigation primarily focused on the influence of hybrid ratio, laminate geometry, and degree of dispersion on flexural and interlaminar shear characteristics. Damage mechanism has been explained and SEM observations were carried out for morphology analysis. Hybridization resulted in some interesting consequences. Optimum stiffness and toughness were achieved when the proportion of carbon fiber and glass fiber were substantial, respectively. The brittle and catastrophic failure of plain carbon composite has been avoided through intra-tow hybridization with highest dispersion. Therefore, it is proposed to selectively incorporate the glass and carbon fibers through intra-layer hybridization technique. It is also proposed to mix the fibers as intimately as possible. Vacuum assisted resin infusion process is also recommended to attain high quality of impregnation.

**Keywords:** warp knitting, hybridization, hybrid ratio, dispersion, vacuum assisted resin infusion, scanning electron microscopy.

# **Energy Absorption of Auxetic Warp-knitted Spacer Fabrics Under Quasi-static Tension**

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## **Abstract**

In order to discover the affecting relationships between auxetic property and energy absorption of warp-knitted spacer fabrics under uniaxial tension, warp tensile as well as weft tensile is exerted respectively to fabrics with four different knitting structures reconstructed from rotating hexagonal models, and stress-strain curves are obtained and processed so as to evaluate their auxetic properties and energy absorption. Results show that energy absorption of fabrics is determined by both structural deformation capacity and yarn loading capacity in which the latter plays a dominant part while the former has little influence. The effects of auxetic properties on energy absorption are included in the structural deformation capacity. Higher energy absorption comes with better auxetic performance under uniaxial tension with the same yarn loading capacity.

**Keywords:** Auxetic, warp-knitted spacer fabric, energy absorption, tensile property



# **Poster Presentations Section**

## **Investigation of Performance Properties of Basalt Knitted Fabric**

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### **Abstract**

The present research is related to investigation of mechanical and functional properties of unconventional knitted structures. The aim of this study is to analyze the properties of unconventional knitted fabric for using them in technical applications i.e. protective applications. The structures selected for investigation were single jersey and 1x1 rib. The mechanical properties like shear and bursting strength were studied. All the functional properties like thermal properties of the fabrics i.e. resistance & conductivity were studied vis-a-vis physiological behavior, electrical and acoustic properties were also studied. On the basis of the results, the influence of the fabric structure on various property parameters were analyzed. The results indicate that effect of fiber and knitted fabric structure on mechanical and functional properties are significant. It can be concluded that rib fabrics have overall better properties as compared to single jersey knitted fabrics.

**Keywords:** Knitted fabric, Basalt, Shear strength, Thermal conductivity, Functional Properties

## Study the Pilling in Spun Polyester Sock

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### Abstract

Pilling is an unwanted effect on fabric surface caused by the protruding fibers of the yarn from which fabric is formed. Due to the fiber migration from the inside the yarn toward the surface of yarn and twisted together to form small bowls named as pill. Fabric pilling is affected by many interacting factors. Normally spun polyester has more tendency to formulate pills on the surface than cotton and other low strength fibers. Due to high strength the wear off strong polyester anchor fiber does not occur which cause to appear pills on the surface of the fabric. Influence of yarn count, twist, fabric construction, machine and post treatment have already been addressed by many other researchers. This study focuses on effect of fiber deniers on pilling in sock. Three different fiber deniers 0.8, 1.2 and 1.4 and two types of yarns, single and plied yarn are used. All the fiber denier used of 38mm length and TM of 3.8. It is found that best result is given by the microfibers having fiber denier 0.8. It is due to low strength of microfibers. Low strength of microfibers causes to wear off the anchor fibers easily. Hence the pills wear off easily and don't accumulated on the surface. This trend is found reversing when yarns having fiber denier above one is considered. This behavior is apparently found because in high fiber denier yarns less number of fibers are available which result less protruding. Overall trend obtained suggest that there is a remarkable influence of fiber denier which effects pilling. Fiber denier value can be mannered to minimize pilling in knit fabrics.

**Keywords:** Pilling, fiber migration, microfibers, wear off

## **Effect of Hydrophilic and Hydrophobic Alternate Yarns on the Moisture Management Properties of Knitted Fabric**

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### **Abstract**

The purpose of this research is to produce a plain 1x1 jersey knitted sports fabric with one hydrophilic yarn and one hydrophobic yarn in the alternate positions in order to give better moisture transfer and hence better moisture management properties. Six different types of polyester were taken as hydrophobic yarns as spun polyester, macro filament polyester, microfilament polyester, channeled polyester, and cationic polyester along with one 100% cotton treated yarn with water repellent finish. All these hydrophobic yarns were knitted in combination with 100% comb cotton. It was observed that addition of hydrophobic component strongly improved the moisture management properties of resulting fabrics and these fabrics could be used for summer wear and sportswear as well.

**Keywords:** Plain jersey, Hydrophobic, Hydrophilic, Cotton, yarn, Moisture management

## **Preparation of Cotton/ Acrylic/ Thermolite Tri-blend Yarn for Thermal Comfort of Knitted Fabrics**

Muhammad Bilal Qadir<sup>1</sup>, Zulfiqar Ali Malik<sup>1</sup>, Ahsan Nazir<sup>2</sup>, Ali Afzal<sup>1</sup>, Zubair Khaliq<sup>1</sup>, Amir Shahzad\*<sup>1</sup>

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### **Abstract**

Comfort has a diversity of meanings as it relates to the wearer. Comfort is the tangible feelings that consequence from the fabrics in contact with the skin. The purpose of this study was to produce a tri-blend yarn of cotton, acrylic, and Thermolite (C/A/Th) for thermal comfort of knitted fabric for winter wear. Tensile and tear strength, air-permeability, moisture management and thermal resistivity characteristics were investigated by using standard testing methods. It is proven that the fibers percentage in the blend ratio of yarn is a primary factor. Overall C/A/Th 50/10/40 showed best tensile and tear strength as well as air permeability, moisture management, and thermal resistivity. By increasing the ratio of Thermolite, the tenacity is increased which shows that the Thermolite being a polyester based fiber has a good strength. The characterization of knitted fabric revealed that the fabrics made from 50/50 C/Th showed highest tensile strength both in the wales and course direction while C/A showed lowest tensile strength in wales and course direction. Similarly, highest tear strength was also experienced by the fabric sample made of 50/50 C/Th. On the other hand, lowest tear strength was observed in C/A 50/50 blend. Moreover, the air-permeability values were highest for 50/50 C/Th while lowest for C/A/Th of 50/30/20 fabric. In case of moisture management, the highest MMT value was obtained for 50/50 C/Th while lowest for C/A/Th of 50/20/30 blend. Thermal resistivity was observed highest for C/Th 50/50 while lowest for C/A of 50/50 blend. These knitted fabrics could be used for comfortable winter wear.

**Keywords:** Knitted, Yarn, Thermal, Thermolite, Acrylic, Cotton,

## **Development and Characterization of Water Wicking Behavior of Hosiery Yarns and Knitted Fabrics**

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### **Abstract**

The aim of this research work was to develop and investigate the water wicking performance of some hosiery yarn and knitted fabrics on the basis of fiber types and yarn structure. Three types of fibers named, cotton, Coolmax and Tencel were selected for this purpose and three kinds of Ne 10s hosiery yarns were produced using conventional ring spinning techniques, Siro spinning technique and plying and twisting spinning techniques. A 100% cotton ring spun yarn was produced as a reference sample. While the other two types of yarns were specialized tri-blended yarns composed of 40% cotton, 40% Coolmax and 10% Tencel fiber. The specialized yarns were produced on Siro spinning and plying and twisting spinning techniques. The wicking properties of specialized yarns were evaluated on the basis of yarn structure and fibers selection in a hybrid yarn in comparison to the pure cotton spun yarn. The height of water column raised in the yarn was noted against the interval of time. In tri-bleed Siro yarn, the maximum height of 42mm was achieved in the first 60 seconds. In case of tri-blend plied yarn of similar count, the maximum height of 32 mm was achieved in first 60 seconds. However for pure cotton spun yarn, no quick water wicking was observed in the initial interval of 60 seconds. Then three kind of single jersey knitted fabric were produced from these yarns and wicking behavior was observed from each sample of knitted fabric. Tri-blend Siro yarn based knitted fabric shows highest wicking rate compared to ply yarn based knitted fabrics. The wicking behavior of pure cotton yarn based knitted fabric samples was extremely low. The findings of the research are quite a significant showing that a novel combination of specialized fiber and yarn structure can help to produce textile based structure with fast wicking behavior. Such a fast wicking behavior can be used to develop some innovative products like moisture wicking and quick drying fabrics, active moisture wicking pants, moisture-wicking active tops, capillary actions mats and many others.

**Keywords:** Knitted, Single jersey, Wicking, SIRO yarn, Tencel, Coolmax

## **Role of ICT to Improve the Quality and Production of Knitted Fabrics**

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### **Abstract**

Knitted fabric gained popularity over the woven fabric due to its unique characteristics like elasticity, fabric density, thickness, Production cost and feel (Comfort). These fabrics are widely used in sportswear, hosiery, and high fashion industry that demands its more production and better quality. Information and communication technology (ICT) is now playing an important role in revolutionizing the industry by integrating the concept of telecommunication and computing like storage, enterprise software, monitoring and detection systems to store, retrieve, manipulate and access the useful information effectively that eventually move the industry to better control over their production as well as on quality of their products. ICT in knitting process is an evolving area during the recent years that incorporates the automation in knitting process to increase its production rate. Further, it also helps in improving the quality of knitted fabric through effective monitoring of fabric with the help of sensors. This paper mainly discusses the role of ICT in improving the quality of the knitted fabric by describing the importance of digital image processing and artificial neural network in detecting knitted fabric faults. Further, this paper will also describe the automation in the production of knitted fabrics.

**Keywords:** Knitted fabric, Quality control, ICT, digital image processing, Automation in knitting.

## **Effect of Elastance and Cotton Percentage on Dimensional Stability of Socks**

Sikander Abbas Basra\*<sup>1</sup>, Dr. Hafsa Jamshaid<sup>1</sup>, Haritham Khan<sup>1</sup>, Hafiz Shabaz<sup>1</sup>, Zeeshan Azam<sup>1</sup>,  
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### **Abstract**

One of the most important problems in socks manufacturing industry is change in size that affects the dimensions of final product. Different factor affects the dimensional stability of sock, but most contributing factors are elastane percentage, main yarn material, and process type. Therefore, it is opted to study the effect of elastane percentage in plating yarn, cotton percentage in main yarn materials, wash and bleach on dimensional stability of socks. Mostly bleaching and washing of socks is done on commercial level, therefore bleach and wash was selected for this study.

In this research, different materials and different process are applied on plain plating knitted socks on a same resource group and there dimensions stability was studied. Four different percentages of elastane in plating, two main yarns materials, and two process types were taken as level of input variables to study the effect on dimensional stability. Effect of elastane percentage, main yarn material type and process type on physical properties of knitted fabric was also studied in this research. Dimensional stability test was performed on socks. After testing, Minitab software was used for analysis of variance of obtained results using full factorial design. Significance of all factors and levels were analyzed.

**Keywords:** Socks, Elastane yarn, Stability of socks, Minitab-software, Dimensional stable socks.



## **Impact of Elastane Percentage on Stretch and Recovery of Socks**

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### **Abstract**

Optimum stretch is basic requirement in sock to support blood flow in foot and ankle. This stretch is achieved with fabric structure type and material used in it. In fabric structure, mostly loop geometry creates optimum stretch. Elastane in material either covered or twisted is used to support stretch and recovery in socks. As per our knowledge, stretch and recovery behavior of different knitted fabrics i.e. single jersey, rib, interlock, fleece had been studied earlier but no significant research has been carried out on socks to sort out the problem of uneven stretch and recovery keeping in view the elastane percentage and process applications. In this research, different percentages of elastane and different process are applied on plain plating knitted socks on a same resource group and there stretch and recovery was studied.

Different factor affects the stretch and recovery of sock, but most contributing factors are elastane percentage, main yarn material, and process type. Therefore, it is opted to study the effect of elastane percentage in plating yarn, cotton percentage in main yarn materials, wash and bleach on stretch and recovery of socks. Mostly bleaching and washing of socks is done on commercial level, therefore bleach and wash was selected for this study.

Four different percentages of elastane in plating, two main yarns materials, and two process types were taken as level of input variables to study the effect on stretch and recovery. Level and factor combination was sixteen. Effect of elastane percentage, main yarn material type and process type on physical properties of knitted fabric was also studied in this research. Stretch and recovery test was performed on knitted fabric. After testing, Minitab software was used for analysis of variance of obtained results using full factorial design. Significance of all factors and levels were analyzed.

**Keywords:** Socks, knitted fabric, Elastane, Plated knitted socks, Minitab, elasticity of knitted

## **Study of Shrinkage Behavior of Sandwich Half Terry Socks**

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### **Abstract**

Socks are commonly used in clothing worn to absorb sweat and evaporate the perspiration while providing warm feeling as well as decreasing the risk of frostbite in cold climate surroundings. One of the most important problem in the socks manufacturing industry is the shrinkage that affects the dimensions of the final product. Shrinkage arises mainly due to the residual strains in the fabric relaxing during any wet treatment. In this research, three different materials; Cotton 100 %, PC 52:48 and Cool-max Cotton 50:50; with two different yarn counts of 16/1 and 20/1 for each type of materials were used as the main yarn in the sandwich half terry socks and their shrinkage behavior were studied. The shrinkage in the socks by Cotton 100 % with 20/1 yarn count was found higher as compared to other socks with PC 52: 48 and Cool-max Cotton 50:50.

**Keywords:** Sock, Shrinkage, Perspiration, Dimensions, Yarn Count

## **Thermo-physiological Comfort Analysis of Polyester Cotton Blended Interlock Knitted Fabrics**

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### **Abstract**

The aim of this study is to investigate the effect of different parameters on air permeability and thermal comfort properties of interlock knitted fabrics. The parameters considered for this study includes blend ratio, yarn linear density, specific heat of yarn, fabric thickness, fabric areal density and stitch length in range of P/C 65/35-40/60, 24.6-36.9 Tex, 2.506-3.038 J/g/K, 1.05-1.34 mm, 239-484 g/m<sup>2</sup> and 3.1-4.2 mm respectively. The fabrics were developed at 18 gauge Jacquard circular interlock knitting machine with positive yarn feeding system. The results showed that stitch length is directly proportional to air permeability and thermal resistance of interlock knitted fabric. It was found that blend ratio did not significantly affected the air permeability whereas, blend ratio influence the specific heat of yarn which is directly proportional to thermal resistance of knitted fabric. The results showed that yarn linear density is reversely proportional to air permeability while directly proportional to fabric thermal resistance. The influence of fabric thickness was found less significant for thermal resistance of interlock knitted fabrics. The fabric areal density was found reversely proportional to air permeability as well fabric thermal resistance. The study will help to design fabric parameters as per thermophysiological requirement of the interlock knitted fabrics.

**Keywords:** Thermo-physiological, comfort, interlock, cotton, polyester

## **Comparison of Dimensional Behavior of Fully Fashion Flat Knitting Panels Prepared from Wool and Acrylic Yarn**

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### **Abstract**

The purpose of this research was to study the dimensional behavior of fully fashion flat knitting machine panels prepared on different knitting parameters. V-bed knitting machine fabric formation procedure is more advanced, and has different needle selection capability as compared to circular knitting machine. Using computerized flatbed knitting machines, various knitting patterns and structures can be created. 32/2 Ne Wool and acrylic yarns were used for sample formation. From the results it has been concluded that pre-knitting tension on yarn effects the dimensions of knitted panels after relaxing, washing and steaming. Medium (four-point) pre knitting tension on yarn with tight stitch length produced more dimensional stable structure than looser or medium stitch length. The structure with tight stitch length and medium pre-knitting tension resisted the shrinkage more after relaxing, washing and steaming process. Tensile results of acrylic yarn showed more strength than wool yarn and also having more percentage of elongation than wool. By comparison it is concluded that wool flat knitting panels showed more resistance towards shrinkage than acrylic panels prepared on same knitting parameters.

**Keywords:** Dimensional behavior, V-bed flat knitting machine, 3D shape knitted panels, Single jersey.

## **Study the Effect of Inlay Yarn on Mechanical Properties and Stability of Weft Knitted Structures**

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### **Abstract**

The aim of this study is to investigate the mechanical behavior of weft knitted inlay structures. Conventionally knitted structures are famous for their flexible, elastic, low strength and comfort behavior. Different high performance (Kevlar), natural (Flax and jute) and synthetic fibers (Nylon and Polyester) are used in different combination of inlay and knit yarns. Sample were knitted on a double bed hand flat knitting machine with 7 gauge. All samples were knitted using plain rib 1 \* 1 structure in which an inlay yarn is passed in course direction after every single coarse. Depending upon type and count of inlay yarn used the mechanical performance and structure stability increased significantly in inlaid structures. It was found that strength of inlay structure is increased significantly and its extension and growth is reduced up to 1% in direction of inlay i.e. weft direction.

**Keywords:** Knitted fabric, inlay yarn, Kevlar, Flax, jute, Nylon, Polyester, Rib knitted

## **To Study the Influence of Structure and Yarn on Mechanical Properties of Plain Single Jersey Structure**

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### **Abstract**

In this paper influence of structure and yarn properties on mechanical behavior of weft knitted fabrics is studied. The plain single jersey fabric was knitted using different yarns i.e. natural (Cotton), synthetic (Polyester filament, polyester spun and Nylon), mineral (Glass), high performance (recycled spun Kevlar) and their blend (PC 52:48). Mechanical behavior of all Sample was evaluated on Zwick/Roell Z100 and results shows that on application of force, at 1st stage all samples shows same behavior. The initial young's modulus of all samples is same, which shows that all sample have same structure behavior. When value of force is increased in 2nd stage all samples shows different behavior and their Young's modulus was different depending upon type of material. It is concluded from results that initial behavior is independent of material used and for better mechanical performance of knitted fabrics one need to select suitable structure while selecting the material.

**Keywords:** Knitted fabric, Single jersey, Knitted mechanical behavior, Polyester, Nylon, Glass, Kevlar

## **Microencapsulated Phase Change Materials to Develop Thermoregulating Smart Textiles**

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### **Abstract**

Phase change materials are those materials which can store energy upon heating and release the same amount of energy upon cooling. Hence when the temperature of surroundings or body increases, the phase change materials melt and absorb that energy in the form of latent heat and when the temperature of body or surroundings lowers, the materials release that absorbed heat keeping the body in comfort zone. Owing to the phase changing nature of these materials, they need to keep in protective shell called micro or nanocapsules using different encapsulation techniques. Later on these capsules containing PCM can be inserted into man made or synthetic filaments during melt or dry extrusion process. They can also be applied on knitted and woven textiles to develop thermoregulating textiles. This research will provide the understanding of use of phase change materials to develop thermoregulating textiles as well as a comparison between capsules treated and untreated fabric.

**Keywords:** Phase change material, Smart textile, Microencapsulated, Nano capsule, Thermo-regulating

## **Rheological Investigation of the Polyvinyl Alcohol Solutions as Resin for Knitted Structure Based Composites**

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### **Abstract**

The physical properties of polymer solutions have an enormous impact on polymeric materials. The polar interactions between polymer and solvent molecules play an important role in the dispersion of polymer chains in a polymer solution. However, the limited polymer and solvent interaction may lead to poor physical properties of the solution and ultimately the polymeric material. This is because of the stronger polymer to polymer interactions. This interaction can be reduced with the application of a cross-linking agent. In addition, physical parameter like temperature, the molecular weight of polymer and concentration play an important role in defining the final physical properties of polymer solutions. In this study, the physical properties of polyvinyl alcohol solutions in dimethyl sulfoxide (DMSO) in association with a cross-linking agent, boric acid, were rheologically investigated regarding shear rate, temperature and molecular weight of the polymer. The impact of the crosslinker and physical parameters on the physical properties of polyvinyl alcohol solutions was elaborated. This solution will be of high importance as a resin for the knitted structure based composites. The penetration of the solution inside the knitted structure will enhance the properties of the matrix and consequently composite will have better performance.

**Keywords:** Polyvinyl alcohol, Resin, Knitted matrix, Composite, Temperature



## **Role of Phase Change Materials to Reduce Heat Stress of Fire Fighter Turnout Gears**

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### **Abstract**

Phase change materials (PCMs) are the materials which have high heat of fusion and change their shape from solid to liquid and back from liquid to solid on absorption and release of heat. Heat of fusion enables PCMs to store and release large amount of energy during phase transformation. Due this excellent property of PCM's they may be used in large number of applications. PCM's provide protection from extreme weather conditions.

Phase change materials (PCMs) are used in internal thermal lining of fire fighter clothes to reduce the heat stress. The reduction of heat stress depends upon the type of material and position with respect to human body. In this study different types of PCM's, effect of their position in fire fighter protective cloths and synergistic effect with other materials such as aerogel and cooling materials is reviewed.

**Keywords:** Phase change material, Fire fighter cloths, Human body protection

## **Study the Abrasion Effect on Polyester Yarn Due to Elevated Temperature During Knitting**

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### **Abstract**

Polyester is widely used in fabrication process and its demand and consumption increasing day by day. Polyester filaments are used widely in knitted fabrics relative to its product end uses. Polyester has low Tg and increase in heat can change its properties widely leading to many problems. In knitting machine due to mechanical contact of machine parts heat is produced in machine parts like needles that are in contact with yarn. The polyester has harsh feel and it imparts great stresses on needle and due to friction heat is produced in needles. This needle heat is a very near to polyester Tg. So there is a danger of abrasion effect on polyester filaments. This research paper deals with the investigation of heat production in knitting machine while using polyester filaments.

**Keywords:** Polyester yarn, Knitted fabric, Knitting Needles

## **A Review of Materials Used for Antistatic Property in Textile Fabrics**

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### **Abstract**

Due to the extensive use of electronics in this modern age and their sensitivity along with personal protection of the user is a big question mark now a days. This situation compel us to take such preventive measures which can help us to reduce such risks for the user and electronic devices too. Electronic devices are inclined to errors whenever they are affected by the static charges and electromagnetic fields. Static electricity is also problematic whenever it produces in flammable environment (areas of handling gases and chemicals). Because fire accident occurs when sparks from static charges catches flammable volatiles. Therefore, in such environments protection is very necessary. Researchers has investigated for such materials which can mitigate this problem. This study is done to review the all investigated materials for getting anti-static property in textile fabrics. Basics property of all materials used for this purpose was conduction. Because static charges are basically gathering of positive or negative charges on the surface of textile which occur due to rubbing of different materials. When they find some conductive medium, these charges flow through it and neutralizes the surface. Metals, conductive coating, high performance fibers, carbon coatings etc. were used for this purpose.

**Keywords:** Antistatic, Textile fabrics, Static electricity

## **Different Techniques Used to Enhance Thermo Physiological Comfort and Working Efficiency of Fire-fighters (A Review)**

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### **Abstract**

Fire-fighters must face the problems of high heat stress due their high physical activities and interface with direct flash flame. Due to high physical activities, fighter's body also generate heat. Ultimately high heat stress is generated between fire fighter's body and turn out gears. This heat stress is the major cause of death.

Different active and passive methods are used to dissipate heat energy. Working efficiency and thermo physiological comfort is dependent upon the ease and speed of heat dissipation. Different techniques used for heat dissipation include the use of phase change materials, aerogel, super absorbents, ice vest, extractor fans, misting fans, hand and forearms immersion in water, cold air and changing the design of clothes.

**Keywords:** Thermo physiological comfort, fire fighter, heat stress

## **Development of Special Knitted Fabric Through Modification of Hand Flat Knitting Machine**

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### **Abstract**

Knitting is the second frequently used method that for fabrication. Certain techniques are possible during the knitting action that can radically change the physical appearance and properties of a knitted construction without seriously affecting the cohesive nature of the loop structure. Co Weave knit fabric mean a knitted fabric having both weft and warp insertion on hand flat knitting machine. Previously there is not much work on this concept. The yarns introduce in the rib structure of fabric as a warp yarn through machine modification. These inlay yarn increased the GSM of the fabric. Through tensile test it is concluded that the inlay straight yarn provides the maximum strength to the structure. These inlay straight yarn provides the minimum percentage elongation to the structure. This is because of the different of yarn density of the fabric. These straight yarns also provide the minimum extension at maximum load to the structure. And it provides the minimum fabric growth % to the structure. The tensile strength is directly proportional to the density of inlay yarn.

**Keywords:** Co-weave knit, Special knitted fabric, Hand flat knitting machine.