ELECTRONIC TEXTILES FOR MEDICAL PURPOSES

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

Hakan Uçar
Bekaert Textiles Group, R&D Manager Turkey, *Waregem, Belgium*
hakan.ucar@bekaerttextiles.com

1. Introduction

Bekaert Textiles is continuously investing in Sleep Science, in research into optimisation of sleep and comfort of sleep. Its own competence centre carries out scientific research on sleep in collaboration with universities, sleepcentres and various technology partners.

This innovation is an intelligent mattress cover that features integrated optical sensors. The optical sensor technology is already used for fire calls, protection against burglary, and the most different monitoring systems. In this case, it registers the breathing of the person lying on the mattress and sends an alarm to a mobile phone in case of respiratory arrest. The mattress cover can, for example, also measure the time of rest, sleeping positions, and pressure points making it very versatile. The accuracy of the technology makes it very suitable for use in health care. Since the solution is not based on electricity, the human body remains unaffected.

2. Analyses and Discussions

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

For now the products;

- Only mattress covers
- 3 projects have been identified (see below)
- 3 projects = 3 concepts
- Control unit / interface will be standard

- Different fabrics for health care and for traditional market (different specs)

Project 1: Prevention of step/fall - out (un)intentionally (FP)
- For bedridden patients who nevertheless want to leave the bed
- Only for beds with siderails up
- Only for foam mattresses, other types have to be tested

Project 2: Absence/Presence (AP)
- Is person in bed or not ?
- Time a mattress has been used
- Time slot for people leaving and not returning

Project 3: Breath Control (BC)
- Is person still breathing?
- Is person still moving?

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

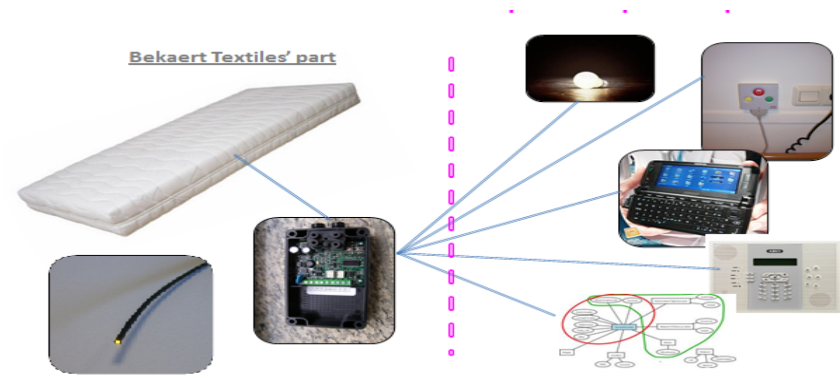
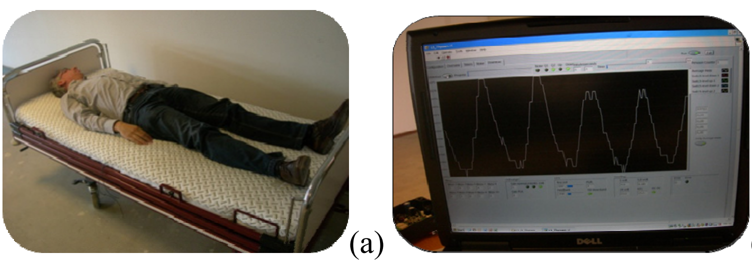


Figure1. The Smart Wrap® consept



(a) (b)

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

3. Conclusion

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

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

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THERMAL PADS MADE OF CONDUCTIVE FABRICS

S.Vassiliadis[1], D. Domvoglou[1], S. Potirakis[1], A. Partsalis[2], D. Mecit[3], M. Örnek[3], S. Turan[3]
[1] *TEI Piraeus, Department of Electronics Eng., Athens, Greece*
[2] *Ioannina General Hospital, Ioannina, Greece*
[3] *MARTUR S.A. Automotive Seating and Interiors, Bursa, Turkey*
svas@teipir.gr

The electrically conductive textiles are known since the decade of the 70's. The textile fibres are made of polymers, which are in general electrical isolators. The overcoming of this initial chemical structural characteristic of the material by the development of suitable technical methods was very important. One category of conductive textiles is based on the selection of specific polymers with intrinsically increased conductivity. Alternative category of methods includes the use of conductive materials such as carbon powder, metallic wires etc. The conductive textiles have been initially used for the production mainly of protective clothing for electromagnetic shielding and heating applications[1],[2]. Although the interest of the researchers has expanded later on many application fields like development of textile antennas, transmission lines, signal and power transfer for wearable computer systems etc, the heating applications remain of great importance. The clothing uses are not any more exclusive and the heating textiles have wider potential uses field [3],[4],[5].

A Turkish industrial company has developed electrically conductive fabrics mainly for automotive applications [6]. The fabrics are useful for the elimination of the development of static electricity. The conductivity is achieved by a thin metallic fibre/wire wrapped around the body of the yarns. The interlacing of the warp and weft yarns results in the creation of a fine conductive grid with extensive applications potential.

Specimens of the conductive fabrics have been used for the development of thermal pads. The aim of the current study is to investigate the heating capacity of the fabrics in relation to the certain limitations deriving from the fibrous material and the application field. The temperature of the thermal pad should not exceed a limit of 50º C, in order to avoid any melting of the textile fibres, made of polymers. On the other hand, the use of the thermal pads on the human body for its heating should be safe and to avoid any overheating of the human skin. The heating rate has been measured as well as the distribution of the temperature values over the effective area in conjunction to the orientation of the fabric have been measured. The results of the tests are positive and it is concluded that these fabrics can be used for the thermal pad applications. A preliminary medical assessment has been made and an electronic safety device has been foreseen. The overall behaviour and the performance of the thermal pads are promising and further investigation will follow.

Key Words: Thermal Pads, conductive fabrics, heat radiation

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DEVELOPMENT OF AN ELETROACTIVE TEXTIL SYSTEM FOR OBJECTIVE ASSESSMENT OF SLEEP QUALITY

M. M. Tavares[1], N.J.R. Belino[1], M. A. V. Patto[2], M.J.O. Geraldes[1]
[1]*University of Beira Interior, Textile Department, Covilhã, PORTUGAL*
[2]*University of Beira Interior, Health Sciences Department, Covilhã, PORTUGAL*
michellamt@hotmail.com

This project aims to study the relationship between the anatomical position during sleep rest and some neurodegenerative diseases. Sleep studies are gaining a major importance nowadays. In this context, the present research work envisage the development a new technological solution that allow us to establish a link between the nocturnale movements of sleep disorder's patients patients with their polysomnographic recorded data. For this purpose, the authors will develop na electroactive textile system, in order to acquire biomechanics information during their night rest. The collected data will be statistically processed to verify any possible relation between night movements and the stage and evolution of sleep disorder's patients and also the effectiveness of the medication used.

Key Words: Non-conventional textiles; electroactive textiles, sleep quality; sleep disorders; neurology;

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MEDTEX PROJECT – A TEXTILE BASED CONTRIBUTION FOR THE PROPHYLAXIS OF PRESSURE ULCERS

N.J.R. Belino[1], M.J.O. Geraldes[1], M.N. Figueiredo[1], P.A.R.C. Ferreira[2], N. Pimenta[2], F. Cardoso[2], J. L. Matos [3]
[1]*University of Beira Interior, Textile Department Covilhã, Portugal*
[2]*INOV – Instituto de Novas Tecnologias, Lisboa, Portugal*
[3]*QSC – Quinta de S. Cosme, Lda., Vila Nova de Tázém, Portugal*
belino@ubi.pt

Pressure ulcers are skin lesions that affect seriously the patient's quality of life. This pathology is caused by low pressure application during a long period of time over boner preeminence or, in another way, high pressure application for a short period. This paper describes the initial prototype of a textile based technological solution to perform real time control of the anatomical position of bedridden patients suffering from pressure ulcers. For this purpose the authors developed an elctrotextile system with an integrated sensing layer that captures the anatomical position of the body along time and communicates with a PC to inform healthcare personnel about the necessity of changing and pressure relief.

Key Words: Pressure ulcers; prophylaxis; smart textiles; electrotextiles; remote sensing; medical textiles

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WOUND DRESSINGS

WOUND HEALING EFFECT OF ALGINATE DRESSINGS WITH MEDICAL HONEY

Marjetka Kralj Kunčič[1], Tijana Ristić[1], Ciril Triller[2], Jasna Cerlini[1], Andrej Zabret[1], Mojca Šimnic Šolinc[1], Dragica Maja Smrke[2]

[1] *TOSAMA, Production of Medical Supplies, Vir, 1230 Domžale, Slovenia*

[2] *University Medical Centre Ljubljana, Department of Surgical Infections, 1000 Ljubljana, Slovenia*

tijana.ristict@tosama.si

Alginate dressings are well known among medical textiles and often used as modern dressing for treatment of chronic wounds. To reach antimicrobial effect alginate dressings can be impregnated with different substances [1]. In our research, alginate fibres were impregnated with natural substance – honey. Honey was used as remedy for wound healing since ancient Egyptians time [2]. It actively promotes healing due to phytochemical components, low levels of hydrogen peroxide and high sugar concentration [3]. The last provides high osmotic effect, which results in antibacterial effectiveness. Consecutively, alginate dressings with honey can clear infection from wound and also act beneficently to wound and skin as it enables moisture environment [4]. Chronic wounds are special problem as their healing is much prolonged. We report results of a clinical study, where the alginate honey dressings with Slovenian chestnut honey were used in treatment of venous leg ulcers. Our hypothesis was that dressings with honey enhance healing of ulcers in comparison to alginate dressings without honey. The enhancement of wound closure was more pronounced in patients, whom ulcers were treated by alginate honey dressings. Dressings cleaned the infected wounds after 5 changing; epithelisation from granulated wound edge was promoted (Figure1). Debridement, offloading and infection were successfully controlled and therefore 80 % of venous leg ulcers were healed and successfully treated. Observations demonstrate that honey in combination with alginate can give positive results of chronic wounds healing. All data support the concept that medical textiles with natural antimicrobial substances can be applied for medical purposes.

Figure 1. Venous leg ulcer before treatment (left) and after 5 changing of alginate dressings with Slovenian chestnut honey (right)

Key Words: Alginate dressings, honey, antimicrobial effect, chronic wounds

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NOVEL ATMOSPHERIC PLASMA ENHANCED CHITOSAN NANOFIBER/GAUZE COMPOSITE WOUND DRESSINGS

Marian G. McCord[1,3], Rupesh Nawalakhe[1], Narendiran Vitchuli[1], Quan Shi[1], Mohamed Bourham[2], Xiangwu Zhang[1]

[1] *Fiber and Polymer Science Program, Department of Textile Engineering, Chemistry and Science, North Carolina State University, Raleigh, NC 27695-8301, USA*
[2] *Department of Nuclear Engineering, North Carolina State University, Raleigh, NC 27695-7909, USA,* [3] *Joint Department of Biomedical Engineering, North Carolina State University, Raleigh, NC 27695-7115, USA, and University of North Carolina, Chapel Hill, NC, 27599, USA*
mmccord@ncsu.edu

Abstract

Electrospun nanofiber dressings have demonstrated the potential to revolutionize wound care by providing significantly enhanced moisture management, barrier properties, and bioactivity. However, nanofiber webs are inherently weak and difficult to handle [1]. Deposition of electrospun nanofiber coatings on conventional textile bandages addresses the need for structural support, but faces challenges of delamination due to compliance mismatch or poor adhesion. This work is focused on improving the mechanical properties and stability of composite bandages. Chitosan nanofibers were electrospun onto atmospheric plasma treated cotton gauze to create a novel composite bandage with higher adhesion, better handling properties, enhanced bioactivity, and improved moisture management. Plasma treatment of the gauze substrate was performed to improve the durability of the nanofiber/gauze interface. Electrospinning of chitosan was possible in the range of 3-7% concentration in trifluoroacetic acid (TFA). The composite bandages were analyzed using peel, Gelbo Flex, antimicrobial assay, MVTR (moisture vapor transmission rate), XPS (X-ray photoelectron spectroscopy), absorbency and air permeability tests. The peel test showed that plasma pre-treatment of the substrate and plasma post-treatment of the composite bandages increased the force required to peel off the nanofiber layer up to 4 times as compared to that of untreated composite bandages. Plasma pretreatment of the gauze fabric prior to electrospinning and post treatment after electrospinning significantly reduced the degradation of the nanofiber layer due to repetitive flexing. Air permeability and moisture vapor transport were reduced due to the

presence of a nanofiber layer upon the substrate. Gauze samples with chitosan nanofibers had higher liquid absorbency than the ones without nanofibers on them. The chitosan nanofiber layer contributes significantly to the antimicrobial properties of the bandage. Surface elemental analysis of the plasma treated cotton substrate showed an increase in oxygen functional groups as compared with untreated gauze.

Results of Peel Test

Electrospinning of chitosan nanofibers was carried out on untreated and plasma-treated 100% cotton substrate. Atmospheric plasma was used for post-treatment of the composite bandages (i.e. nanofibers electrospun on treated/untreated cotton substrate). A peel test method was devised for evaluating the adhesion between the nanofiber mat and the fabric substrate based on ASTM D2261-Tearing strength of woven fabrics by tongue (Single Rip) method [2] using an Instron Tensile Tester. Substrates treated with 100% helium plasma and 99% helium/1% oxygen plasma have shown up to 4 times increase in the force required to peel off the nanofiber layer from substrate as compared to the control samples (without pre-treatment and the post-treatment of samples) (Table 1). Post-treatment of composite bandages alone showed lower adhesion force as compared to both pre-treatment and post-treatment of composite bandages. Tearing of the nanofiber web was observed during the peel tests on plasma pre- and post-treated substrates indicating improved adhesion between nanofiber layer and the substrate.

Table 1. Required force to peel off the nanofiber layer from the substrate

	No post- treat	**He post- treat**	**He/O_2 post-treat**
No pre-treat, gf	11.05±4.8	25.30±14.38	27.38±4.2
He pre-treat, gf	42.28±15.0	36.63±12.7	45.10±13.8
He/O_2 pre-treat, gf	31.23±3.06	34.05± 7.4	47.43± 9.1

The results from peel testing can be attributed to the effect of plasma pre-treatment to induce active sites on the substrate which would increase the surface bonding and crosslinking between nanofiber and cotton substrate as well as within the nanofibers [3-6]. Along with the active species formed at the surface of the substrate during pre treatment, and the nanofibers during post treatment, the increase in adhesion may also be attributed to the roughness caused by etching effect of the plasma which would increase the frictional force between them [7].

Key Words: Electrospinning, chitosan nanofibers, adhesion, plasma treatment, antibacterial wound dressing.

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A RESEARCH ABOUT MEDICAL TEXTILES FOR THE PREVENTION OF DECUBITUS ULCERS

Deniz Duran[1], Güldemet Başal[2], Diren Mecit[3]
[1]*Ege University, Emel Akin Vocational Training School, Bornova, Izmir, Turkey*
[2]*Ege University, Department of Textile Engineering, Bornova, Izmir, Turkey*
[3]*Martur A.Ş., Bursa, Turkey*
deniz.duran@ege.edu.tr

Decubitus or pressure ulcers, also known as bedsores, in immobile patients are associated with prolonged pressure, shear and friction forces or a combination of these factors acting on the skin and the soft tissue underneath. The healing of high-grade decubitus often takes several months. [1,2] Considering the aging population in developed countries like US, Canada and most of the European countries, this healthcare threat presents a significant risk to hospitalized patients, imposing huge cost on both treatment and care for patients. [1] It is estimated that every year between 0.1% and 0.5% of the population in each country is suffering from decubitus. In industrial countries with ageing populations, the importance of long-term health care is expected to increase significantly over the next decades and decubitus is suspected to contribute to fast growing health costs. [2]

Decubitus or pressure ulcers are a severe medical problem for immobile patients in clinical environments and nursing homes. [2] Textile materials, such as clothing and bedding, are known have a considerable influence on factors, such as pressure, shear/friction, and skin hydration, which contribute to skin ulceration. [1]

This paper presents the results of a research about the properties of double layered knitted fabrics made from engineered polyester yarns, to be used as bed linen for immobilised patients. The main focus of the study was to investigate the effect of different engineered fibres on the friction, dry-keeping and some comfort related properties of the bed linens. Measurements were performed before and after twenty washing cycles; the results and their possible impacts on effects on decubitus ulcer formation were discussed. Results obtained will be presented in the full text.

Key Words: Decubitus ulcers, immobility, engineered polyester, cotton, double layered fabrics

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NANO-BIOPOLYMER ACTIVE WOUND DRESSINGS AS AN AUXILIARY THERAPEUTIC TOOL FOR PRESSURE ULCERS TREATMENT

C.M.F. Mendes[1], N.J.R. Belino[2], F.J.M.S Oliveira[3]
[1]*Centro Hospitalar da Cova da Beira, Covilhã, Portugal*
[2]*University of Beira Interior, Textile Science and Technology Department, Covilhã, Portugal*
[3] *Hospitais da Universidade de Coimbra, Surgery Department, Coimbra, Portugal*
cmf.mendes@hotmail.com

1. Project Framework

1.1. Context of the theme: a Public Health Perspective

Pressure sores are ulcers resulting from tissue local ischemia in patients with spinal cord injury (quadriplegics, paraplegics or hemiplegics) or impaired patients, elderly or chronically ill. Patients with spinal cord injury have lesion of nociceptive afferent fibers that are responsible for the painful stimulus for changing position and, in second group of patients, these signs are ignored [1,2,3].

Pressure sores are a serious health problem, cutting across all types of health care, which requires a high consumption of human resources and materials.

The etiology of pressure sores has not been fully clarified, but it is known that continuous pressure on the skin leads to ischemic phenomena associated with nutrient deficiency and subsequent tissue necrosis [4]. Ulcers may develop in areas where there is pressure on bony prominences, such as the sacrum, ischium, trochanter, or, less commonly, the heel, occipital, dorsum of the foot, the medial malleolus and the knee cap [5,6,7,8].

Studies indicate that pressures between 60 and 580 mmHg in the period from 1 to 6 hours can cause a sore. Apart from pressure, friction and shearing forces may act synergistically in the development of a wound in patients who are malnourished, incontinent, bedridden or mental disorders [4].

A great number of classifications are proposed for pressure sores. The most widely used is the classification of "Centro Nacional de Dados sobre Lesão Medular" [9,10,11], where they are described four progressive grades of tissue damage [10,12]. Pressure sores may develop in 24 hours or take up to five days for your event. All health professionals responsible for monitoring the patient should be familiar with the main risk factors. In this sense, the observation of prophylactic measures to eliminate continuous pressure, shear or friction is very important to prevent the formation of ulcers [4].

1.2. Context of the theme: Economic Perspective

The prevalence of pressure sores in hospitals range from 2,7% [13] to a maximum of 29,5% [14,15,16]. Quadriplegic patients (60%) [13,16] and elderly with femoral neck fractures (66%) [16,17] reach the highest rates of complications, followed by critically ill patients (33%).

In general, about 40% of patients with spinal cord injuries who complete treatment will develop a pressure sore [16,18]. As the elderly population is steadily increasing in our society, patients with home assistance are recognized as high rosk for developing pressure sores [10].

The economic impact of treatment of pressure ulcers is huge. When a patient develops a pressure ulcer during their hospital stay, hospital costs increase as the period of hospitalization significantly changes.

Looking at the huge number of bedridden elderly people living in institutions of continuing care and long duration, pressure sores have acquired large importance in our days, since 25% to 33% of patients arrive at hospitals with pressure sores, and about of 35% of the patients develop ulcers during hospitalization. There are still records that the pressure ulcers are a direct cause of death in 7% to 8% of paraplegics [22].

Although some authors have pointed out that 95% of pressure sores can be prevented, it is noted that in Portugal the average prevalence in hospitals is 11,5%. Is further documented that for the Portuguese population in the Services of Medicine, there is a prevalence of 17.2% of institutionalized patients with pressure sores and, on average, each patient has not one, but 2.07 of pressure sores.

For this reason pressure ulcers are undoubtedly a public health problem. However, although they are currently a subject of attention from health care providers, the solutions on the market do not meet all the requirements and treatment needs.

2. Brief Literature review about the state-of-the-art

When the wound becomes chronic, it is not always easy to select the most appropriate wound dressing. Most health professionals believe that this should be chosen taking into account a multiple set of factors. Based on the studies ad knowledge of wound healing, several methods and interesting strategies have been developed that have recently evolved to a new generation of bioactive smart products that actively interact in the several phases of the wound in order to stimulate healing. There are several treatment options on the market, such as wound dressings with collagen, hydrocolloids, hyaluronic acid, polyacrylate, metal oxides etc.

The main goals in wounds treatment practices are: quick and effective occlusion of damaged tissue, effective absorption of exudates, removal of bacteria and infections, fast healing, comfort and quality of life of patients. There are several types of products for treating wounds, depending on the wound type: mechanical sutures to close the wound, bandages and dressings for wounds, sealants and surgical dressings, skin substitutes and other biological materials.

Innovative textile materials can be developed and used as a way to obtain wound dressings that meet the current requirements for the wounds treatment, including; structural function; purity, nontoxic and sterilizable; microorganisms barrier, among other; absorption of exudate and fluids without causing irritation or maceration; comfortable, pain relief; insulation, breathable, allowing gas exchange; effect of mechanical protection; fluid and moisture absorption; easily removable without trauma; anti-allergic and does not impair the wound with loose fibers or other particles; healing properties that are regulated by substances added to the textile materials.

In 1979, Turner defined the characteristics of an ideal wound dressing and, nowadays, there are already solutions available on the market. However it is know that has not been created any material that meets all the criteria and requirements.

3. Goals

This PhD thesis aims to contribute to solving a problem that causes pain, suffering, death and massive spending on human and materials resources.

A new generation of textile products can be developed for wounds prophylaxis and treatment. Several textile materials can be combined to create and improve some properties through new technological solutions. So, the main goal of this research is the design and development of wound dressings to treating wounds caused by pressure sores, based on medical textiles.

Thus, several textile structures will be designed based on nanofibers of different bioplymers (chitin, calcium alginate, sodium alginate, collagen and hyaluronic acid) and/or with coatings (silver nanoparticles), will operate as an active matrix to prevent and treat pressure sores.

A bacteriological study of the ulcer and its evolution, as well a comparative analysis of treatment of these wounds, based on the developed dressings and the best local practices in clinical practice will be held in (Centro Hospitalar Cova da Beira and Coimbra University Hospitals).

Key Words: Medical textiles; wound dressings; pressure sores; nanofibers; bioplymers

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ANTIMICROBIAL FUNCTIONALIZING AND CLOTHING COMFORT

THE INVESTIGATION OF COLOUR CHANGING OF ANTIBACTERIAL ZEOLITE APPLIED COTTON FABRICS BY THE TIME

C. Can[1], A. Körlü[1], M. Ateş[2]
[1]*Department of Textile Engineering, Ege University, İzmir, Turkey*
[2]*Department of Main and Industrial Microbiology, Ege University, İzmir, Turkey*
candan.akca@ege.edu.tr

The first important researches about antibacterial textiles had begun during II. World War. Microorganisms were isolated from the military uniforms then they were defined. After that some finishing processes were applied to textiles in order to kill microorganisms [1]. After the first researches the studies about antibacterial textiles has been continueing by increasing. Today antibacterial textile products are the one of the important textile product group in all textile market [2].

A lot of heavy metals are known toxic for microorganisms in low concentrations. Heavy metals bind in vivo cell proteins and denatures them. As a result of this bacteria dies [3]. Copper [4], zinc [5, 6] and cobalt [7] are also used in textile industry as antibacterial agent but the most common metal is silver [8, 9]. Silver is used frequently in wound dressings [10]. Because of it's strong antimicrobial property. And also bacterial resistance to silver is so low. It is necessary to use carrier for silver because of the some technical problems in the application. Zeolit is one of the important natural carrier for silver [11].

Zeolite can be antibacterial agent by ion change method using metal ion sources. Antibacterial zeolites can be used in antibacterial finishing of textile products. In this study natural zeolite mineral modified by $AgNO_3$, $Zn(NO_3)_2.6H_2O$, and $Cu(NO_3)_2.21/2H_2O$ solutions in two concentrations (0, 1 M and 0,01 M). Then modified antibacterial zeolites applied to cotton fabrics. Application solutions are in different concentrations (5 g/l, 1,25 g/l, 0,3125 g/l). The whiteness degrees of antibacterial cotton fabrics were measured after the application and following 3 months. Spectrofotometer (Minolta CM-3600 d) was used and whiteness degree calculated according to Stensby formula.

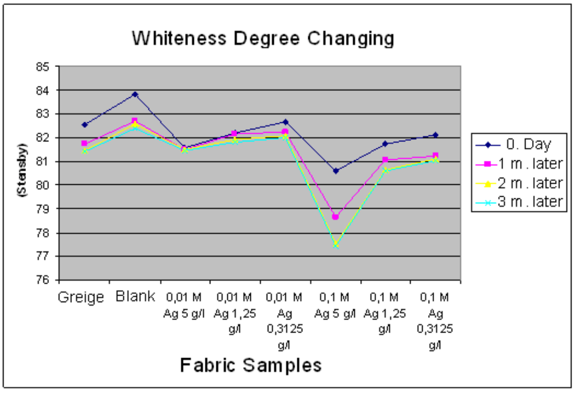

Figure 1. Colour changes of Ag-Na-Zeolite Applied Cotton Fabrics

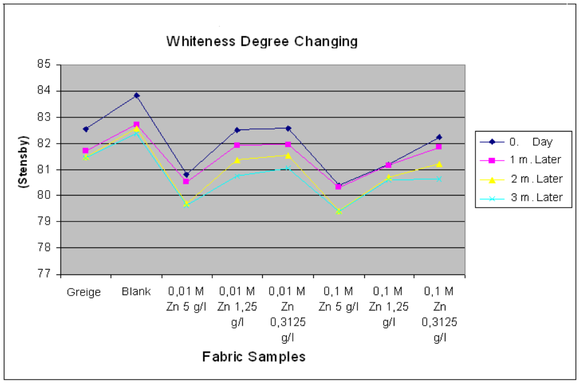

Figure 2. Colour changes of Zn-Na-Zeolite Applied Cotton Fabrics

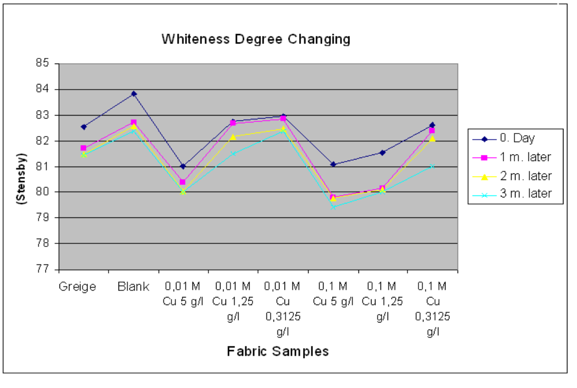

Figure 3. Colour changes of Cu-Na-Zeolite Applied Cotton Fabrics

It is clearly seen in the graphics that whiteness degree of antibacterial zeolite applied cotton fabrics are decreasing by the time. But this state isn’t handicup for using fabrics because color changing is not so much.

By the increasing of the amount of metal ion on the fabric, whiteness degree is decreasing. The amount of modified zeolite in the application solution and the concentration of the modification solution have critical role on the colour changing.

Key Words: Zeolite, silver, antibacterial, textile

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FABRICATION OF SILVER COATED FIBERS FOR ANTISTATIC AND ANTIBACTERIAL APPLICATIONS

L. Ozyuzer[1], Z. Meric[1], M.D. Yaman[2], Y. Selamet[1], B. Kutlu[3], A. Aksit[3]

[1] *Izmir Institute of Technology, Department of Physics, Izmir, Turkey*
[2] *Teknoma Technological Materials Ltd., Urla, Izmir, Turkey*
[3] *Dokuz Eylul University, Department of Textile Engineering, Izmir, Turkey*
ozyuzer@iyte.edu.tr

The wide range of nanoparticles, nanofilms and nanocomposites with various structures can be applied to the fibers, bringing new properties to the final textile product. For all these technical applications, it is desirable to produce such textile materials with especially designed surface features to meet various needs. Various techniques have been developed to functionalize textile materials [1]. Physical vapor deposition can be applied to modify textile materials to create various functions. In this study, we designed a new magnetron sputtering system which is called inverted magnetron sputtering. The surfaces of monofilament (60 dtex) and multifilament (70 dtex, 17 filament) synthetic fibers, such as polypropylene and polyamide, whose diameters are in the range between 60-125 μm, coated with silver [2]. Because silver has the highest electrical conductivity in metals and additionally it has antibacterial properties. Textile fibers were coated in various thicknesses. These fibers weaved into fabrics in order to investigate antistatic and antibacterial properties. For characterization optical microscope and SEM images were taken. Besides, XRD, electrical results, mechanical strength tests were done. In order to determine optimum film thickness, by using three different methods coating thicknesses were investigated and results compared. Resistances of Ag on fibers found and film thickness calculated from bulk Ag resistivity. The thickness was also calculated from deposited mass of silver. The both results were compared with independent thickness measurement on a glass substrate with a surface profilometer. The analysis of data commented surface scattering effect. When these fibers were weaved to become fabric due to these properties, fabrics will take place of technical textiles. Besides, the obtained fabrics have potentials to be used for surgery room garments, electromagnetic shielding, radar absorbing materials and infrared camouflage [3].

Key Words: Metal coating, metallize fiber, silver, antistatic fiber, antibacterial fiber.

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THE EFFECTS OF ANTIBACTERIAL SOL-GEL COATINGS TO PHYSICAL PROPERTIES OF COTTON FABRIC

Buket Arık, Necdet Seventekin
Ege University, Textile Engineering Department, Izmir, Turkey
buket.arik@ege.edu.tr

Sol-gel technology is a promising manufacturing method to produce antibacterial materials for biomedical applications [1]. The sol–gel reaction involves the hydrolysis of metal precursors and condensation of the resulting hydroxyl groups to form a nanostructure [2]. The kinetics of the hydrolysis and polycondensation reactions can be described with the help of the equations shown below;

$$M(OR)_x + H_2O \rightarrow M(OR)_{x-1}OH + ROH$$

$$2M(OR)_{x-1}OH \rightarrow (OR)_{x-1}M\text{-}O\text{-}M(OR)_{x-1} + H_2O$$

$$M(OR)_{x-1}OH + ROH \rightarrow (OR)_{x-1}M\text{-}OR + H_2O$$

In these equations; M refers to metal species (Ti, Si, Al, Zr, etc.), and R refers to alkyl groups (methyl, butyl, ethyl, etc.). These reactions generate an oxide skeleton in the solution. When this solution is exposed to the air or heating, the solution gels and becomes rigid [3].

There are two main types of sol-gel systems with antibacterial activity. These are titania based photocatalytic systems and sol-gel coatings with embedded colloidal metal or metal compounds (especially silver). Titan-IV-isopropoxide (TTIP) and tetraethylorthosilicate (TEOS) are mostly used metal alkoxides for these coatings and they form TiO_2 and SiO_2 respectively on the surface of the samples. While, TiO_2 is a type of semiconductor and active catalyst support, SiO_2 has high thermal stability and excellent mechanical strength. Moreover, both of them are non-toxic and can be used for antibacterial finishing of textiles [4].

Besides antibacterial activity, other desired functions are simple application of the material to the substrate surface and retention of the bulk properties of the substrate almost unchanged. Therefore, in order to meet the required functionality and durability, good mechanical properties of the coating and good adhesion to the substrate are very important [5].

Chitosan, which is a copolymer of β [1, 4]-linked 2-acetamido-2-deoxy-D-glucopyranose and 2-amino-2-deoxy-D-glucopyranose, is a deacetylation product of chitin found in marine invertebrates. This polysaccharide has several useful properties, such as non-toxicity, biocompatibility, biodegradability, antibacterial activity, chemical reactivity and film forming ability, which makes it an important biopolymer for textile applications [4, 6-8]. However, the poor solubility of chitosan limits its application and processing convenience. Moreover, the textile material's tensile strength, colour, handle and other physical properties which are especially difficult to satisfy can be affected adversely from chitosan coating under certain conditions. On the other hand, formation of organic–inorganic hybrid materials provides another approach to improve the physico/chemical properties of chitosan and other biomaterials [6]. In addition to this, the use of coatings based on the combination of chitosan, titania and silica brings an ecological benefit since all the components are completely harmless natural products [4].

In this study, the effects of the hybrid coatings prepared by the combination of chitosan, titania and silica on the cotton surface were evaluated. For this aim, the pure and combined coatings were applied to cotton samples by sol-gel method. After that, the antibacterial and physical (whiteness, tensile strength and stiffness) properties of the coated samples were tested. The coating solutions prepared in different ratios were applied to cotton samples with a wet pick up of 90%. Then the samples were exposed to drying and curing processes. To evaluate the washing durability, the treated samples were washed in Linitest Plus (Atlas) according to the ISO 105-C01:1989 E standart method. Before and after the washing process, antibacterial test according to the ASTM E2149-01 standart was made to the samples. The structure of the coatings were studied by scanning electron microscopy (SEM) using Phillips XL-30S FEG device. The colour change in the samples was measured via spectrophotometer (Hunterlab Color Quest II). The tensile strength and elongation at break values were determined according to the TS EN ISO 13934-1 standart method by automatic tensile testing equipment (Lloyd). The hardness test was carried out in Shirley hardness test equipment according to the TS 1409 standart method. To the results, hybrid coatings were found to be more effective in terms of antibacterial activity and washing durability than pure coatings (prepared by chitosan, titania or

silica). SEM images revealed the hybrid coatings were compatible with the cotton substrate. The physical tests proved that the hybrid systems were more favourable than pure chitosan coating.

Keywords: Sol-gel process, chitosan, titania, silica, antibacterial, physical, cotton.

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THERMOPHYSIOLOGICAL COMFORT OF ANTIMICROBIAL MEDICAL CLOTHES BASED ON NANOFIBRE LAYERS

Lubos Hes[1], Marcela Munzarová[2]
[1]*Technical University of Liberec, Czech Republic*
[2]*Nanovia CZ, Ltd., Litvínov, Czech Republic*
lubos.hes@gmail.com

Introduction

Due to very small pores, nanofibre layers can serve as efficient barrier against penetration of microorganisms like bacteria and viruses based. Their function depends in the mechanical collecting of microoganisms with dimensios exceeding the functional gaps among the fibres creating the barriers. If such barrier fabrics are also used as part of clothing, they should also fulfill the general requirements on clothing comfort. These requirements preferably present the highest posible water vapour permeability (WVP) and optimum thermal insulation. In this study, the mentioned thermophysiological parameters of antimicrobial three-layered sandwiches with middle layer of nanofibrous structure, manufactured by the Czech Nanovia company, were analysed and discussed. The measurent of WVP and thermal resistance various products of the Nanovia Company was carried out by means of the Czech PERMETEST commecial tester.

Characteristics of the Tested Products

The Nanovia company production is based on the Nanospider technological equipment manufactured and delivered by the Czech Elmarco Company. Principle of this electrospinning production line has been alredy described elsewhere. The nanofibre barrier layer (NFL) produced by this equipment is then sandwiched between two other nonwoven (spunbond or meltblown) single layers and their cohesion is achieved by lamination or thermobonding - see e. g. the Fig. 1. Pore volume in this structure is significantly smaller than the size of microorganisms. For example the size of Staphylococcus aureus is approximately 1 micron, and the size of N1H1 virus is about 150 nanometers (Fig. 2).

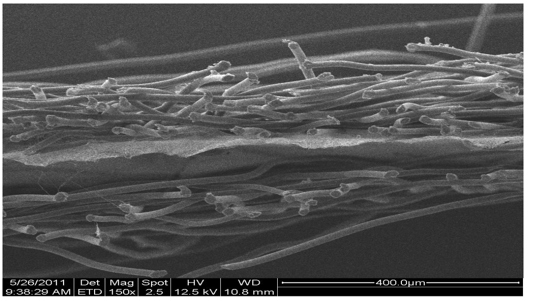

Figure1. Sandwich spunbond/NFL/spunbond

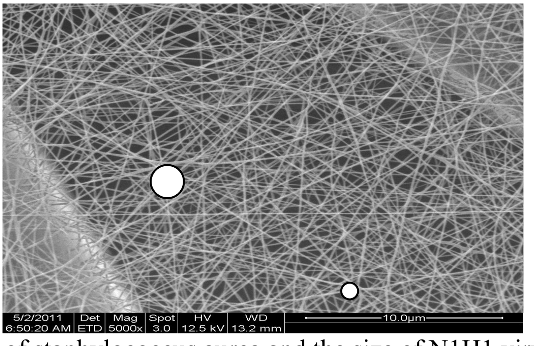

Figure 2. The size of staphylococcus aurea and the size of N1H1 virus in contrast with nanofibrous structure

The above described production technology serves in the Nanovia Ltd. Company for manufacturing of various products. In the group of Nanovia AntiMicrobe fabrics the company Nanovia Ltd offers the following three basic versions (three types) of fabrics:

1. Nanovia AntiMicrobe – stop bacteria is a material suitable for manufacturing of medical clothes **according to norm EN 13795** – surgical masks, surgical gowns and clothes.

- Structure: nonwoven fabric spunbond type/NFL/nonwoven fabric spunbond type
- Bacteria penetration resistance: ≥ 99,9 %
- High liquid and body fluids resistance (contact angle ≥ 120°)

Suitability of Nanovia AntiMicrobe – stop bacteria material for manufacturing of surgical gowns and surgical masks was tested and certified according to norm EN 13795.

2. Nanovia AntiMicrobe – stop bacteria is a material suitable for manufacturing of surgical masks **according to standard prEN 14683**.

3. Nanovia AntiMicrobe – stop viruses is a material suitable for manufacturing facemasks providing 100% bacteria collecting quality and 99,9% collection of viruses.

- Structure: Nonwoven fabric spunbond-meltblown type/NFL/nonwoven fabric spunbond type
- Bacteria penetration resistance ≥ 99,9 %
- Virus penetration resistance ≥ 99,9 %

Ability of this material to effectively collect viruses and bacteria was tested and confirmed by the Nelson Laboratories in the United States of America.

Water vapour permeability tester

The PERMETEST instrument (manufactured by SENSORA) used in this study enables the determination of relative WVP [%] and evaporation resistance Ret [m^2Pa/W] of dry and wet fabrics within 3 -5 minutes see the Fig. 2. Measuring head of this small Skin Model is covered by a resistant semi-permeable foil, which avoids the liquid water transport from the measuring system into the sample. Cooling flow caused by water evaporation from the thin porous layer is immediately recorded by a special sensing system and evaluated by the computer. Time delay between the start of the moisture transfer and cooling heat record is just several times longer then that for human skin. Thus, in terms of heat transfer phenomena this instrument presents the model of real human skin. Given by a new concept of measurement, which enables to distinguish even small changes of water amount absorbed in the fabric during unsteady state of diffusion and to record e.g. the heat of absorption and the effects of the fabrics composition and structure, very good measurement repeatability was achieved, with CV often under 3%. The instrument provides all kinds of measurements very similar to the ISO Standard 11092, and the results are evaluated by identical procedure as required in this standard. The correlation coefficient of measurements related to the ISO Standard SKIN MODEL exceeds 0.9. The results are treated statistically, displayed and recorded [8].

When the results of measurement should be expressed in terms of the water vapour resistance R_{et} [m^2Pa/W] according to the ISO 11092 Standard, then the following relationship is applied:

$$R_{et} = (p_{wsat} - p_{wo}) (1/q_o - 1/q_s) = C(100 - \varphi)(1/q_s - 1/q_o)$$

Here, q_s and q_o mean heat loses of moist measuring head in the free state and covered by a sample. The values of water vapour partial pressures $p_{w\,sat}$ and p_{wo} in Pascals in this equation represent the water vapour saturate partial pressure valid for the temperature of the air in the measuring laboratory t_o (22-25 ^oC), and the partial water vapour pressure in the laboratory air. The constant **C** will be determined by the calibration procedure. Special hydrophobic polypropylene reference fabric for this purpose is delivered with the instrument.

Figure 3. PERMETEST fast skin model

Besides the water vapour resistance, also the relative water vapour permeability of the textile sample P_{wv} can be determined by the instrument, where P_{wv} = 100% presents the permeability of free surface. This practical parameter is given by the relation:

$$P_{wv}\,[\%] = 100\, q_s / q_o$$

POSTER SESSION

UV PROTECTIVE TEXTILES

Seniha Elemen, Ahmet Çay, E. Perrin Akçakoca Kumbasar
Ege University, Faculty of Engineering, Department of Textile Engineering, Bornova, Izmir, Turkey
perrin.akcakoca@ege.edu.tr

Medical textiles are one of the 12 main application areas of technical textiles defined by Techtextil which is the leading international trade exhibition for technical textiles. Textile materials used in the medical sectors can be categorised into four groups according to the application areas: nonimplantable materials, extracorporeal devices, implantable materials and healthcare/hygiene products [1]. In healthcare/hygiene products, protection against ultraviolet (UV) radiation is one of the most important properties especially for skin diseases.

The amount of UV radiation received at the surface depends on the thickness of the stratospheric ozone layer. The risk of skin cancer increases with ozone depletion in the stratosphere which increases the amount of UV light that reaches the earth [2]. Skin cancer also depends on the sun exposure in childhood. A large part of a person's lifetime UV exposures occur during childhood [3].

UV radiation is a small part of the electromagnetic spectrum which is divided into shortwave UVC (200–280 nm), middle-wave UVB (280–320 nm) and long-wave UVA (320–400 nm) (Figure 1-a). The penetration of UV radiation in human skin is important for the development of various pathological changes. It was reported that, UVA can penetrate the deep dermis while UVB affects the epidermis and superficial dermis. On the other hand, UVC radiation hardly penetrates into the epidermis (Figure 1-b). However UVC radiation is absorbed by the atmosphere's ozone layer [4-7]. UV radiation damage DNA in human skin and cause basal cell carcinoma, squamous cell carcinoma, melanoma, photoaging and immunosuppressive effects [7, 8].

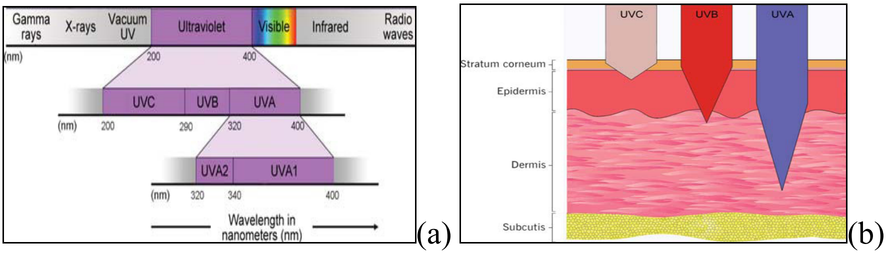

Figure 1. (a) Electromagnetic spectrum (b) Penetration of UV radiation into the skin [4]

Apart from sun avoidance and use of sunscreens, clothing provides protection from sun and skin cancers. UV protection of clothes depends on their UV protection factor (UPF) which is defined as ‘the ratio of the average effective UV irradiance calculated for unprotected skin to the average effective UV irradiance calculated for skin protected by the test fabric’ [9,10].

UV radiation permeability of a textile product is affected by fiber type, structure of fabric, color, wetness, laundering, finishing process etc. [11-15]. There are some opportunities to improve UV protection of textile like using UV absorbers or special finishing technology. UV absorbers which do not have any color, absorb in the UVA and UVB ranges of daylight spectrum. They are used to improve UV protection of textiles using different techniques [16]. The UV-blocking property of a fabric is also enhanced by titaniumdioxide, zincoxide additive finish that absorbs ultraviolet radiation and blocks its transmission through a fabric [17-18]. Photosensitive optical polymers fibers can be applied to block UV rays from light, protecting skin and soft tissues [19].

In this review, requirements for UV-protective textiles, the test methods and the latest research and information about the UV protection is mentioned.

Key Words: Medical textiles, protection, ultraviolet radiation, UV protection factor.

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DRUG DELIVERY TEXTILES

Çiğdem Akduman, E.Perrin Akçakoca Kumbasar, Ahmet Çay
Ege Üniversity, Izmir, Turkey
cigdem.akduman@ege.edu.tr

The use of textiles and fibres in medical purposes has been known from ancient times. Sutures and wound dressings are commonly well-known examples of fiber-based medical textiles. However, textile related controlled drug delivery systems were lately developed in the last few decades [1]. Drug delivery is highly innovative in terms of material to assist delivery, excipients and technology, which allow fast or slow release of drugs. A device or a material that provides a sustained release of drug can maintain desired drug concentrations in the blood with reduced number of doses, also the advantage is minimizing the concern of undesirable, sometimes toxic, side effects [2]. Considering textile based external systems, delivery through the skin bypasses the liver, thus make it possible to lower drug doses and allow site-specific delivery [1, 3].

Textile materials are quite versatile materials, combining different materials and structures. Properties and functionalities of textiles are affected by chemical, physical and physical-chemical combination of core elements. Depending on their fabrication process, textile materials have relatively ‘open’ and ‘loose’, accessible structures, with absorptive capacities as well. This open accessible structure and large surface area makes textile materials a proper material for in- and ex-vivo drug delivery applications [1].

Over the years, various delivery methods have been developed. Transdermal patches are the well-known oldest method. In many cases, in transdermal patches the textile material is simply forming just a support layer in the delivery system [1, 4]. Owing to the huge progress in polymer science, supramolecular chemistry, nanotechnology, nanobiotechnology, high-performance textile drug delivery technologies have been developed and allow advanced drug delivery systems.

Ionexchange fibres [5] drug-loaded helical and hollow fibres [6, 7], encapsulated drugs and cyclodextrin applications [9, 10] and drug loaded nanofiber mats [11-20] are the current investigated drug delivery options in textiles.

In recent years, drug release systems based on electrospun nanofibers seem to be effective due to their high surface-to-volume ratio. The high specific surface area and short diffusion passage length give the nanofiber /drug system higher overall release rate than a bulk material like polymer films. The release profile can be controlled by modulation of nanofiber morphology, porosity and composition [11-20].

In this review drug delivery systems related to the textiles will be discussed in terms of biodegradability, controllability, toxicity and the fabrication process. It will be focused on the opportunities of textiles functionalized with cyclodextrins, drug-containing nano-fibres produced by electrospinning.

Key Words: Drug delivery, nanofibers, electrospinning, cyclodextrins

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A REVIEW OF ANTIBACTERIAL AGENTS USED FOR TEXTILE APPLICATIONS

Buket Arık[1], Ebru Bozacı[1], Aslı Demir[2], Tülay Gülümser[1], Esen Ozdogan[1], Necdet Seventekin[1]
[1] *Ege University, Textile Engineering Department, Izmir, Turkey*
[2] *Ege University, Emel Akın Vocational High School, Izmir, Turkey*
buket.arik@ege.edu.tr

Customer desire for comfort, hygiene and well-being has created a large and rapidly increasing market for antibacterial textiles and various antibacterial textile agents have emerged. These antibacterial agents differ in their chemical structure, effectiveness, method of application, washing durability and influence on people and the environment as well as cost [1].

Natural fibers such as cotton, viscose and flax are very susceptible to bacterial attacks because their porous hydrophilic structures retain water, oxygen and nutrients, which provide a perfect media for the growth of microorganisms. Therefore, various antibacterial finishes have been developed for textiles [2].

Bacteria are tiny living organisms and they can have a major impact on human life. Bacteria need an environment providing nutrients, humidity and appropriate temperature to survive. Bacteria can be identified as either gram positive or gram negative, which can be distinguished by the content and structure of their cell wall through a staining procedure called gram stain [3].

An antibacterial finish is used to reduce the spread of microorganisms by either killing or inhibiting their growth on the fabric surface. Three mechanisms (controlled release, regeneration, barrier block) of antibacterial agents could be used to control or inhibit bacteria [3]. For this finishing process metal and metal salts, quaternary ammonium compounds, N-halamines, chitosan, polybiguanids, halogenated phenols, nanoparticles of noble metals and metal oxides, dyes and bioactive plant-based antibacterial agents can be used [1,4]. Some of these products are applied at the finishing stage while the others can be incorporated into synthetic fibers during extrusion. On the other hand, the use of several other biocides, such as chitosan and its derivatives, specific dyes and regenerable active *N*-halamine compounds and peroxyacids, is in the development stage [4].

In recent years, the scope of the studies has directed not only to antibacterial activity but also to the durability of this activity and safety concerns. It should be considered that the release of finishes from the textile into the surroundings could have negative impacts on living organisms in water because they can affect susceptible bacteria, thereby potentially selecting resistant bacteria [1]. For this aim the researchers have started to perform human and aquatic toxicity and irritation tests. Arslan-Alaton studied the degradation of a commercial textile biocide formulation containing a 2,4,4′-trichloro-2′-hydroxydiphenyl ether as the active ingredient with advanced oxidation processes and ozone of acute toxicity tests (LC_{50} values) [5]. Rajendran et. al, developed an effective technology for the extraction of sericin which is known as a degradable biomedical material, this sericin extract was coated onto cotton fabric by a pad–dry–cure method and the antibacterial activity was tested [6].

In order to enhance the durability of antibacterial treatments, derivation of the agents and new application processes have been investigated. In this point of view, Fu et. al, synthesized three water-soluble chitosan derivatives bearing double functional groups. The synthesized chitosan derivatives were applied to cotton fabrics together with citric acid (CA) as the crosslinking agent to evaluate their usage as durable antibacterial textile finishing agents. The antibacterial activity of O-QCTSS treated fabric was still more than 75% after 20 consecutive home launderings [7].

In this review, the most promising antibacterial agents available for textile processes were investigated in terms of chemical structure, application to textile surface, efficient and durable antibacterial activity and health issues. Therefore, the latest researches on this matter were compiled and the results of these studies were evaluated.

Key Words: Antibacterial, textile, antibacterial activity, washing durability, toxicity

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CLOTHING OF RHEUMATIC DISEASE

Zümrüt Bahadir Ünal[1], Behiye Elif Şamli[1], Hülya Bahadir Çolak[2], Sibel Eyigör[3]

[1]*Ege University, Faculty of Engineering, Department of Textile Engineering, Bornova, Izmir, Turkey*

[2]*Tepecik Training and Research Hospital, Internal Medicine, Nephrology, Izmir, Turkey*

[3]*Ege University, Faculty of Medicine, Department of Physical Medicine and Rehabiliation*

zumrut.bahadir.unal@ege.edu.tr

Clothing is one of the most important factors to protect human health. Clothes must have some characteristics to be healthy. Primarily, the chosen piece of clothing has to be adequate to the season's warmness. Particularly the inner surface of the garment should not cause allergy, not be irritating to one's skin and absorb the sweat. Garment pattern is important for comfort and health besides fabric material, structure and finishing treatments. Garment pattern and fabric should not restrain movement in accordance with using of garment. Tightness of clothing should not affect negatively human's circulatory system.

Clothes should keep body temperature at constant temperature of 37°C with maximum tenth difference depending on the season. Clothes always have a stabilizing effect between skin and environment temperature. Clothes must balance between the warmth of the skin and its environment. If they fit to the ambience' temperature the elevated body temperature's mechanism comes off. Therefore you have to keep in mind the body's temperature which becomes higher during working. Approximately 90% of body surface is faced with the micro-weather conditions under clothes instead of weather conditions in environment. Fabric material, structure and handling properties are the most important factors that affect the micro-weather conditions.

Rheumatism is the name given to disease with more than 200 varieties that cause various disorders at internal organs, bring about swelling, pain, limitation of movement at the muscle and skeletal system that provide the movement of the body. Rheumatic disease emerge herewith genetic factor effect, weakened immune system, various infections, environmental conditions and exposure to cold. Most rheumatic diseases are influenced negatively by the cold weather, current and moisture.

Increase in the sweat and heat dissipation to the environment triggers the rheumatism. Most people, suffering from rheumatism feel better in warm clothes. Therefore body should be kept warm and appropriate wearing for preventing the pains and exacerbation of the disease. People, suffering from rheumatism should stay out of extreme cold and hot, prefer cloths that are not tight. Some properties of these clothes are good thermal insulation and moisture management.

Besides expensive drug, a cure at spa and exercise can be done thermotherapy with thermal clothing economically. Some scientific researches indicated that this means serious declines in drug utilization. Also thermal cloths protect the body against sudden thermal change and provide thermal effects with increasing blood circulation. For that purpose sales of angora companion medical stuff like stays, socks, wristband, undershirt, kneepad, elbow pad, shoulder pad, muffler, glove and beret. These segments prevent heat abduction to environment from the area that has disease. By this means provided local hyperemia (accumulation of heat) and consisted local heat keeps the mechanism of temperature regulation in the range of specific hot throughout the day. There are scientific researches stating that due to these reasons are the pains on the decrease. For example some angora blended products are suggested as support for treatment at diseases such as rheumatism, arthritis, sciatic, diarthrosis and muscle pains, carpal tunnel syndrome, chilblain, circulatory abnormalities and kidney disorders.

The most common causes of admission to the hospital for rheumatism sick are pain and limitation of movement. Expenses for medical workup, treatment and hospitalization reach to high amounts. Decreasing costs of warm clothes will contribute for government’s budget. These clothes help to maintain an optimal level heat and humidity equilibrium of skin. This situation has the influence of decreasing the patient presenting with rheumatism.

The aim of this research is to awake the peoples’ awareness, suffering from rheumatism for suitable clothing. It will make a public-opinion poll as the method of measurement. As a result that survey will be analysed and shared with several societies.

Key Words: Rheumatic diseases, clothing, angora, thermophysiological comfort

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ELASTIC YARNS IN MEDICAL TEXTILES

Tuba Bedez Üte, Hüseyin Kadoğlu
Ege University, Textile Engineering Department, İzmir, Turkey
tuba.bedez@ege.edu.tr

Elastic yarns for medical textiles are generally used for non-implantable materials for external applications on the body. The well known application areas of elastic yarns in medical textiles are compression stockings, light support materials, medical corsets, orthopaedic bandages and dressings [1].

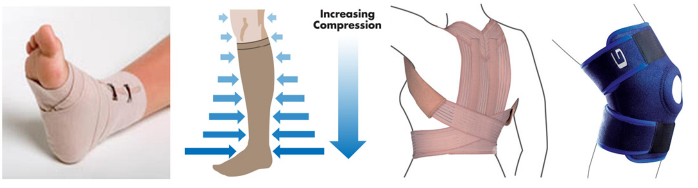

Figure 1. Elastic bandages, compression stockings, medical corsets and support materials [2, 3, 4].

Due to different requirements naked elastane is not used in the textile structure. Generally it is covered with other raw materials which are chosen according to the end use. Elastic core-spun yarns have the same feel as the shield fibers and they are comfortable to wear due to their adjustable elasticity [5]. With the use of elastic yarns in the garments, a better fit on the body like a second skin can be succeeded [6]. The most common methods for producing elastic yarns are single and double covering, ring twisting, doubling and stretching on two for one twisting frames, elastic twisting by hollow spindle method, twisting on elasto-twister, core spinning, sirospun and air covering. Recently, OE rotor spinning method was used to produce elastic core spun yarns. The new elastic rotor-spun yarns are less expensive, less hairy and more uniform than elastic twists and ring-spun core yarns [7].

Compression stockings are a type of hosiery that exerts a graduated pressure to the lower leg and foot to extenuate circulatory problems, especially prevent excessive blood accumulation in the lower extremities caused by faulty vein valves. For this purpose strong elastic materials have to be used for compression stockings unlike ordinary socks [8, 9]. Compression stockings should provide a precise and gradient compression and should apply pressure at the ankles instead of the calves. Besides they have to provide sufficient clothing comfort to the user, otherwise patients may refuse to wear them if they do not fit well [10]. Constant elasticity, precise compression and wearing comfort must be provided with elastic medical materials. With the increasing requirements, yarns can be produced with natural materials such as seaweed, bamboo, aloe vera, for satisfying improved comfort and performance properties [11]. The functional properties of knitted medical stockings can be determined by the raw material and the design parameters such as gradual compression and size. Control over the compression degree was fulfilled by the amount of elastomer incorporated in the product and by the knitting system. The European Standard specifies that the raw material used for compression hosiery includes a stretchable yarn, made by covering an elastic core of polyurethane with other types of fibers (cotton or polyamide) [12]. Compression stocking can be produced from two types of yarns. Body yarn provides the thickness and the rigidity of the fabric, the inlay yarn determines the compression. Inlay yarns can be produced single or double covered. Single covered yarns are produced with covering a filament on the elastic core and they have relatively poor elasticity. Double covered yarns have more stable structure due to twist balancing [13]. The compression ratio can be adjusted with changing the elastan count [14]. It is found that, when the number of inlay yarns in the compression stockings structure increases, wale way extensibility increases but course way extensibility decreases significantly. In terms of yarn count, inlay yarn significantly affects the course way extensibility. The compression stockings knitted from coarser inlay yarns have lower wale way but higher course way extensibility [15].

The elastic bandages are commonly used to hold and protect a medical device such as a dressing or splint or to provide support to the body. Muscle sprains and strains can be treated with elastic compression bandages by applying localized pressure. Recently, the composition of elastic bandages has changed due to risk of the latex allergies. The modern elastic bandages are produced from cotton, polyester and latex-free elastic yarns. By changing the ratio of the component fibres, various grades of compression can be achieved [16, 17]. Orthopedic support materials are used for protection and to support of the joints in various parts of the body. The most common application areas of orthopedic support materials are knee, ankle, elbow, waist, shoulder. The elasticity of light support materials can be provided by using hard-twist crepe yarns. Aside from the use in medical purposes, elastic girdles can be used to beautify the lower body part of the body for aesthetic purposes [18]. The structure and te materials used in the production of that girdles are very important, to avoid possible health problems and discomfort.

Key Words: Bandages, compression hosiery, corsets, elastic yarns, medical textiles.

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RECENT DEVELOPMENTS IN HEALTH CARE

Berna Cureklibatir[1], Esra Zeynep Yildiz[1], Ziynet Ondogan[2]
[1] *Ege University, Emel Akin Vocational Training School, Izmir, Turkey*
[2] *Ege University, Textile Engineering Department, Izmir, Turkey*
berna.cureklibatir@ege.edu.tr

The original function of textiles was to shield man from cold and rain. Later on in history, aesthetic aspects also came to play a role in clothing. Much more recently, a new generation of textiles has arisen; smart or intelligent textiles. Intelligent textiles are a relatively new discipline in the textile sector. They are active materials that have sensing and actuation properties [1].

Nowadays, as the world and technology change, new areas that require novelties emerge. Many societies are undergoing demographic changes such as the aging of the population, further integration of disabled persons and an increase in chronic diseases. Citizens, patients and health providers face new challenges as they strive to optimize quality and cost [2].

There is a foreseeable demand of simple, efficient and economical monitoring systems for home health care purpose to reduce health care expenditure of the society and also to improve the quality of life of the people. However, measuring physiological variables several times a day is inconvenient to most people, especially the elderly and non-hospitalized patients suffering from chronic diseases [3].

Many researchers have been done to suggest solutions for this problem like smart clothes which gather information about personal health and life style, then transfer and analyze the info. Heart rate, respiration and body temperature can be measured by the cloth that is worn and related people can be informed, if necessary [4]. Also, caloric intake and expenditure, patterns of sleep, contextual activities such as working-out and driving, even parameters of mental state and health can be checked [5].

The potential impact of smart textiles for health care is significant; risk assessment and diagnosis will be faster and more accurate, treatment and care will be more effective. The ageing population increasingly requires health monitoring. These new textiles are knowledge based with high added value. They can be custom made for specific end uses. Consequently their economic impact is expected to be extremely high as well [1].

Key Words: Health care, elderly, non-hospitalized patients, health monitoring.

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DESIGNING AND DEVELOPING A CARRIER CORSET SUITABLE FOR USAGE AT PREGNANCY PERIOD

Erhan Kenan Çeven[1], **Atıf Ersöz, Yusuf Ziya Karaca**[2]
[1]*Uludag University, Faculty of Engineering and Architecture, Textile Engineering Department, Gorukle Campus, 16059, Nilüfer, Bursa, Turkey,*
[2]*Aşıkpaşa Hospital, Clinic of Orthopedics and Traumatology, Kırşehir, Turkey*
rceven@uludag.edu.tr

Abstract
Nowadays, as the women have a more active part in working life, the back pain experienced during pregnancy increases. The most affected part from these back pains is the women having the professions in which they are incurred to standing for long periods like teaching and surgery. There are many reasons for back pains. Some of the reasons are shifting forward of one's center of gravity due to the additional weight of the fetus and the environment in which the fetus is and the local weight gain at the pelvis area. The pregnant can stretch the back muscle as trying to provide the body balance in order not to fall down. And this situation can cause back pain. 70% of all pregnant women experience back pain during the period of pregnancy. With this project study it is aimed at designing, developing and commercially producing a carrier corset suitable for usage at pregnancy period.

Key Words: Carrier corset, pregnancy, back pain

Literature Review
One of the most common complaints during pregnancy is back pain. It leads to a loss of labor and difficult birth. As the pregnancy progresses back pain complaints increase and the movements of the pregnant is restricted. Some of the most important reasons for this pain are shifting forward of ones center of gravity due to the additional weight of the fetus and uterus and also the local weight increment at the pelvis area [1–4]. Pregnant women involuntarily move their shoulders back and the abdomen forward in order to walk comfortably and balance the body. All these cause the flattening of the spine and stress at the back muscles resulting with the pains [5,6]. Increased pregnancy hormones, particularly progesterone soften the pelvic bone joints in order to facilitate the passage of the baby at birth. Also the spine joints are

softened and the anatomical structure of this region changes. This situation also leads to back pains [5]. In the beginning of the pregnancy little weight is gained. This is 1- 1.5 kg. Thereafter there is approximately 400 g weight gain at each week. After 14 weeks, it is possible to get 0.5 kg per week. This means 2 kg per month. After 30 weeks the weight gain decreases. The body weight increase up to 20 % at the last month of the pregnancy [7]. The distribution of the weight gain is: fetus (3.5 kg), blood circulation (1.8 kg), fat, edema, muscle (4.5 kg), placenta (0.7 kg), uterus (0.8 kg) and amniotic fluid (0.7 kg) [8]. In the various studies done prospectively and retrospectively, it is reported that 14.2 – 76.6 % of the pregnant women suffer from short-or long-term low back pain at any stage of pregnancy. Approximately, 1/3 ratio of the pregnant women's daily living activities are affected by the pains and these pains lead to significant disability at 6-15 % of the women. In a study, it was reported that 22 % of the women were found to be suffering from back pain also before pregnancy. Other studies reported that the severity of the back pain emerging during pregnancy was more at the pregnant women who suffer from back pain at pre- pregnancy period [9].

Analysis and Discussion

Figure 1 shows the anatomical changes existing week by week during the pregnancy period.

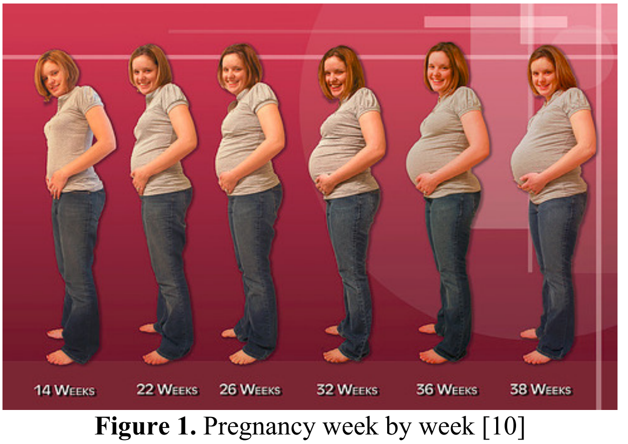

Figure 1. Pregnancy week by week [10]

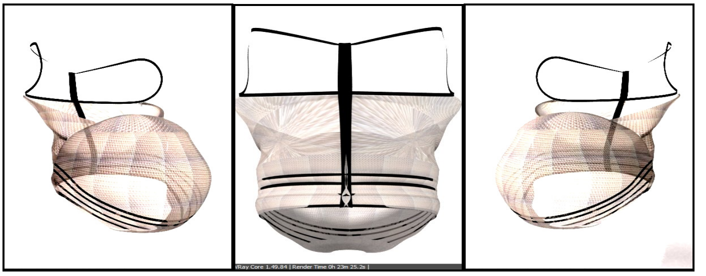

Figure 2. Corset design

Figure 2 shows the corset design which has a knitted structure. The structure consists of cotton and/or bamboo elastane core-spun yarn which enables flexibility and moisture absorbent property to the fabric. It is aimed at transferring some of the load at the belly to the shoulder by the strips passing through the lower part of the belly. These bands also will ensure the body's center of gravity to a point near its original position. The design of the corset will also reduce the frequent toilet needs of pregnant by lowering the pressure of the growing uterus on the urinary bladder. In addition to these utilities, baby will be protected from electromagnetic waves emitted from electromagnetic sources such as mobile phones and computers by using silver fiber blended yarns having EMS (Electromagnetic Protection) feature at the structure of the corset.

Conclusion

The study has multi-disciplinary property and expected to contribute to the university-industry cooperation. Patent application related to the new product design will be made.

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POTENTIAL NATURAL COMPOUNDS FOR WOUND DRESSINGS

Gamze Doğan[1], İpek Erdoğan[2], Güldemet Başal Bayraktar[1]
[1] *Department of Textile Engineering, Ege University, İzmir, Turkey,*
[2] *Department of Bioengineering, Izmir Instıtute of Technology, İzmir, Turkey*
gamze.dogan@usak.edu.tr

Wound Healing Society defines wound as the result of disruption of normal anatomic structure and function [1]. Wounds can be classified as acute or chronic wounds due to repair process. Acute wounds arise from external factors such as friction, cuts, burns and chemical injuries. Chronic wounds fail to heal because of repeated tissue insults or underlying physiological conditions [2]. Wound dressings are synthetic or natural materials that aid wound healing. Wound dressings that can be in film, foam or fibrous forms are classified due to their compositions. Class I consists of cultured epidermal equivalent, class II includes dermal components as collagen and matrix proteins and class III is a combination of dermal and epidermal components, also referred as composite skin [3]. Ideal wound dressing should provide thermal insulation and optimum moisture for wound interface, allow oxygen and CO_2 gas transition, protect wound from microorganisms and decrease infection risk. Also they should be non-allergenic, non-inflammable, non toxic, and free from particulate contaminants [4]. In this survey, properties of ideal wound dressings, plant extracts that can be used with wound dressing materials will be discussed.

Natural compounds have been attracting attention for thousands of years due to their important features. They prevent and reverse infectious diseases. In the last decades, antimicrobial and antioxidant activities of natural compounds, development and potential uses of new products incorporated with these compounds were widely searched. Olive leaf extract (*Olea europaea*) [5], Turkish Sweetgum (*Liquidambar orientalis*) [5], Thyme oil (*Thymus vulgaris*) [6], Lotus (*Ziziphus jujuba*) [5], Juniper (*Juniperus communis*) [5], Terebinth (*Pistacia terebinthus*) [7], Mastic (*Pistacia lentiscus*) [7], St John's wort (*Hypericum empetrifolium*) [7], Maiden hair tree (*Ginkgo biloba*) [8], *Jasminum auriculatum* [8], and Asiaticoside (*Centella asiatica*) [8, 9] are some of the natural compounds that have potential uses with wound dressings due to their antimicrobial, anti-inflammatory and/or antioxidant properties that help to the healing process.

Olea europea includes phenolic compounds that make itself antioxidant. Health benefits such as cardioprotective and chemopreventive effects arise due to antioxidant activity [10, 11]. Its antimicrobial effect was proved against bacteria and fungi [12]. *Liquidambar orientalis*, that is antibacterial and antifungal, has a favorable effect on wound healing [13]. It is also used in treatment of bronchitis and asthma [14]. Thymol and carvacrol are the active materials found in *Thymus vulgaris*. *Thymus vulgaris* gains antiaxidative, anticarciogenic and antimicrobial activity [15,6]. Antibacterial activities of *Pistacia terebinthus*, *Pistacia lentiscus*, and *Hypericum empetrifolium* loaded on silk fibroin/chitosan films were investigated and were found antibacterial against *Escherichia coli* and *Staphylococcus epidermidis* [7]. *Ziziphus jujube* and *Juniperus communis* are other plant extracts that have been investigated in terms of antimicrobial activity [5]. *Jasminum auriculatum* and *Ginkgo biloba* are the extracts that improve wound healing process [9]. *Ginkgo biloba* also increases the blood fluidity and exhibits antioxidant activity [16]. Active materials of *Centella asiatica* supports rapid wound healing [9]. By increasing collagen synthesis in vitro and extra cellular matrix accumulation in vivo, enhances tensile strength of wound tissues [10].

Studies on plant extracts and their usage as wound healers are going on rapidly. Since contents of plant extracts may differ according to growing region, they have the advantages of exhibiting two or more effects during treatment. Plant extracts mentioned in this study and many others are good candidates for wound dressing applications.

Key Words: Wound dressing, natural compounds, antimicrobial activity, antioxidant activity

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MEDICAL NONWOVENS

Deniz Duran[1], Kerim Duran[2]
[1]*Ege University Emel Akın Vocational Training School, 35100 Bornova-Izmir, Turkey*
[2]*Ege University Textile Engineering Department, 35100 Bornova-Izmir, Turkey*
deniz.duran@ege.edu.tr

Nonwovens are a relatively new class of nonwoven materials which integrate to new application areas to replace conventional textile materials and gain more importance day by day. Nonwovens are formed by bonding the fibers by various techniques. Due to their unique microstrucure, porosity, absorbency, light weight and high surface are, microfiber meltblown nonwovens are promising materials for various application areas. [1]

Nonwovens are known for delivering superior performance in specialized tasks because they can be designed the way an application needs them to be. The properties which make nonwovens the best choice for medical products are; excellent barrier properties, superior efficiency, better performance (comfort, thickness and weight, water vapor transmission, air permeability etc.), increased protection for user (better physical properties like tensile, tear resistance, abrasion resistance etc.) and less potential for cross contamination. [2]

This paper focuses on drawing an overwiev of medical nonwovens market, products and related properties. After significant development of nonwovens, medical nonwovens were designed in a way to suit the medical needs and give a performance much better than their woven counterparts in terms of cost, effectiveness, disposability etc. According to INDA, medical and hygiene sectors combined together consume more than 90% of the total nonwoven production in US in 2008. On the other hand, in developing countries of Asia, Africa and South America, demand for medical nonwoven is increasing significantly as a result of a fast-growing, increasingly urbanized, young, health-conscious population. In future, the demand of nonwovens in medical field is expected to grow steadily. [2]

In hospitals, cross-contamination is always one of the biggest problems which were attributed largely to re-using of woven gowns, masks and other similar articles which would get contaminated and potentially spread the germs. The advent of nonwovens facilitated the development of a more cost effective alternative which was disposable and reduced the problem of cross-contamination greatly.

Medical nonwoven products are effectively employed in use in ambulances, consultation couches, laboratories, operating rooms, wards etc. These products find applications in a variety of products such as medical filters such as blood filters, surgical drapes and gowns to prevent the transmission of infectious agents between patients and clinical staff during surgery, wound care, absorbent pads, incontinence products, apparel for patients and staff. Baby diapers, bed linen and blankets, burn dressings, gowns, disposable underwear, dressings, drug delivery devices, face masks, filter media, nasal strips, pillows, shoe covers, sponges, sutures, tissue scaffolds, towels, wraps etc. [2,3]

Key Words: Medical nonwovens, medical filters, wound care, tissue scaffolds, barrier fabrics

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FINISHING OF COTTON MEDICAL TEXTILES

K. Duran, A. Körlü, C. Can, S. Elemen
[1]*Department of Textile Engineering, Ege University, İzmir, Turkey*
kerim.duran@ege.edu.tr

Micro-organisms are part of our daily life. You will always find bacteria on a healthy skin. This colonization protects our organism. Micro-organisms can basically be divided into bacteria, mildew, yeast and viruses. Close contact with the skin, long periods between washings and a special microclimate can favour a fast growth of germs. These bacteria and fungi and their decomposition products cause infections, unpleasant odours in clothes, sportswear and shoes and allergies [1].

So, customer desire for comfort, hygiene and well-being has created a large and rapidly increasing market for hygienic textiles. Numerous manufacturers in the textile industry have responded to this demand by launching their brands of antimicrobial and hygienic products [2]. The growth of microorganisms on textiles inflicts a range of unwanted effects not only on the textile itself but also on the wearer. These effects include the generation of unpleasant odor, stains and discoloration in the fabric, a reduction in fabric mechanical strength and an increased likelihood of contamination. For these reasons, it is highly desirable that the growth of microbes on textiles be minimized during their use and storage. Consumers' demand for hygienic clothing and active wear has created a substantial market for antimicrobial textile products. Estimations have shown that the production of antimicrobial textiles was in the magnitude of 30,000 tones in Western Europe and 100,000 tones worldwide in 2000. There is also a broader market for antimicrobial fibers, for instance, in outdoor textiles, air filters, automotive textiles, domestic home furnishings and medical textiles. This high demand, in turn, has stimulated intensive research and development [1, 2].

Medical textiles (textile materials used in the medical and related healthcare and hygiene sectors) are an important and growing part of the textile industry. Wound dressings are an important part of the medical textiles industry. Wound dressings are materials used to cover the wounds. The primary functions of the wound dressings have been to avoid to strikethrough and to protect the wound site from contamination and further injuries. Wound dressings need to be easy to apply and easy to remove. These traditional requirements for wound dressings have largely been met by the various types of gauzes, woven, nonwoven and knitted gauzes [3]. Carboxymethylated gauze are hygroscopic and have high moisture-retentive value according to the conventional cotton gauze [4,5].

The aim of this project is to investigate carboxymethylation of cotton gauzes and determine the treated textiles' mechanical and physical properties. It's expected that moisture-retentive value of carboxymethyl gauze will increase according to the conventional cotton gauze. And the capacity to hold greater amounts of antimicrobial solution on carboxymethyl gauze will create the possibility of more effective antimicrobial treatments. It's expected that carboxymethylated cotton gauze will be an ideal burn dressing. Because carboxymethylated cotton gauze are hygroscopic, which, upon the uptake of wound extudates and reduce the tendency of fibers to adhere to the wound. Because of their gel-forming characteristics, they can be easily removed without any tissue damaging of the new healed wounds of burn patients.

Central composite design will be used during the experiments. The effect of four parameters (time, temperature, NaOH concentration and chloroacetic acid) with five levels will be investigated.

Factors	Levels				
	-2	-1	0	1	2
X_1- CMAA concentration (g/l)	0	100	200	300	400
X_2-NaOH concentration (g/l)	0	120	160	200	240
X_3- Temperature (?C)	20	30	40	50	60
X_4- Time (min)	20	30	40	50	60

No	MCAA (gr/L)	NaOH (gr/L)	T (C)	t (min)	No	MCAA (gr/L)	NaOH (gr/L)	T (C)	t (min)
1	100	120	30	30	16	300	200	50	50
2	300	120	30	30	17	0	160	40	40
3	100	200	30	30	18	400	160	40	40
4	300	200	30	30	19	200	0	40	40
5	100	120	50	30	20	200	240	40	40
6	300	120	50	30	21	200	160	20	40
7	100	200	50	30	22	200	160	60	40
8	300	200	50	30	23	200	160	40	20
9	100	120	30	50	24	200	160	40	60
10	300	120	30	50	25	200	160	40	40
11	100	200	30	50	26	200	160	40	40
12	300	200	30	50	27	200	160	40	40
13	100	120	50	50	28	200	160	40	40
14	300	120	50	50	29	200	160	40	40
15	100	200	50	50	30	200	160	40	40

Key Words: Carboxymethylation, cotton, antibacterial, textile

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PROTECTORS FOR HIP FRACTURES

Gözde Ertekin, Arzu Marmaralı
Ege University, Faculty of Engineering, Department of Textile Engineering, Bornova, Izmir, Turkey
gozde.damci@ege.edu.tr

Fractures amongst older people are a major public health problem. This is true not only economically but also for the health and well-being of older people, because fractures cause long-standing pain, functional impairment and disability, and have a high mortality rate. Moreover, a fracture and the fear of its consequences, such as isolation, loss of independence and admission to a nursing home, can cause significant mental and psychological suffering [1].

Hip fractures represent a severe health problem for the elderly [2]. A hip fracture is a break near the top of the thighbone (femur) where it angles into the hip socket. The break is usually detected at the femoral neck or intertrochateric region of the hip joint [3]. 1.66 million hip fractures occurred worldwide in 1990 [4] and the projections indicate that each year the number of hip fractures occurring in the world will rise from 1.66 million in 1990 to 6.26 million by 2050 [5].

More than 90% of all hip fractures are the consequence of a fall, which typically occur from standing height towards the side, and are characterized by a direct impact to the hip [6]. According to Kannus et al., 25% of sideways falls in the elderly cause hip fractures [7]. It has been well documented over the years that a third of individuals over 65, and nearly half of those over 80, fall each year [8]. According to the survey, fall has become the third reason that causes the elderly people paralyzed in bed [9].

Various methods has been developed for the prevention of fractures, including exercise, calcium and vitamin D supplementation, specific drugs to prevent or treat osteoporosis, and multifaceted interventions to modify the risk of falling. However, since in most cases of hip fracture the immediate cause of the fracture is a sideways fall with direct impact on the greater trochanter of the proximal femur, a logical option is to use a device to protect the hips [10]. Hip protectors are designed to decrease the impact of a fall from the vulnerable hip area (the femoral neck) and/or to redistribute it to less vulnerable areas. As a result, the force that is transferred to the hip in a fall is reduced and the potential of a hip fracture is minimized [3].

Hip protectors are garments worn by older people who are at risk of falling and are thus at an increased risk of experiencing a hip fracture. The standard design of hip protectors includes two pads, one sewn into each leg of a pair of briefs. The materials used in the undergarment and hip protector pads differ between makes, and the size and method of protection offered by the pads also vary [8]. Hip protectors have been developed through substantial biomechanical testing and have been found to be technically able to prevent hip fractures by protecting the bones, notably the greater trochanter and proximal femur, during a fall episode [11].

In 1988, Wortberg proposed the first hip protector, which was made of a special silicone rubber. Since then, alternative concepts such as the use of airbags or a fluid-containing pad system have also been suggested [2].

At present, mainly two types of products, namely energy-absorbing soft pads and energy-shunting hard shells, as well as combined systems, are used to protect the hip in the case of impact loads in the area of the greater trochanter. The principle of an energy-shunting hip protector is to distribute impact loads away from the trochanter to the surrounding soft tissue, while an energy-absorbing device attenuates impact forces by means of a shock-absorbing material [2].

In this study, a comprehensive research on the types and properties of hip protectors and studies conducted on hip protectors will be accomplished.

Key Words: Hip fracture, prevention, hip protector

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WORKING SAFELY IN PATHOLOGY

Mustafa Ertekin, Erhan Kırtay
Ege University, Faculty of Engineering, Department of Textile Engineering, Bornova, Izmir, Turkey
mustafa.ertekin@ege.edu.tr

Pathology is the precise study and diagnosis of disease. Pathologists are doctors who diagnose and characterize disease in living patients by examining biopsies or bodily fluids. In addition, pathologists interpret medical laboratory tests to help prevent illness or monitor a chronic condition [1].

The key to safety in the surgical pathology laboratory is to recognize that this area is a dangerous place. A variety of noxious chemicals are routinely used in the surgical pathology laboratory, and tissues infected with the human immunodeficiency virus (HIV), hepatitis viruses, mycobacteria and other agents enter through its doors on a daily basis. Not only are these infectious agents present in the laboratory, but their transmission is also facilitated by the frequent handling of bloody tissues and the routine use of surgical blades, knives, saws, and other sharp instruments (see Figure 1.). Clearly, the surgical pathology laboratory is no place to ‘‘let down one’s guard’’ by becoming careless or distracted [2].

Figure 1. Blades, scalpels and other sharp instruments

Besides histological diagnostics, conducting autopsies and preparing and dissecting surgical pathology specimen are the main tasks of surgical pathologists. Because precision is paramount for pathological workup of tissue, both former activities include the use of various extremely sharp blades and scalpels. Not surprisingly, the constant use of such instruments quite frequently leads to injuries. Cutting injuries and needle stitch injuries could vary from harmless superficial wounds to deep lacerations. An additional danger associated with the handling of fresh or partially fixed human tissue is the danger of transmission of blood-borne diseases [3].

For the protection of oneself and for the safety of others, the pathologists should use protective personal equipment in the cutting area at all times. Protective personal equipment prevents contact of potentially infectious materials with the skin and mucous membranes, and it diminishes the transfer of infectious material outside of the surgical pathology laboratory. Protective personal equipment should include surgical scrubs, waterproof shoe coverings, a surgical gown and/or waterproof forearm wraps, a cap, a mask, eye protection and gloves [2].

Pathologists can reduce the likelihood of cutting and needle-stitch injuries by using technology that creates barriers to exposure.' One important primary barrier to exposure is the latex glove. However, this barrier is too easily breached by needles and sharp surgical instruments. Once breached, a glove is no longer an effective barrier to infection, necessitating a change in gloves as soon as practical after the breach is detected. Unfortunately, most glove breaches are not noticed for some time after perforation. [4]

In this study in order to show the inefficacy of the latex glove we produced 3 different knitted fabrics made of cotton, polyester and para-aramid fibres and compared their cut resistance according to EN 388 "Protective Gloves Against Mechanical Risks".

Cotton, polyester and para-aramid yarns are spun on a sample ring spinning frame and then fabrics are knitted as single jersey by a lab knitter. Yarns are spun with the same parameters like the coefficient of twist (αe =3.5), spindle speed (7500 rpm) and yarn count (20 Ne).

The results show that:

Latex glove's, cotton and polyester fabrics' T_n (the number of tenth of cycles necessary to cut through the n^{th} testing fabric) values were all "0", so gloves made of cotton or polyester with these fabric structures will perform same as latex gloves with regard to cut resistance. The para-aramid fabric which has the lowest weight value was more cut resistant than cotton and polyester fabrics.

Since hands are the body area most frequently injured by scalpel blades, their protection requires special attention. Considering the medical and other costs of such injuries, cut-resistant protective gloves will be an easy, effective and cheap safety measure to be taken.

Key Words: Cut resistance, protective glove, pathology

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BURN GARMENTS FOR HYPERTROPHIC SCARRING

D. Gazioglu[1], K. Kanchi Govarthanam[2], S.C. Anand[2]
[1]*Uludag University, Textile Engineering Department, Bursa, Turkey*
[2]*The University of Bolton, Institute of Materials Research and Innovation, Bolton, UK*
dyggazioglu@gmail.com

Skin burns are usually caused by contact with fire, heat, electricity, light, radiation, hazardous chemicals and friction. The degree of the burn is classed based on the extent and depth of the burn [1].

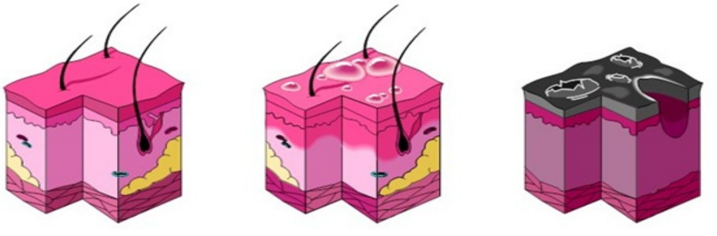

Figure 1. Types of burns

Hypertrophic scarring is caused due to increased vascularisation of the burnt area with abnormally large vessels, and also due to the abnormal orientation and synthesis of collagen fibres. Managing burns is important because they are common, painful and can result in disfiguring and disabling scarring [2]. There are a lot of methods to manage the burns; preventive managements, curative managements, and new developments [3].

A third degree burn is classed as a severe burn and compression therapy is universally accepted as the treatment to manage hypertrophic scarring caused after such burns. The use of pressure garments relies on two factors; firstly the limitations of blood flow to the scar area; and secondly, constant pressure to prevent the growth of hypertrophic scar tissue [1].

Figure 2. Pressure garment

The thermophysiological properties of the compression garment provide comfort by preserving body temperature and moisture output close to their normal levels [1,4].

In this study, the dimensional, mechanical, and thermophysiological properties of four fabrics procured from different sources were thoroughly studied and compared. The study was aimed at the determination of their suitability to be utilised for the management of hypertrophic scarring. It was established that one of the fabrics investigated possessed superior properties in comparison to the other three fabrics. It was also demonstrated that the characteristics of this particular fabric can be further enhanced for its suitability for use as compression garment for this specific area of application.

Key Words: Burns, hypertrophic scarring, pressure garments

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APPAREL PRODUCTION STAGES OF A MEDICAL TEXTILE; SHELL CUSHION FOR HANDICAPPED CHILD

Meral İşler[1], A. Aslı İlleez[2], Mücella Güner[1]
[1] *Ege University, Textile Engineering Department, İzmir, Turkey*
[2]*Ege University, Emel Akın Vocational High Scholl, İzmir, Turkey*
meral.isler@ege.edu.tr

Abstract
In apparel production product variety is getting increased day by day. While most of the companies producing simple textile products (t-shirt, pants, skirts etc.), few of them producing high value added products (medical textiles, technical textiles…). Production stages of both categories are similar in most steps. In this study apparel production stage of a medical textile was examined. Production of a shell cushion and the additional covers for a wheelchair used for handicapped children was chosen for this study.

Key Words: Clothing, medical textile, production, shell cushion, handicapped wheelchair

Introduction

Wheelchairs and related mobility accessories (cushions, clothing and gloves) are the equipment those are made the living easy for disabled children. A wheelchair is not just a mode of transport, but a tool for an independent lifestyle [1]. Handicapped person often requires a cushion to distribute the supportive forces over the largest area possible in order to reduce the risk of the development of a pressure sore. The paraplegic, or someone with a pelvic obliquity, may require a specially contoured cushion to redistribute seating pressures. Additionally, postural support can be provided by a relatively simple harness or by lateral support pads, either fitted as extras to standard wheelchairs or included as part of some wheelchair designs. The severely handicapped person may require padded inserts in his wheelchair or an intimately moulded seat which helps to control some spasms as well as provide a functional, comfortable posture [2].

Figure 1. Image of cushion sample examined in the study

In this study a kind of shell cushion and the additional covers for a wheelchair used for handicapped children (shown in figure 1) was examined. This type of seating tends to be used for children who cannot attain a stable, comfortable position in off-the-shelf, adjustable seating. Some systems are made up of interlinking components (modular seating) that can be re-shaped when necessary. Others are permanently moulded into a particular shape.

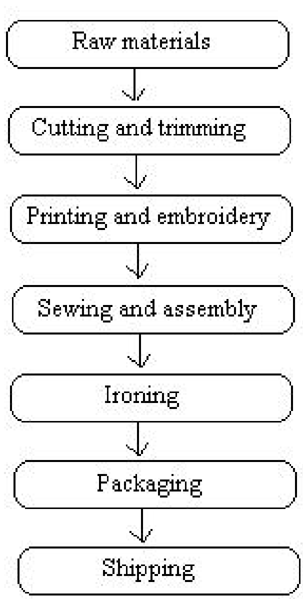

Figure 2. Main stages of apparel production

Figure 2 illustrates the workflow of the operations of a typical apparel manufacturing company [3,4,5,6]. In this study, production steps of an apparel company in which medical textile were produced. Each production step was analysed and explained with all details. Similar and difference jobs were determined.

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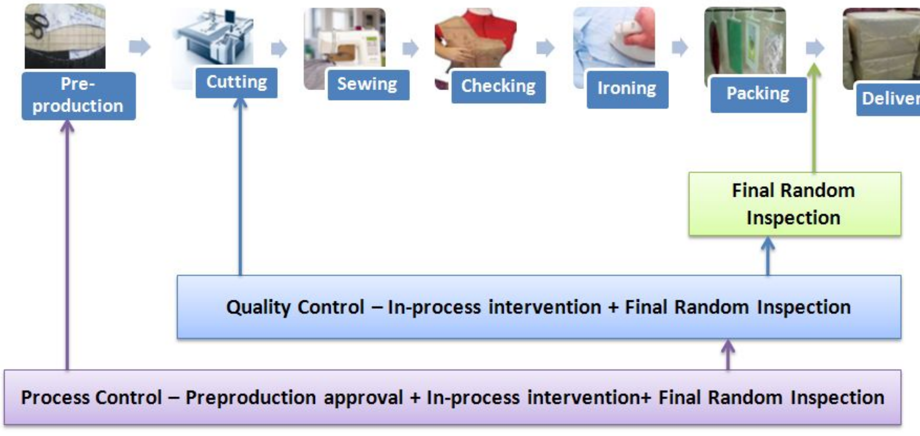
QUALITY CONTROL POINTS FOR MEDICAL TEXTILE PRODUCTION IN AN APPAREL COMPANY

Meral İşler[1], A. Aslı İlleez[2], Mücella Güner[1]
[1] *Ege University, Textile Engineering Department, İzmir, Turkey*
[2]*Ege University, Emel Akın Vocational High Scholl, İzmir, Turkey*
meral.isler@ege.edu.tr

Abstract
Rapid developments in international competition have obliged textile enterprises to take new approaches in order to gain a competitive advantage [1]. Nowadays, for apparel companies to compete in national and international markets, they have to satisfy the expectations of the customers in terms of time, cost and quality [2].

Quality control is a process employed to ensure a certain level of quality in a product or service. It may include whatever actions a business deems necessary to provide for the control and verification of certain characteristics of a product or service. The basic goal of quality control is to ensure that the products, services, or processes provided meet specific requirements [3, 4, 5].

For textile and apparel industry product quality is calculated in terms of quality and standard of fibers, yarns, fabric construction, color fastness, surface designs and the final finished garment products. However quality expectations for export are related to the type of customer segments [6].
Medical textile is one of the product types that can be produced in an apparel company. Production method of medical textiles is similar in many respects with basic products. Quality is one of the most important components during their production process because all goods used in a health-related situation. It is difficult to ensure this quality standard. End product should be controlled in some production stages.



In this study, quality control stages performed during production of a medical textile in an apparel company examined.

Key Words: Quality control, medical textile production, clothing

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AN OVERVIEW OF MEDICAL TEXTILE MARKET

Nezahat Cansu Karagoz[1], Zumrut Bahadir Unal[2]
[1]*Ege University, Sciences Institute, Textile Engineering, Izmir, Turkey*
[2]*Ege University, Department of Textile Engineering, Izmir, Turkey*
ncansukaragoz@gmail.com

Technical textiles are defined as textile materials and products manufactured for primarily functional characteristics and technical performance rather than aesthetic and decorative features. Medical textiles are one of the sub-groups of technical textiles. Medical textiles, also known as biomedical textiles, are textile products and constructions, for medical and biological uses used for first aid, clinical, or hygienic purposes. This area also shows a strong growing rate. Depending on the polymer technology, as a result of the development of available fibers, the production of new fibers and diversification of textile structures in medical textile products, which are suitable for use in many fields of medicine and surgery, are grow and these are used for the people and animals medical care and hygiene. Monofilament or multifilament yarns, woven, knitted, nonwoven and composite structure fabrics are used in the materials. The selection of medical textiles is an important subject for the healthcare sector in terms of benefits and costs. Manufacturers are produce textile materials and products to meet the specific needs of strength, flexibility, absorbency, softness, biodegradability, humidity and air permeability. The new textile fibers and various textile surfaces can be used in such cases like prevention of wound infections, hygiene in operating rooms and surgical procedures for patients and staff, performing the functions of damaged organs and tissues, and sewing vessels.

This group has a wide assortment of products, in general surgical clothes and blankets, bandages, compression stockings, medical masks, wet wipes, hygienic bonds, water-proof mattress covers, surgical thread or artificial kidney, artificial liver, artificial heart, artificial vein are given as example. These products performance characteristics and unit values are very high compared with conventional textiles. Therefore has an important place in the textile economy. While some medical products are produced in our country, some of them are imported. With this research medical fields place in our economy will be examined widely.

Key Words: Technical textiles, medical textiles, Turkey market, development

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CLOTHING PROBLEMS OF PHYSICAL DISABILITIES

Özlem Kurtoğlu Necef[1], Derya Tama[2], Ziynet Öndoğan[2], Zümrüt Bahadır Ünal[2]
[1]*Emel Akın Vocational Training School, İzmir, Turkey*
[2]*Ege University, Textile Engineering Department, İzmir, Turkey*
ozlem.kurtoglu@ege.edu.tr

Body image in people with physical disability is an important area of investigation, which has received little attention in the research literature [1]. Physical impairment refers to a broad range of disabilities which include orthopedic, neuromuscular, cardiovascular and pulmonary disorders. People with these disabilities often must rely upon assertive devices such as wheelchairs, crutches, canes, and artificial limbs to obtain mobility [2]. Nobody knows when would be the physical disability become part of their life. It may occur at any time due to sudden accident or illness. Some people meet physical disability, the moment they are born. No matter when or how they start, physical disabilities affect daily living decisions- especially those about clothes [3]. Physical disability should not be a hindrance in the way of people who are fond of clothing. Besides, clothing is an essential part of one's life. Therefore people who are physical disable they may find it hard to get dress up and undressed [4].

In this paper, types of physical disabilities and the difficulties while getting dress up and undressed were examined. Research was prepared with the people with physical disability in Izmir by using face to face questionnaire method. The obtained data were evaluated by using proper statistical software program. As a result of this study, the clothing problems, which people with physical disabilities faced, were determined and solution proposals discussed.

Key Words: Physical disability, clothing problems, garment design, clothing comfort

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PHYSICAL REQUIREMENTS FOR WOUND CARE GAUZES

Nilgün Özdil[1], Gonca Özçelik Kayseri[2]
[1]*Ege University, Department of Textile Engineering, İzmir, Turkey*
[2]*ege University, Emel Akin Vocational High School, İzmir, Turkey*
nilgun.ozdil@ege.edu.tr

Textile products are used in me dical and healthcare sector in various forms. Wound dressing, bandages and swabs are widely used conventional medical textiles [1].

Wound covers used in various medical and surgical applications are textile materials which are not implanted into the body [2]. Materials available today range from simple cotton gauzes to sophisticated multifunctional systems made from natural or synthetic materials [3]. But traditionally cotton gauze is widely used as a wound cover.

Prior to the late 1800s, many people died from simple wounds, whether as a result of the lack of medical knowledge or due to infection present from the absence of sterile conditions. Even minor wounds were often disfiguring with inferior materials and methods of bandaging. From the mid- to late-1800s absorbent gauze was found to provide the best wound dressings and use eventually spread into the home. Gauze is ideal for covering and protecting wounds, stopping the flow of bleeding, cleaning wounds and general wound care, on top of immobilizing an injury [4].

Cotton gauzes were used for dressing because of their good absorption property and softness. Even today hospitals use the gauzes for dressing purposes mostly in layers to form swabs for better and higher absorption [1]. Gauze is a light, thin, loosely woven fabric commonly made of cotton and generally has a loose open weave, allowing fluids from the wound to be absorbed into the fibers, wicked away, or passed through into other absorbent materials in the wound's dressing. Most gauze dressings are non-adherent and may be dry, moist, or impregnated. Sterile pads are used for many medical purposes, especially on open wounds, but non-sterile pads may be used for cushioning, cleaning, and absorbing areas less at risk of infection [5].

Although the type of fibre used and the fabric structure varies with the specific end use, all medical fibres must be non-toxic, non-carcinogenic, non-allergic and capable of being sterilized without suffering chemical or physical damage. In addition, for many applications absorbency is essential, favouring the use of cotton or viscose [1].

The requirements and test methods for absorbent cotton gauze and absorbent cotton and viscose gauzes are described in the **"EN 14079:2003** Non-active medical devices – Performance requirements and test methods for absorbent cotton gauze and absorbent cotton and viscose gauze" [6].

Table 1. Physical requirements for hydrophilic cotton gauze

Type (according to the thread count per cm^2)	Warp count per 100 mm	Maximum breaking load in warp direction (N)	Filling count per 100 mm	Maximum breaking load in filling direction (N)	Weight (g/m^2)
12	73±4	-	45±4	-	13,0
13 light (thin)	73±4	-	57±4	-	14,0
13 heavy (thick)	70±4	35	60±4	20	17,0
17	100±5	50	70±4	30	23,0
18	100±5	50	80±4	30	24,0
20	120±6	60	80±4	35	27,0
22	120±6	60	100±5	40	30,0
24a	120±6	60	120±5	50	32,0
24b	140±6	70	100±6	40	32,0

In the standard absorbent cotton gauze is defined as cotton cloth of plain weave, bleached to a good white and purified, being white and practically odourless, containing not more than slight traces of leaf, pericarp seed-coat or other impurities. Cotton ribbon gauze is supplied in continuous ribbons of various widths with fast selvedges. Absorbent cotton and viscose ribbon gauze is another type that having in the warp cotton threads and in the weft viscose threads or combined cotton and viscose threads.

Absorbent gauzes should be reasonably free from weaving defects and there shouldn't be any hole, tear, missing thread and distortion. The warp and weft density, weight and breaking load values are the main physical properties that affect the usage performance of the gauzes. The physical requirements of hydrophilic cotton gauze stated in the standard are given in Table 1.

The physical requirements of hydrophilic cotton and viscose ribbon gauze are given in Table 2.

Table 2. Physical requirements for hydrophilic cotton and viscose ribbon gauze

Type (according to the thread count per cm^2)	Warp count per 100 mm	Maximum breaking load in warp direction (N)	Filling count per 100 mm	Weight (g/m^2)
22a	120±3*	60	100±5	33,5
22b	120±3*	60	100±5	44,0
24a	120±3*	60	120±6	36,0
*Tolerance is ±4 for the dressing in 25 mm and 50 mm width, and ±8 for the dressing in 12.5 mm				

In addition to the physical requirements, the other test methods that affect the absorption property such as determination of the foreign fibres and sinking time are given in TS EN 14079 standard.

In terms of foreign fibre content, when the fibres are observed under the microscope, nearly all fibers should be cotton or viscose, only a few foreign fiber should be exist. For the sinking time test, 1 g gauze sample should be taken and folded four times (16 folds) and put into the water in 20±2°C temperature slowly and the average sinking time should not be more than 10 seconds.

Key Words: Wound care, gauze, cotton gauze, performance test

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SURGICAL SUTURES: THE MECHANICAL PERFORMANCES

Nilgün Özdil[1], Gonca Özçelik Kayseri[2]
[1]*ege University, Department Of Textile Engineering, İzmir, Turkey*
[2]*ege University, Emel Akin Vocational High School, İzmir, Turkey*
nilgun.ozdil@ege.edu.tr

Introduction

Combination of textile technology and medical sciences has resulted into a new field called medical textiles [1]. In this area, as one of the significant textile material, surgical sutures have important function to bring and hold tissues together separated by surgery or trauma. Sterile strips, adhesive, clips and staples are the other methods, but the suture in its many forms and characteristics remains the predominant method for wound closure [2]. Among biomaterials used as implants in human body, sutures constitute the largest group of materials having a huge market [3]. The USP system was established in 1937 for standardization and comparison of suture materials, corresponding to metric measures [3]. Sutures come in various sizes that ranges from USP 00 (very large) to 10-0(very tiny) [4,5].

Sutures are, in general, categorized according to the type of material (natural or synthetic), the lifetime of the material in the body (absorbable or non-absorbable), and the form in which they are made (braided, twisted, and monofilament). Natural sutures are made of catgut or reconstituted collagen (RC), or from cotton, silk, or linen. Metallic fibres such as steel fibres are also used extensively. Polymeric fibres could be absorbable or non-absorbable. Synthetic non-absorbable sutures may be made of PP, PET, PBT, PA, different proprietary Nylon, or Goretex [3].

Non-absorbable sutures do not dissolve by the body and are less tissue-reactive and therefore remain in place until they are removed. Absorbable sutures are dissolved by the body's tissues. Braided sutures are made up of several thin strands of the suture material twisted together and are easier to tie than non-braided sutures. Non-braided sutures are simply a monofilament, a single strand and are recommended for most skin closures, especially wounds that may be at risk for infection [5].

Suture materials are characterized by various methods involving physical and mechanical properties, handling characteristics, and biological and biodegradation behaviour [3]. The mechanical properties of the sutures are as important as biological performance. Due to the wide range of wounds involved, suture materials having different physical and mechanical properties are needed [6].Sutures fail for various reasons such as breaking of suture materials or slipping of the knots. Failures can result in wound dehiscence, which is a serious complication in surgery. Therefore, knowledge of mechanical properties or surgical knots in different suture materials is important since the knot is the weakest part of a suture [7].

Bayraktar and Hockenberger investigated the knot performance of four different non-absorbable sutures by using square knots with two and three throws and compared the results [8]. In another study, they investigated knot performance of monofilament and braided polyamide sutures by applying two different knots with two, three and four throws in dry and wet states [9]. Muffly et al. investigated the effect of suture end length on the knot strength by using 3 commonly used sutures and 3 different cut lengths [10]. In another study, the stress- strain behavior of seven synthetic absorbable and non-absorbable sutures was conducted [6]. Brouwers et al. tested seven suture knots made in seven materials with a dynamic load [7]. Greenwald et al. investigated the material properties of ten 2-0 suture materials tensiometrically at time = 0 and again after 6 weeks incubation in rats [4].

Material and Methods

In this study, by using different surgical sutures, two of the major mechanical properties such as maximum breaking and knot breakage loads (TS 5459:1998) were determined. In order to determine the effect of material type, braided PGLA(poly-%90glycolide-%10co-latide), silk, polyglactin and monofilament polypropylene sutures, and for the effect of size, PGLA sutures in USP-0, USP-2, USP-3 sizes were used.

Results and Discussion

Maximum breaking and knot breakage load values of the surgical sutures are given in Figure 1. As it can be seen, knot structure causes a significant decrease in all types of sutures. The highest decrease belongs to the polyglactin suture, whereas the knot in polypropylene suture subject to minimum decrease among all sutures due to the monofilament characteristics of polypropylene suture.

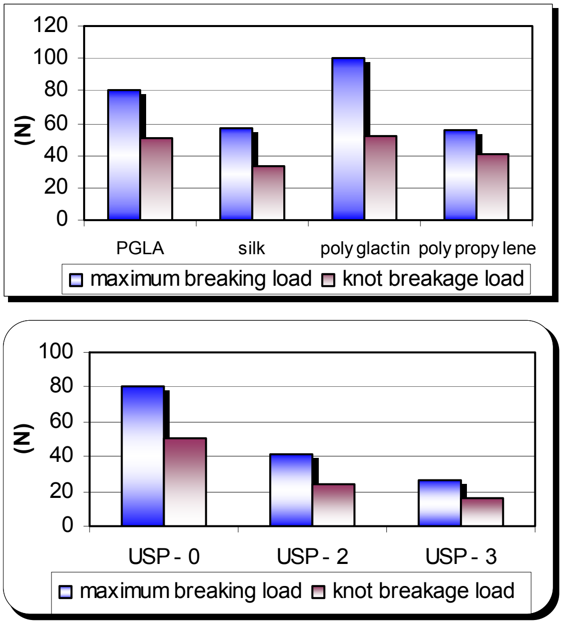

Figure 1. Maximum breaking and knot breakage load values of different sutures and sizes

In order to determine the effect the suture diameter on the mechanical properties, PGLA sutures in three different sizes were chosen and the results are given in Figure 2. With the increment of USP number, the suture gets thinner and maximum breaking and knot breakage load values decrease significantly. Knot structure causes nearly 50% loss in the mechanical performances of the sutures. In order to compare the results of knot breakage load values of the surgical sutures, the reference values given in the standards were used [3]. It can be stated that all the investigated sutures have satisfactory knot breakage performance according to the standard (Table 1).

Table 1. Minimum required knot breakage load values according to the suture sizes

USP suture size	Minimum average knot breakage load
0	(1.500 kgf) 14.7 N
2-0	(1.100 kgf) 10.8 N
3-0	(0.680 kgf) 6.7 N

Conclusion

Mechanical performances of the surgical sutures constitute an important role in the application. According to the tissue, suitable sutures should be

chosen in terms of applied force so that during the healing period of the wounds, failure in the tissue does not occur. In this study surgical sutures in different material and size were tested. The maximum knot breakage values of the all the sutures correspond the required values given in related standards.

Key words: Surgical suture, silk, polyglactin, polypropylene, PGLA

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SHELF-LIFE STUDY OF N -TRIMETHYL CHITOSAN ANTIMYCOTIC ACTIVITY AGAINST CANDIDA ALBICANS

Tijana Ristić[1,2], Monika Novak[1], Marjetka Kralj Kunčič[1], Matej Bračič[2], Andrej Zabret[1], Mojca Šimnic Šolinc[1], Lidija Fras Zemljič[2]
[1] *Tosama d.o.o., Health care, Vir, Domzale, Slovenia*
[2] *University of Maribor, Institute for Engineering Materials and Design, Maribor, Slovenia*
tijana.ristic@tosama.si

Vulvovaginal candidiasis (VVC), usually caused by *Candida albicans*, is a common problem affecting women of all ages. Approximately 75 % of them will develop a vaginal infection with a *Candida* strain during their life and about 40 % – 50 % will suffer a second one [1]. About 5 % - 8 % of women will experience recurrent VVC [2]. Novel vaginal delivery systems and microbiocides based on mucoadhesive polymers have been explored for treatment of VVC [1, 3]. Among polymers, chitosan and its derivatives have attracted considerable attention because of their known antimicrobial activity, biocompatibility and biodegradability. In this study N,N,N-trimethyl chitosan (TMC) was investigated for its antimycotic activity against *Candida albicans*. TMC's quarternary moieties have permanent positive charge and thus should exhibit superior antimycotic activity even at higher pH values where unmodified chitosan is inactive. The inhibitory effects on the growth of *C. albicans* of two TMCs with different degree of quarternization (DQ), i.e. 80 % (TMC 80) and 60 % (TMC 60), were estimated by turbidity method. The growth of fungi was determined by optical density, measured at 600 nm at different incubation time intervals. Additionally, the stability (shelf-life) of antimycotic activity of TMCs was determined by using WHO (*World Health Organization*) Guideline for Stability Testing of Active Substances and Pharmaceutical Products. Accelerated storage conditions were used (40° C ± 2° C, 75 % RH ± 5 % RH, 6 months), which corresponds to 2 years storage at ambient temperature 25 °C and relative humidity RH 40%. Both TMC samples showed good inhibitory effects at pH above 7. Concentration dependent efficiencies were observed. TMCs at concentration 0,5 % (w/v) showed better antimycotic activity than at concentration 0,2 % (w/v). Furthermore, the antimycotic efficiency decreased as the degree of trimethylation increased (Fig. 1). This could be assigned to the steric hinderance effect of trimethylated amino groups. The same effect was reported in another study [4].

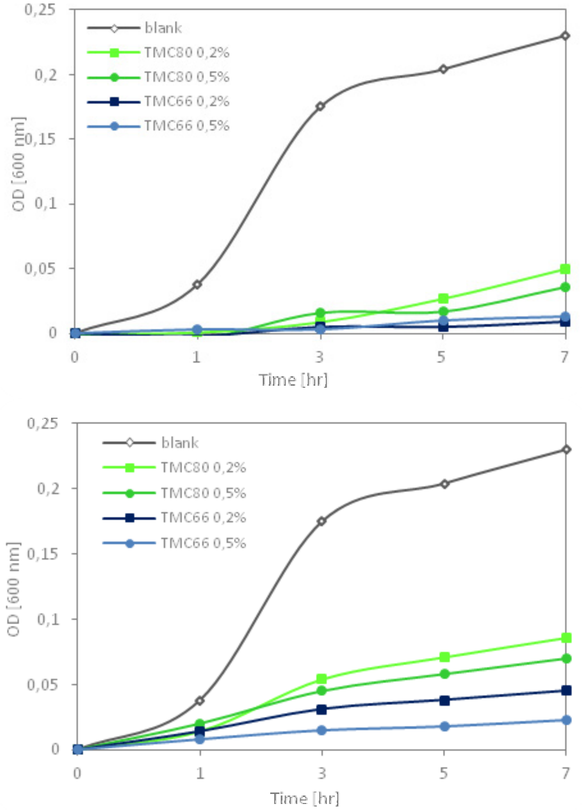

Figure 1. The growth rates of *Candida albicans* before (top) and after 6 month stability testing (bottom)

After 6 month stability testing a slight decrease in antimycotic activities has been observed. Even though, results are still promising while the used test method has demonstrated that in real-time conditions TMC solutions would maintain sufficient antmycotic activity for 2 years. This is extremely important for using chitosan and its derivatives in medical applications. Moreover, trimethyl chitosan has proven to be suitable candidate for preventive or alternative treatment of yeast infection, such as vaginal candidiasis. İn addition, TMC could be incorporated into fibre materials for developing new advanced medical textiles.

Key Words: Trimethyl chitosan, antifungal activity, shelf-life, vaginal candidiasis

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USAGE POTENTIAL OF CHITOSAN AND ITS DERIVATIVES FOR TEXTILE APPLICATIONS

Gorkem Sahan[1], Buket Arik[1], Aslı Demir[2], Tulay Gulumser[1], Esen Ozdogan[1]

[1]*ege University, Textile Engineering Department, Izmir, Turkey*
[2]*ege University, Emel Akın Vocational High School, Izmir, Turkey*
gorkemsahan@gmail.com

Since the first concept of "antibacterial finishing for textiles" emerged in 1941 (Hirschmann & Robson, 1941), the textile industry has made significant improvements in developing antibacterial fibers and agents. A safe, healthy and comfortable living environment becomes more important and the protection from the infection of pathogenic microorganisms needs to be improved. Hence, the demand for medical textiles and healthcare textiles is increasing. A number of chemicals have been used to impart antibacterial activity to textiles. However, many of these chemicals are toxic to humans and cannot easily degrade in the nature [1, 2]. In this respect, especially biopolymers gain importance because of their biocompatibility and biodegradability.

Chitosan (Ch) is a natural polysaccharide consisting of β -(1-4)-2-acetamido-2-deoxy-D-glucose (GlcNAc) and β-(1-4)-2-amino-2-deoxy-D-glucose (GlcN) as repeating units. It is derived from chitin by alkaline hydrolysis which obtained from the shells of crabs, shrimps and other crustaceans. Chitosan is a non-toxic, biodegradable and biocompatible natural polymer, and has long been used as a biopolymer and natural material in the pharmaceutical, medical, papermaking and food processing industries. In textile industry, chitosan is used in many processes such as dyeing of cotton, durable press finishing, wool finishing, antimicrobial and antistatic finishing etc [3-5].

As a natural renewable resource with a unique property, chitosan is one of the safest and the most effective antibacterial agents. The extent of the antimicrobial action of chitosan is influenced by intrinsic and extrinsic factors such as molecular weight, degree of deacetylation, pH, temperature, etc. It is necessary to understand these factors for the effective application of chitosan as an antimicrobial agent [1, 5].

Quite a number of textile materials (cotton, silk, polyamide, and polyester, and nonwoven polypropylene fabrics) have been modified with chitosan or its derivatives. However, these activities are limited to acidic conditions because of its poor water solubility above pH 6.5, where chitosan starts to lose its cationic nature and the lack of strong chemical bonding with textile substrates causes some problems in repeated launderings. Therefore, many efforts on chitosan derivatives have been made to introduce hydrophilic character by a chemical modification in order to improve the water solubility [1, 3, 6].

Tayel et al produced fungal chitosan from the source of the waste biomass of *Aspergillus niger* and this fungal chitosan was applied as a cotton fabric finishing agent using pad-dry-cure method. They found that chitosan-treated cotton fabrics exhibited a strong antimicrobial activity against both *E. coli* and *Candida albicans* and stated that this fungal chitosan could be a suitable material for many medical and hygienic applications [7].

Mohammadi et al engaged in the surface modification of wool fabric using anhydrides to graft the chitosan and acylated with two anhydrides, succinic anhydride and phthalic anhydride, using different solvents (dimethylsulfoxide and N,N-dimethyl formamide). They found that the grafted samples have antibacterial potential due to existence of the antibacterial property of chitosan [8].

In this study, chitosan and its derivatives as antibacterial textile agents were investigated. For this purpose, recent studies on this subject were compiled and compared.

Key Words: Antibacterial agent, Chitosan, chitosan derivatives

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SULPHATED HEMICELLULOSES – ALTERNATIVE ANTICOAGULANTS FOR PET SURFACE MODIFICATIONS

Simona Strnad[1], Aleš Doliška[1], Nena Velkova[2], Lidija Fras Zemljič[1]
[1]*University of Maribor, Faculty of Mechanical Engineering, Institute of Engineering Materials and Design, Slovenia*
[2]*TT Okroglica d.d., Volčja Draga, Slovenia*
simona.strnad@uni-mb.si

Different textile shapes from woven, knitted and nonwoven flat textiles play an important role among biomaterials owing to their specific mechanical and morphological properties. Fibrous biomaterials are used in various implants, which are designed for high performance in blood contacting applications, like: vascular grafts, mechanical heart valves' sewing rings, stents, etc. Fibrous poly(ethyleneterephthalate) (PET) is one of the most frequently used biomaterials in cardio-vascular surgery. However, PET still does not possess optimal hemocompatible properties, which would satisfy the demands in cardiovascular surgery. The main complications that occur in vascular grafts' replacements are reduced patency due to intimal hyperplasia or thrombus formation. In the contact between blood and biomaterial the most complex interactions between body and the implant occur. The main factors, which influence the course of these interactions, are surface chemical composition, surface energy, geometry, topography and roughness. Different PET surface coatings have been proposed for cardiovascular applications. The most widely used anticoagulant is a highly-sulphated glycosaminoglycan heparin, derived from mammalian sources and is as well applied as a coating for internal (luminal) vascular graft surfaces. However, owing to certain adverse effects caused by heparin, such as the abnormal bleeding of treated patients and/or potential contamination, alternative biopolymers derived from plants are investigated in order to develop new anticoagulant surfaces. So far, however, no surface modification has produced satisfactory results 0.

The presented research was focused on the introduction and development of procedures for modifications of PET surfaces with alternative sulphated polysaccharides from plant origin in order to improve materials' hemocompatibility. It is already well known that presence of acidic groups like sulphate and/or carboxyl is related to anticoagulant and antithrombotic effects 00. Polysaccharides, like galactoglucomannan (GGM) from softwood, glucuronoxylan (BX) from hardwood and arabinoxylan (AX) from oat spelts were derivatised in order to introduce carboxyl and/or sulphate groups. GGM is the main hemicellulose type in softwoods and is normally present in amounts of 15 % to 20 % of the wood material. Xylans are second most important substance of cell wall beside cellulose and largest source of sustainable hemicellulose on the Earth. Both GGMs and xylans are by-products in the pulp-and-paper and cereal industry and are not yet efficiently reused. Xylans represent about 10 – 15 % of softwood and about 10 – 35 % of hardwood. However residuals of annual plants are by far most efficient source of xylan, thus in oat spelts it represents about 35 – 40 % 0. The influences of different derivatisation procedures onto hemicelluloses' chemical character were thoroughly analysed using FTIR, elemental analysis, and polyelectrolyte titrations. Anticoagulant properties were investigated using activated partial thromboplastine time (APTT) determination. The interdependencies between deprotonated functional groups amounts at certain pH and polymers' antithrombotic abilities were studied. The adsorption abilities of non-modified and chemically modified GGMs and xylans onto PET were investigated using quarz crystal microbalance with dissipation unit.

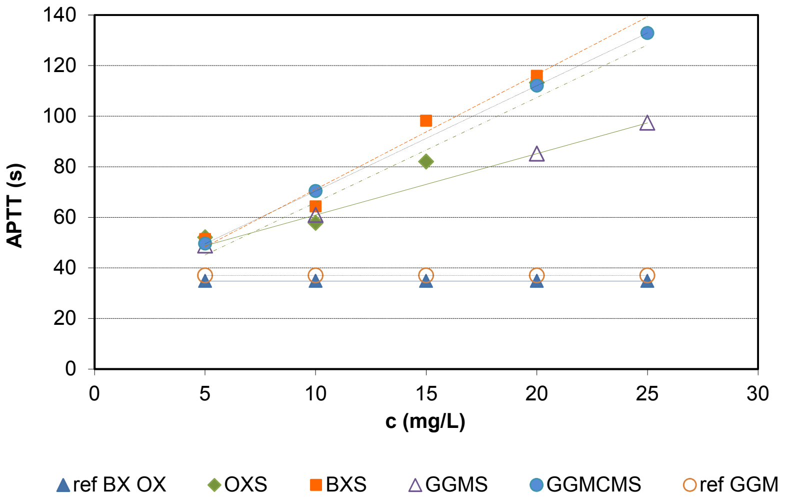

Figure 1. Antithrombotic activities (Activated partial thromboplastine time - APTT) for carboxymethylated (GGMCMS) and sulphated (GGMS) galactoglucomannan, sulphated glucurono- and arabino- xylan (BXS and OXS) and non-modified xylan (ref BX OX) and galactoglucomannan (ref GGM) samples.

The results showed that sulphation procedure successfully introduced sulphate groups to different hemicellulose samples. Longer sulphation times and higher sulphur content did not influence on stronger antithrombotic effect of sulphated samples. On the other hand the presence of carboxymethyl groups additionally increased samples' antithrombogenicities. At concentrations of 20 mg/L both sulphated xylan samples and carboxymethylated sulphated GGM prolonged coagulation times in regard to non-sulphated samples by 2-fold (fig. 1).

Key Words: Sulphated polysaccharides, hemicelluloses, vascular grafts, hemocompatibility

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CLOTHINGS OF PARAPLEGICS

Derya Tama[1], Özlem Kurtoğlu Necef[2], Ziynet Öndoğan[1]
[1]*Ege University, Textile Engineering Department, İzmir, Turkey*
[2]*Emel Akın Vocational School, İzmir, Turkey*
derya.tama@ege.edu.tr

Paraplegia may be caused by injury or disease but it leads to numbness in the lower part of the body resulting in immobility of the lower limbs and incontinence many a times [1]. They are often wheelchair-bound and experience some difficulty in daily living tasks such as bathing. And also, the dressing ability of such persons is completely affected. Paraplegic people need clothing that fits their abilities and lifestyle. Their clothes should give them utmost comfort and ease of movement. Paraplegic people, confined to wheelchairs, encounter various types of problems cause of their disqualification. Some of the major problems are; pressure sores, spasticity of limbs, slipping legs in garments and removing them, bed wetting because of incontinence and even problems related with blood circulation. Inappropriate clothing that put pressure on the body, thick seams, rough fabric or bulky trims if placed in pressure areas such as under the seat or against the back may also cause the formation of pressure sores [2]. Under such conditions, they need specially designed clothing made from special materials. In this study, firstly the problems of paraplegic people were analyzed. Then, the current situation of paraplegic people's clothing and their materials and also the clothing related problems were studied. Considering paraplegic people's needs, current materials were combined with medicals and the solution proposals were discussed.

Key Words: Clothings of paraplegics, dressing ability, inappropirate clothing

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WICKABILITY AND RATE OF ABSORPTION OF SELECTED COMMERCIAL WOUND DRESSINGS

M.Uzun, S.C.Anand, T. Shah
Institute for Materials Research and Innovation, The University of Bolton, Deane Road, Bolton, BL3 5AB, UK
mu2mpo@bolton.ac.uk

One of the criteria of an ideal wound dressing is that it provides a moist wound environment on the wound bed without maceration. Maceration is the softening of tissue that has remained wet for a long period. A heavily exuding wound promotes maceration, even if a highly absorbent dressing is used. Pooling of exudates at one place on the wound bed can cause maceration which not only delays wound healing but promotes wound infection. To combat the above adversities, it is crucial that the wound dressing possesses high absorption and enhanced wicking. Inappropriate dressing selection can cause wound maceration [1].

In this study, the absorption and wicking of commercial nonwoven wound dressings were investigated *in vitro*. The commercial wound dressings were procured from the UK wound dressing manufacturers and used as received (Table 1). The wicking property of the dressings was tested by using sterile donor horse serum (First Link Ltd., UK). The fluid lateral wicking test, which is commonly used by the UK dressing companies, shows the rate of transportation of the absorbed horse serum within the structure. The test was performed by using a plastic vial containing 20 ml of horse serum which was placed at the centre of the dressings and held in place for 60 seconds under 250g of weight. After 60 seconds, the non-absorbed horse serum was removed, and the images of the wicked area of the dressings were analysed by using the Image Tool software (Figure 1). The rate of absorption of the dressings was measured in accordance with the sinking method [2]. In order to determine the rate of absorption of the dressings, 'Solution A' was prepared by using sodium chloride (2.298 g/l) and calcium chloride dihydrate (0.368 g/l) in deionised water.

Table 1. Description of commercial wound dressings

Product	Dressing mass ($g\ m^{-2}$)	Thickness (mm)	Sinking Time (seconds)	Composition (inner layer/outer layer)
Aquacel®	112	1.7	3.50	100% Hydrofibre®
Aquacel® Ag	105	1.6	5.40	Silver treated Hydrofiber® nonwoven
Aquatulle™	35	0.4	26.0	Pansement-tulle Hydrofibre®
Kaltostat®	145	1.9	3.10	calcium and sodium alginate
CarboFlex™	447	3.9	15.0	alginate and Hydrofibre® absorbent/ ACC knit/ alginate and Hydrofibre® / polyethylene film
CliniSorb®	260	1.2	5.0	polyamide web/ACC woven/polyamide web

It is obvious from Figure 1 that Aquacel® and Aquacel® Ag possessed the lowest wicking. It is also observed that the silver treatment does not affect the wickability of the Aquacel® dressing. CarboFlex™ exceeded the 2 cm distance, but it still does not display high wickability. Aquatulle™, Kaltostat® CliniSorb® possessed the highest fluid wicking capacity. Aquatulle™ is a hydrofiber® based dressings, however, it showed higher wickability.

The absorption rate (sinking time) of the dressings varies from 3.5 seconds to 26.0 seconds (Table 1). Aquatulle™ had registered the highest value of sinking time due to its lighter weight compared to the other dressings. The presence of silver in Aquacel® hinders the rate of absorption. The rate of absorption of Hydrofiber® dressings, Aquacel® and Aquacel® Ag, is lower than that to the alginate Kaltostat® dressing. This perhaps the ability of hydrofibre® to produce high amount of gels than alginate fibres. CarboFlex™ sank at 10.7 seconds which is the lowest value of time recorded.

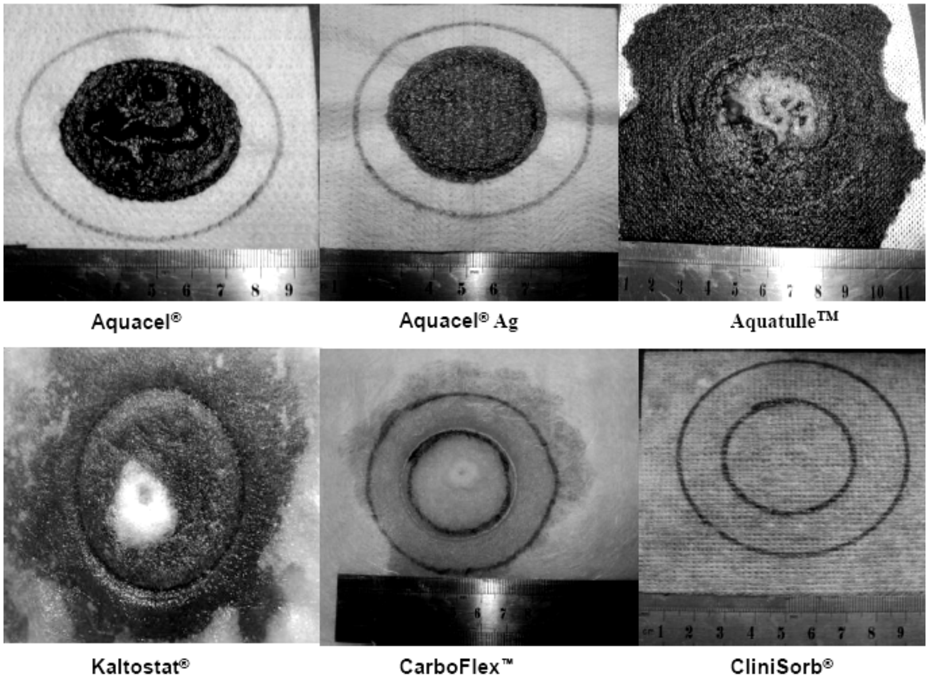

Figure 1. The wicking images of dressings after 1 minute of horse serum application

Key Words: Wound dressings, rate of absorption, wicking, silver treatment

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DEVELOPING MULTIFUNCTIONAL FABRICS FOR NURSES' CLOTHING

Ü.Y. Yıldız[1], M.E. Üreyen[2, 3], Ç. Aslan[4], A.S. Koparal [5], A. Doğan[6]
[1]*Graduate School of Sciences, Biotechnology Program, Anadolu University, Eskisehir, Turkey*
[2]*School of Industrial Arts, Anadolu University, Eskisehir, Turkey*
[3]*Medicinal Plants, Drugs and Scientific Research Center, Anadolu University, Eskisehir, Turkey*
[4]*Graduate School of Sciences, Nanotechnology Program, Anadolu University, Eskisehir, Turkey*
[5]*Department of Environmental Engineering, Anadolu University, Eskisehir, Turkey*
[6]*Department of Materials Science and Engineering, Anadolu University, Eskisehir, Turkey*
meureyen@anadolu.edu.tr

Introduction

There are many studies in literature demonstrating the transmission of microorganisms by the people that are exposed to the contaminated textile products to the other patients or healthy people. Also spreading risk of nosocomial infection was demonstrated to be reduced by preventing the contamination of textile products in many studies conducted. The nursing process of nurses consists of patient care procedures, medical treatment and assisting of the doctors. The spreading of infections by transfer of the pathogens from the infected patients or nurses to the other patients constitutes the primary source of the problem.

Microorganisms are also known to cause functional, hygienic and aesthetic problems in textile products. Significant success was achieved concerning the development of antimicrobial textiles which prevent the growth of microorganisms on the textile products and many commercial products were launched.

The main aim of this work is to prepare multifunctional fabrics to protect nurses from nosocomial infections. For this aim calcium phosphate based silver doped antibacterial finishing agent that was synthesized in our previous works applied to the 100% cotton and PES/viscose blended woven fabrics with or without water repellent agent. Antibacterial activity, water and oil repellent properties of the all treated fabrics were tested and compared.

Materials and Method

Antibacterial finishes were prepared by calcium phosphate based silver doped nano powders which were synthesized in our previous works. 20 g antibacterial powder added to 80 ml distilled water and was grinded by attritor. Tricalcium Phosphate was added to the solution to prevent from agglomeration. Fluorocarbon based finishing chemical (Nuva 2110) was kindly provided from Clariant Sozal Company/Turkey.

Antibacterial and water repellent chemicals were applied to 100 % cotton and 65/35% PES/viscose, plain weave fabric samples. In the first part of the work, fabric samples treated with antibacterial (A) and water repellent (S) finishes. In the second part, antibacterial and water repellent solutions were applied to one group of fabrics $(A+S)_1$. In the third part, after the antibacterial finishing, fabric samples were treated by water repellent finish (A_1+S_2). pH value of all solutions were adjusted to 5.5 by acetic acid. Finishing was performed using a laboratory vertical padder (ATAC F350) for impregnation and a laboratory stenter (Rapid mini dryer QC A1708) for curing. Sample codes and application conditions are given in Table 1 and 2.

Table 1. Application conditions of treatments on cotton fabrics

Sample code	**Finish**	**Concentration (g/l)**	**Binder (g/l)**	**Dry**	**Cure**
A	Antibacterial	7	9	160 °C, 2 min	
S	Water repellent	35	9	120 °C, 1:30 min	170 °C, 40 sec
(A+S)1	Antibacterial + water repellent	7+35	9	120 °C, 1:30 min	170 °C, 40 sec
A_1+S_2	First step: antibacterial	7	9	160 °C, 2 min	
	Second step: water repellent	35		120 °C, 1:30 min	170 °C, 40 sec

Table 2. Application conditions of treatments on PES/viscose fabrics

Sample code	**Finish**	**Concentration (g/l)**	**Binder (g/l)**	**Dry**	**Cure**
A	Antibacterial	7	9	160 °C, 2 min	
S	Water repellent	30	9	120 °C, 1:30 min	170 °C, 40 sec
(A+S)1	Antibacterial + water repellent	7+30	9	120 °C, 1:30 min	170 °C, 40 sec
A_1+S_2	First step: antibacterial	7	9	160 °C, 2 min	
	Second step: water repellent	30		120 °C, 1:30 min	170 °C, 40 sec

All fabric samples were washed 20 times and after each ten washing cycles water and oil repellency properties of the samples were tested by contact angle measurement (Krüss DSA 100). Antibacterial treated fabrics were tested against *Escherichia coli* (ATCC 25922) according to the ASTM E 2149 method in Anadolu University Center for Applied Environmental Research.

Key Words: Antibacterial finishing, oil and water repellency, multifunctional fabrics, nurses' clothing

CONFORMATION AND SUITABILITY OF THE COMMERCIALLY AVAILABLE ABSORBENT COTTON WOOL

Savvas Vassiliadis[1], Dimitroula Matsouka[2], Costas Boutris[2], Ahmet Çay[3]

[1]*TEI of Piraeus, Department of Electronics, Athens, Greece*
[2]*MIRTEC formerly CLOTEFI, Athens, Greece*
[3]*Ege University, Department of Textile Engineering, Izmir, Turkey*
svas@teipir.gr

Absorbent cotton wool has historically [1] been used as a barrier for bacteria in wound treatment, as an absorbent for exudate, an aid to hemostasis and as physical support for the wound itself. It can be used by the patients themselves; medical and nursing stuff as well as third parties either at a clinical environment or at home. Absorbent cotton wool is obtained from the cotton plant after specific treatments that intend to remove impurities, such as dust, seed husks and fragments, as well as oils and waxes naturally present on the cotton fibres, in order to make the end product absorbent.

End product specifications for absorbent cotton wool marketed within the EU is covered by the requirements set out in the European Pharmacopoeia. The European Pharmacopoeia is a single reference work for the quality control of medicines in the signatory states of the Convention on its elaboration [2]. In the relevant monograph contained in the EP [3] absorbent cotton is defined as consisting "of new fibres or good quality combers obtained from the seed-coat of various species of the genus Gossypium L., cleaned, purified, bleached and carefully carded". In the same monograph specific requirements with regards to the characteristics of absorbent cotton as well as acceptable limits values for those characteristics are given.

For this project absorbent cotton wool products marketed in Greece and Turkey were obtained from the market. The products were examined according to the requirements set out by the European Pharmacopoeia. Samples' testing results were compared both between different samples (brands) and against the limit values specified in the relevant monograph.

Key Words: Absorbent cotton, European Pharmacopeia, conformity testing

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THE IMPORTANCE OF FUNCTIONALISED FIBRE CHARGE DETERMINATION

Lidija Fras Zemljič[1], Matej Bračič[1], Tijana Ristić[2], Simona Strnad[1]
[1]*University of Maribor, Faculty of Mechanical Engineering, Institute of Engineering Materials and Design, Slovenia*
[2] *Tosama d.o.o. Vir, Šaranovičeva cesta 35, 1230 Domžale*
lidija.fras@uni-mb.si

Antimicrobial effectiveness of cellulose textiles today could be achieved by several different ways.[1-6]. The majority of nowadays methods still use reagents that are harmful to the user and the environment, as they contain inorganic salts, phenols and thiophenols, antibiotics, formaldehyde derivatives, etc. These have led to increased interest in the functionalisation processes based on environmentally friendly and biodegradable reagents, such as for example until now less used polysaccharides and their derivatives, which possess antimicrobial properties. Polysaccharides that play an important part in surface coatings for medical applications are dextran, hyaluronic acid, carboxymethyl cellulose, heparin, alginate and others. A special attention is paid to amino polysaccharides, including chitosan, a chitin derivative, after cellulose the most abundant biopolymer on Earth. These cationic polysaccharides contain protonated amino groups, which interact with the cell surfaces of pathogenic microorganisms and, in this way, destroy them by several possible mechanisms. In order to analyse the antimicrobial effectiveness of chitosan coatings on the cellulose fibres, it is therefore essential to study the quality and quantity fibre functional groups; especially amino groups. This study presents the use of titration techniques for the detection of amino group quantity on cellulose fibres functionalized by chitosan. Chitosan and its derivates were adsorbed onto fibres from acidic solution as well as a precipitate, In this way the amount of adsorbed chitosan should differ. The main objective was to analyse the influence of specific functional group (with emphasis on amino group) quantity on the final bioactive fibre properties. Thus, titration methods were used for the characterisation of fibre functional groups. These techniques were combined with other spectroscopic methods such as ATR-FTIR, X-Ray Photoelectron Spectroscopy (XPS). The morphology of functionalised fibres was analysed by Scanning electron microscopy (SEM). Finally, the influence of specific functional groups on the bioactive fibre properties was examined. The antimicrobial properties of fibres functionalised by chitosan were evaluated by ASTM E2149-01, which is a quantitative antimicrobial test method performed under dynamic contact conditions [7].

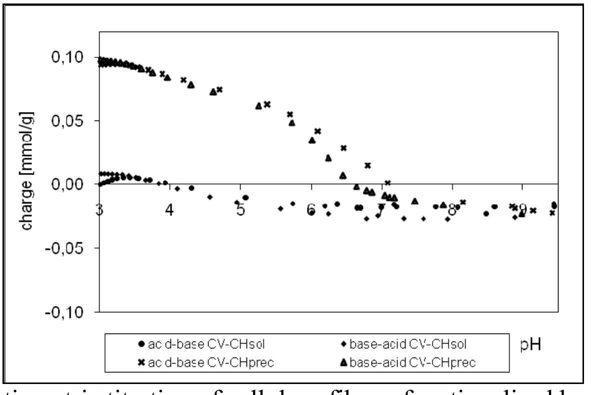

Figure 1. Potentiometric titration of cellulose fibres, functionalised by acidic chitosan solution ($CV\text{-}CH_{sol}$) and precipitated ($CV\text{-}CH_{prec}$) with chitosan [8]

It may be concluded that that a functional group's quantity and quality is responsible for the bioactive properties of fibre material functionalised using polysaccharides. With an increased amount of amino groups, the antimicrobial properties are strengthened. The latest was observed by the functionalization of viscose fibres using precipitated chitosan, where much higher amino groups content was determined.

Our work has shown that a combination of different titration analyses is essential tool for a better and detailed understanding of fibre functional groups' influence on the final antimicrobial properties.

Key Words: Amino polysaccharides, functionalization, amino group, titration, antimicrobial properties

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LIST OF AUTHORS