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INTERNATIONAL CONGRESS ON HEALTHCARE AND MEDICAL TEXTILES

MAY 17-18, 2012

İZMİR/TURKEY

BOOK OF ABSTRACTS

Organized by:
EGE UNIVERSITY
FACULTY OF ENGINEERING
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EGEMEDITEX

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Organization

EGEMEDITEX 2012 is organized by Ege University Engineering Faculty, Department of Textile Engineering

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ABSTRACT BOOK

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PROGRAMME

May 17, Thursday

08.30-09.30 **Registration**

09.30-10.00 **Opening Speeches**

12.30-14.00 **Lunch**

15.20-15.40 **Coffee Break**

20.00 **Gala Dinner**

May 18, Friday

PLENARY SESSION

NONWOVEN FABRICS IN HEALTHCARE AND MEDICAL DEVICES

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Nonwoven fabrics are unique engineered fabrics offering cost effective and often superior alternative solutions for an increasingly wide variety of applications. Nonwoven fabrics are used in everyday life without knowing it or seeing them as they are often hidden from view. Nonwovens are a product for our time, created by a modern and innovative industry. They are often combined with other materials and are called composite materials. The world nonwoven market has more than doubled in the past 10 years, from 3.19 million tonnes in 1999 to an estimated 6.32 million tonnes in 2009. It is now estimated to be US $ 22.4 billion in value in 2009 and 2.67kg per capita annual consumption in Europe.

Textile materials and products designed for use in healthcare and medical devices, a global market valued at over US $ 100 billion, can be divided into the following categories according to their applications:

- non – implantable materials, such as wound dressings, bandages, plasters, absorbent pads, supports etc;
- implantable materials, such as sutures, vascular grafts, arteries, artificial ligaments, artificial tendous, artificial skin, scaffolds for tissue and organ generation etc;
- extracorporeal devices, such as artificial kidney, artificial liver etc; and
- healthcare and hygiene materials, such as babies' diapers, feminine hygiene products, incontinence products, operating room garments, uniforms, hospital bedding, clothing etc

The paper will demonstrate the tremendous growth in the use of nonwoven materials in healthcare and medical textiles products worldwide. A number of case studies will be discussed to encompass the full spectrum of applications of different types of nonwoven fabrics in this vibrant and expanding sector.

ELECTRONICALLY FUNCTIONAL YARNS FOR MEDICAL TEXTILES

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Most wearable technologies manifested themselves in laboratories or as clothes that were specially made and bore little resemblance to garments which users would regard as normal. In the first generation of wearable technologies, electronic devices were simply attached to garments or included in pockets. In the second generation, electronic functionality was achieved by incorporating conducting yarns into the textile structure. However, our research has demonstrated their major drawbacks caused by inherent hysteresis of textile structures which limits their application only to relative measurements. Therefore, we have taken a major step forward and develop a third generation of electronic textiles where integrated circuits are fully incorporated into yarns prior to fabric or garment production.

The aim of the presentation is to report the development of a new platform technology whereby semiconductor devices are directly encapsulated within yarn. Once produced these electronically functional yarns will be incorporated into fabrics using conventional textile machinery or used as sewing thread in garment manufacture. The resultant smart yarn technology will have a profound effect on the production and use of electronic textiles in clothing applications by providing robust functionality that is resistant to wear, washing and drying and can be produced at lower costs than the electronic textiles available today where functionality is often added at the garment stage.

Our current focus involves the packaging of miniature semiconductor sensors, actuators and micro controllers within polymer micro pods that will provide a flexible hermetic seal for mechanical, thermal and electrical protection whilst free fibres between pods will ensure that, where required, the textile characteristics of the resultant fabrics are retained. Prototypes of electronically functional yarns with fully integrated systems for the measurement of 1) temperature and humidity 2) pressure, and 3) position and orientation are being developed.

Temperature and humidity sensors could be used for ambulatory body measurement in medicine. Pressure measurement sensors could be used in garments for the treatment of lymphoedema, ulcers and burns. Position and orientation measurement devices could be used to assist in restoring limb function for patients in the treatment of strokes.

A NOVEL WEARABLE LOW ENERGY MINI SIZE ECG ANT NODE FOR HEALTH MONITORING

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This paper describes new research for devising a new wearable ECG based on ANT. We have used ADS1291 single channel ECG analog front end, MSP430F ultra low power mixed signal processor and ultra low power wireless connectivity protocol ANT to construct a bespoke low energy ECG monitoring system. The system can form part of a garment and its particular characteristics are its low energy and its mini size ECG node whilst keeping its 24 bit DC measurement accuracy needed for health monitoring at medical standards. The system includes a Li-ion chargeable battery and the overall node size is 50X38X12 mm^3, working on 250 Hz sampling rate. Under this configuration the node can continuously monitor the body up to six days with only a single battery charge. The node uses a smart phone as monitor and communication relay. TCP/IP socket API is used through 3G communication, the node can be linked to a remote database and the data collection and analysis is based on data cloud calculation.

Key Words: Wearable electronics, werable EEG, Low energy, smart textiles, ANT

ANTI-INFECTIVE IMPREGNATED MATERIALS AND THEIR IMPACTS

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Antimicrobial impregnated materials are attracting interest in health care applications to protect human beings from infections. One of the examples is nanosilver or silver nanoparticles. Silvers' antibacterial activity has been known from Hippocrates. Although silver use has been limited toxicity reason, nanotechnology has allowed to decrease the toxicity and to increase efficacy against bacteria. It is demonstrated that silver nanoparticules have higher antimicrobial power than free silver ions.

One of the major risk factors of hospital-acquired infections is implantable devices. The most using device in health care is central venous catheters. A well conducted meta analysis concluded that the efficacy of central venous catheters whose outer surface is impregnated with chlorhexidine and silver sulfadiazine to protect catheter related blood steam infection was time dependent and was effective when the median duration of insertion was less than 7 days. Another meta-analysis of three randomized, controlled study results' demonstrated that the catheter related blood steam infection rates were not significantly decreased by catheters both interluminally and extraluminally impragnated with chlorhegzidine/sulfadiazine (OR:0.852; 95% CI, 02-3.6). Although minocycline-rifampin coated catheters have shown to reduce the risk of catheter related blood steam infection compared with polyurethane catheters, the development of resistant flora has increased. Silver coated central venous catheters have been used in attempts to reduce catheter related blood steam infections. Today it is demonstrated that silver nanoparticle impregnated catheters has the advantages such as; continued release of silver ions in antimicrobial concentration, ability to protect both inner and outher surface of catheters and wide antimicrobial spectrum of activity [4]. The major sources of catheter related blood stream infection is the patients' own skin flora around the insertion site. Even after careful skin antisepsis and cover the catheter surface by transparent dressing, central venous catheter related blood stream infection can occur due to regrowth of the skin flora and migration of bacteria from the dermis to the epidermis. In a randomized, multicenter trial it is proven that chlorhegzidine-impregnated sponges were prevented the regrowth of bacteria in the epidermis, and lowered the catheter related infections (0.6 vs. 1.4 per 1.000 catheter-days HR, 0.39; P= 0.03) and catheter related blood stream infection (0.4 vs. 1.3 per 1.000 catheter days; HR, 0.24; P< 0.001). In recent years chlorhegzidine-impregnated gel dressing was developed and have also been shown to decrease the cutaneous flora as seen the sponges

Silver-alginate coated dressings have been found to be safe and to decrease the peripherally inserted central catheter related blood stream infections from 17.2% to 12.4% in a neonatal intensive care unit. Randomized trials are warranted to further validate this result.

Another usage of antimicrobial impregnated materials is in neurosurgery. Neurosurgical catheters can be fully or temporarily implanted in patients with hydrocephalus to prevent brain damage. Both of these usages can evoke bacterial infection. In vitro studies demonstrated that nanosilver impregnated neurosurgical catheters release the silver ion for at least 6 days and it decreased growth of Staphylococcus aureus which is one of the causes of catheter related ventriculitis. In a pilot clinical trial with acute occlusive hydrocephalus patients it is revealed that in the group with nanosilver catheters (n:19) there were no cases of catheter related infections (ventriculitis) and all cerebrospinal fluid cultures were negative while in the control group (patients with normal catheter, n:20) five catheter related infections were detected. The study indicated that nanosilver is potentially beneficial in the prevention of catheter related infections but it needs further randomized large-scale clinical trials. On the other hand antibiotic impregnated external devices may give false negative results when a cerebrospinal fluid sample is drawn through this catheter and may lead to end early the antimicrobial therapy.

Nanocrystalline silver wound dressings have been available for over a decade and are using for the treatment of various wounds. In a randomized clinical trial nanocrystalline silver dressings efficacy has evaluated. Nanocrystalline silver dressings significantly decreased wound healing time by an average of 3.35 days and increased bacterial clearance from infected wounds in patients with burn when compared to conventional silver sulfadiazine dressings. Another randomized controlled study showed that although superficial burn wounds were healed better with nanocrystalline silver wound dressings there was no differences between nanocrystalline silver wound dressings and 1% silver sulfadiazine in healing of deep burn wounds, suggesting that nanocrystalline silver accelerates only re-epithelization but not angiogenesis and proliferation. One of the new fabricated nanocrystalline silver containing dressings is chitosan-nanocrystalline silver. It is showed superior healing rates compared to silver sulfadiazine dressings and chitosan film. As proved by systematic reviews, nanocrystalline silver usage is increasing in healt care settings to provide effective treatment for a range of wounds. In another randomized, prospective study it is shown that the use of 2% chlorhexidine gluconate-impregnated cloths was effective at decreasing the quantity of skin microflora, which is the leading agents of postoperative shoulder infections, than shower with soap and water before shoulder surgery.

In conclusions anti-infective impregnated materials have been using with and/or in addition to infection control measures to prevent or lower the rate of health care associated infections. New materials that prevent biofilm formation and bacterial growth are being tested.

References

[1] Choi O, Deng KK, Kim NJ, Ross L Jr, Surampalli RY, Hu Z., 2008, The inhibitory effects of silver nanoparticles, silver ions, and silver chloride colloids on microbial growth., Water Res., 42: 3066-3074

[2] Timsit JF, Dubois Y, Minet C, Bonadona A, Lugosi M, Ara-Somohano C, Hamidfar-Roy R, Schwebel C., 2011, New challenges in the diagnosis, management, and prevention of central venous catheter-related infections., Semin Respir Crit Care Med., 32: 139-150

[3] Veenstra DL, Saint S, Saha S, Lumley T, Sullivan SD., 1999, Efficacy of antiseptic-impregnated central venous catheters in preventing catheter-related bloodstream infection: a meta-analysis, JAMA, 281: 261-267

[4] Ramos ER, Reitzel R, Jiang Y, Hachem RY, Chaftari AM, Chemaly RF, Hackett B, Pravinkumar SE, Nates J, Tarrand JJ, Raad II., 2011, Clinical effectiveness and risk of emerging resistance associated with prolonged use of antibiotic-impregnated catheters: more than 0.5 million catheter days and 7 years of clinical experience, Crit Care Med., 39: 245-251

[5] Karpanen TJ, Casey AL, Conway BR, Lambert PA, Elliott TS., 2011, Antimicrobial activity of a chlorhexidine intravascular catheter site gel dressing, Antimicrob Chemother, 66(8):1777-1784

[6] Timsit JF, Schwebel C, Bouadma L, Geffroy A, Garrouste-Orgeas M, Pease S, Herault MC, Haouache H, Calvino-Gunther S, Gestin B, Armand-Lefevre L, Leflon V, Chaplain C, Benali A, Francais A, Adrie C, Zahar JR, Thuong M, Arrault X, Croize J, Lucet JC, 2009, Dressing Study Group. Chlorhexidine-impregnated sponges and less frequent dressing changes for prevention of catheter-related infections in critically ill adults: a randomized controlled trial, JAMA, 301: 1231-1241.

[7] Lackner P, Beer R, Broessner G, Helbok R, Galiano K, Pleifer C, Pfausler B, Brenneis C, Huck C, Engelhardt K, Obwegeser AA, Schmutzhard E., 2008, Efficacy of silver nanoparticles-impregnated external ventricular drain catheters in patients with acute occlusive hydrocephalus, Neurocrit Care, 8: 360-365.

[8] Stevens EA, Palavecino E, Sherertz RJ, Shihabi Z, Couture DE., 2010, Effects of antibiotic-impregnated external ventricular drains on bacterial culture results: an in vitro analysis, J Neurosurg, 113: 86-92.

[9] Huang Y, Li X, Liao Z, Zhang G, Liu Q, Tang J, Peng Y, Liu X, Luo Q., 2007, A randomized comparative trial between Acticoat and SD-Ag in the treatment of residual burn wounds, including safety analysis, Burns, 33: 161-166.

[10] Chen J, Han CM, Lin XW, Tang ZJ, Su SJ., 2006, Effect of silver nanoparticle dressing on second degree burn wound, Zhonghua Wai Ke Za Zhi, 44(1) :50-52.

[11] Lu S, Gao W, Gu HY., 2008, Construction, application and biosafety of silver nanocrystalline chitosan wound dressing, Burns, 34: 623-628.

[12] Sibbald RG, Contreras-Ruiz J, Coutts P, Fierheller M, Rothman A, Woo K., 2008, Bacteriology, inflammation, and healing: a study of nanocrystalline silver dressings in chronic venous leg ulcers, Skin Wound Care, 20: 549-558.

[13] Gravante G, Caruso R, Sorge R, Nicoli F, Gentile P, Cervelli V., 2009, Nanocrystalline silver: a systematic review of randomized trials conducted on burned patients and an evidence-based assessment of potential advantages over older silver formulations, Ann Plast Surg, 63: 201-205.

[14] Murray MR, Saltzman MD, Gryzlo SM, Terry MA, Woodward CC, Nuber GW., 2011, Efficacy of preoperative home use of 2% chlorhexidine gluconate cloth before shoulder surgery, J Shoulder Elbow Surg., 20: 928-933.

FIBRE-REINFORCED TISSUE ENGINEERING OF CARDIOVASCULAR IMPLANTS

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Tissue engineering is a promising approach for the repair and replacement of diseased or injured tissues and organs. Ideally tissue equivalents are developed starting from three-dimensional (3D) scaffolds exhibiting (a) high porosity and interconnected pore network for cell growth and flow transport of nutrients and metabolic waste; (b) suitable surface chemistry for cell attachment, proliferation, and differentiation and (c) mechanical properties to match those of the tissues at the site of implantation [1].

While bulk hydrogels act as homogeneous 3D scaffolds with uniform cell distribution and high cellular viability, they generally exhibit poor mechanical properties. The use of fibre reinforcement within cell seeded gels not only provides mechanical stability, but also anisotropic behaviour and the possibility of controlling the organization of the newly synthesised extracellular matrix [2]. This abstract presents different strategies to produce cardiovascular implants based on fibre-reinforced cell seeded fibrin scaffolds.

Atherosclerosis is still the leading cause of mortality and morbidity worldwide. Vascular bypass grafting is a commonly performed procedure in the treatment of atherosclerosis. In addition to autologous arterial and venous grafts, expanded polytetrafluoroethylene (ePTFE) prostheses are currently used as a synthetic “gold standard” in small calibre vascular grafting (I.D. < 6mm). Still the occlusion rate is 42% after 6 months and 67% after 18 months [3]. Histological examinations reveal a great percentage of calcification (68%) within and adjacent to the explanted ePTFE membranes and conduits (arterial, arteriovenous, or cardiac grafts) [4]. Although ePTFE is considered to be immunologically inert, it is often prone to thrombogenesis and infections [5].

The main cause of graft failure is the development of neointimal hyperplasia (NIH) in the graft lumen mainly because of reduced haemocompatibility and foreign body reaction with accompanying myofibroblast migration to the NIH-sites, with further progress of cellular death and calcification [6]. Additionally, a biomechanical compliance mismatching between the native vessel and the bypass graft induces haemodynamic changes such as turbulent flow and shear stress especially near the anastomosis-site leading to thrombus formation and excessive intimal hyperplasia. Therefore there is a high need for small-calibre vascular grafts with long term patency, reduced risk of infection and matching biomechanical compliance properties.

Tissue engineered small-calibre vascular grafts were moulded using a poly (L/D) lactide 96/4 (P(L/D)LA96/4) mesh surrounded by a fibrin gel embedding autologous arterial derived cells. After dynamic conditioning in a bioreactor system tissue engineered grafts were implanted in the carotid artery position of sheep. Graft patency was monitored periodically using a Doppler ultrasound system postoperatively. Explanted grafts at predetermined endpoint of 1, 3 and 6 months were patent and showed complete absence of thrombus formation and no evidence of aneurysm formation or calcification. Histological examination of the grafts revealed a dense homogenous distribution of cells, extensive collagen formation within the graft wall and remodelling of the fibrin scaffold. A confluent and intact monolayer of endothelial cells lining the luminal surface of the grafts could be shown by positive reactivity to eNOS and vWF. Hydroxyproline assay demonstrated progressive collagen synthesis over the 6 month implantation period.

The principle of combining a fibrin gel with a mechanically stable co-structure was further applied to stent angioplasty. After stenting the patency rates of small-calibre grafts are still insufficient. The aim of the BioStent concept is to overcome vessel occlusion by means of an intact functional active endothelial cell layer excluding the atherosclerotic plaques from the luminal side of the vessel. The proposed concept consists of a self-expanding stent covered by a cell seeded fibrin gel. The remodelling of the fibrin scaffold with mature autologous proteins was tested by histological analysis. A confluent endothelial cell monolayer lining the luminal surface of the BioStent was shown by scanning electron microscopy. After the cultivation in a bioreactor system a thin layer of about 200µm completely covering the stent structure was achieved. Furthermore a complete lining of endothelial cells was observed. Results from a first animal study in adult sheep are being evaluated on BioStents explanted up to 6 months after implantation in the carotid artery position.

Fiber and textile reinforcements offer crucial advantages also for valvular prosthesis. An adequate textile structure gives mechanical stability and constraints tissue contraction due to cellular remodelling, which is one of the major shortcomings in the field of cardiovalvular tissue engineering leading to retracted leaflets and therefore insufficient valves. Notably fiber reinforcement has also the potential of guiding the deposition and organization of proteins as to mimic the properties of the native valves.

Key Words: Fibre reinforcement, fibrin, textile, cardiovascular

References

[1] Hutmacher DW., 2000, Scaffold in tissue engineering for bone and cartilage, Biomaterials, 21(24) 2529-2543
[2] Koch S. et al., 2010, Fibrin-polylactide-based tissue-engineered vascular graft in the arterial circulation, Biomaterials, 31(17) 4731-9
[3] Hubert TS, Carter JW, Carter RL, Seeger JM., 2003, Patency of autologous and polytetraflorethylene upper extremity arteriovenous hemodialysis access: A systematic review, J Vasc Surg, 38: 1005-1012
[4] Mehta PI, Mukherijee AK, Patterson TD, Fishbein MC., 2011, Pathology of explanted polytetrafluoroethylene vascular grafts, Cardiovasc Pathol, 20: 213-221
[5] Wilhelmi M, Haverich A., 2003, Materials used for haemodialysis vascular access: current strategies and a call to action, Graft, 6: 6-15
[6] Roy-Chaudhury P, Wang Y, Krishnamoorthy M, Zhang J, Banerjee R, Munda R, Heffelfinger S, Arend L., 2009, Cellular phenotypes in human stenotic lesions from haemodialysis vascular access, Nephrol Dial Transplant, 24:2786-2791

NANOFIBERS IN MEDICAL TEXTILES

INNOVATIVE FIBER BASED DRUG DELIVERY SYSTEM WITH CONTROLABLE DRUG RELEASE

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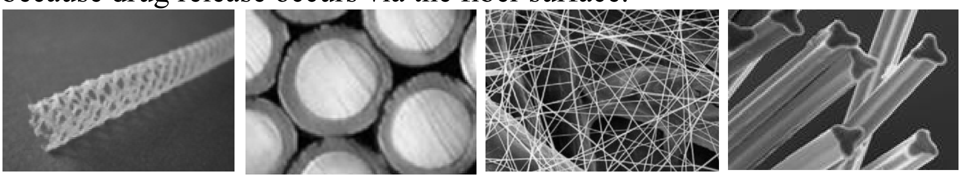
Purpose

Drug delivery systems enable a constant drug release over a certain period of time. Due to a localized drug release and improved drug release kinetics the overall drug dosage can be reduced. The benefits are reduction of unwanted side effects and the elimination of overdosing. Thus, product efficiency and safety, as well as patient convenience and compliance can be improved. The advantages of textile structures for drug delivery systems are the possibility to manufacture two-and three-dimensional structures, their good drapability and the possibility of adjusting mechanical and morphological properties. The high specific surface area of fibers is of special interest for drug delivery systems because drug release occurs via the fiber surface.



Tubular warp-knitted structure | Coextruded fibre c/s | E-Spun nanolayer | Trilobal fibre

Figure 1. Different fiber and textile structures

Methodology

Within a current research project "Laser induced drug release from polymer fibres with incorporated microgel – Photorelease" funded within the program "Exploratory Research Space at RWTH Aachen - ERS", the Institut fuer Textiltechnik of RWTH Aachen University in cooperation with DWI an der RWTH Aachen e.V., Chair for Laser Technology LLT at RWTH Aachen University and the University Hospital Aachen are developing a highly innovative fiber based drug delivery system.

Goal of the project is a drug loaded stent with controllable drug release by the use of laser irradiation. The main idea of the project is based on the chemical bonding of fluorouracil (5-FU) to a microgel, which can be cleft by a laser irradiation of a certain weave length. Therefore, firstly the drug loaded microgel is incorporated into the spin solution using biocompatible polycarbonate-urethane (PCU) as polymer. Hereafter drug loaded fibers are manufactured via air-gap spinning. Finaly, the drug loaded fibers are processed via braiding to stents.

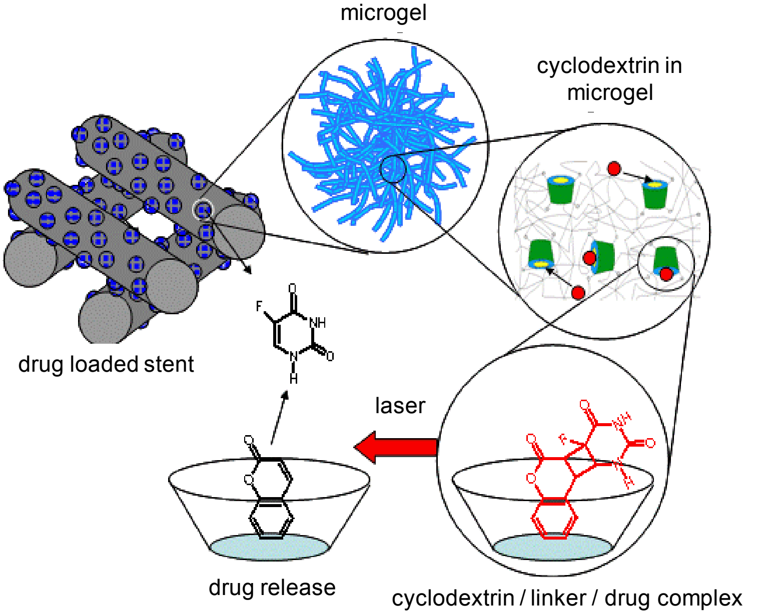


Figure 2. Project concept – RWTH Aachen University ERS Funded Project "Photorelease"

Results

Prior to the fiber production, an appropriate polymer-solvent system needed to be found. A screening of different organic solvents resulted in one solvent, which can be used to produce PCU fibers. N-Methyl-Pyrrolidon (NMP) has the optimal conditions including high solubility, low toxicity and low vapor pressure for the fiber production. The maximum solubility of PCU in NMP that can be achieved amounts to 30%. A piston spinning plant was used to process fibers via air-gap spinning. Water was used as coagulation medium. In order to achiev parameters for a stable production process the residence time of the filaments in the coagulation bath had to be increased. Best results afforded the mixture of 25% PCU and 75% NMP. For fibers with incorporated microgel a composition of 23% PCU, 71% NMP and 6% microgel showed promising results. Due to high costs of fluorouracil (5-FU), the calibration of process parameters occurred only for cyclodextin microgel. Fibers without microgel were produced successfully with a titer of 98 dtex, a tensile strength of 8 cN/tex and an elongation at break of 61%. So far, no stable production process for fibers with incorporated microgel could be established.

Conclusion

A drug release system with controllable drug release is a highly innovative and promising approach for gentle patient therapy. Within this study a fiber manufacturing process could be established that enables the incorporation of the described drug release system into the fibers. This successful fiber development offers a multitude of applications for the drug release systems due to the variety of textile structures which are used for medical implants/devices.

Key Words: Dry/wet spinning, PCU, drug release, 5-FU, microgel

ELECTROSPINNING OF CLAYS- AND MESOPORES-BASED PAN NANO-COMPOSITES: MORPHOLOGY CHARACTERIZATION

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This paper reveals the influence of different clays and meso-porous nano particles, as additives, on the morphology of nano-based polyacrylonitrile composites and their potential application. Nano-based PAN composites have been prepared by electrospinning of colloidal polymer-additive dispersions in DMF. Different combinations of electrospinning process parameters have been investigated in order to obtain certain morphologies which are suitable for potential applications. Certain techniques are available to characterize the morphologies of produced nano-nonwovens including scanning electron microscopy, X-ray diffraction, FT-IR spectra. Micro-pores and meso-pores characteristics have been evaluated by means of N_2 adsorption, where specific surface areas and pore size distributions have been characterized by BET method.

Key Words: Electrospinning, clay, mesopores.

ANTIMICROBIAL NATURAL COMPOUND LOADED POLYAMIDE 6 NANOFIBERS

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Electrospinning is a relatively simple method that sub-micron ranged fibers are produced. High surface area to volume ratio, pore sizes between 500 nm-1 µm, and high porosities of nanofiber webs make them attractive for filtration applications [1]. Some specific materials may be required for some advanced filtration applications such as clean room filters or additional filter layers that can be bounded on face masks. Nanofibers are suitable materials for these applications due to their excellent properties mentioned above. Usage of silver containing PA 6 nanofibers in filtration applications was studied by Pan et al.[2].

This study aims at determining the optimum spinning parameters for PA 6, producing PA 6 nanofiber webs, loading of these webs with Turkish Sweetgum (*Liquidambar orientalis*), and determining antibacterial activities of *L.orientalis* loaded PA 6 nanofibers.

Polyamide 6 is a widely preferred synthetic polymer for electrospinning due to its trouble-free spinability. Effective electrospinning of PA 6 nanofibers were extensively studied in the literature [3-5]. But there were no studies about loading of *L.orientalis* extract on PA 6 nanofibers. *L.orientalis* that grows only in limited location of Turkey was selected because of its excellent antimicrobial properties [6].

The influence of applied voltage, flow rate and distance between needle tip to collector on fiber formation and fiber morphology were studied. Applied voltages of 10, 20, and 30 kV, flow rates of 5 and 10 µL/min, and distances of 10 and 15 cm were selected process parameters carried out to the PA 6/formic acid solution at a constant concentration of 20 wt %. To investigate the morphology of nanofibers, SEM images were taken. Fiber diameters were determined by Image-J visualization and scaling software. The finest fibers were obtained at voltage of 20 kV, flow rate of 5 µL/min, and distance of 15 cm. SEM image, average fiber diameter and fiber diameter distribution can be seen in Figure 1. Beaded fibers were formed at 5 µL/min flow rate, 10 cm distance and both 10 kV and 20 kV voltages. Formation of beads can be explained by the application of a voltage less than the critical value for this polymer solvent system.

Studies on loading of *L.orientalis* on PA 6 nanofiber webs are going on. *L.orientalis* was dissolved in ultra pure water after setting initial concentration. PA 6 nanofibers will be incorporated with extract by shaking at a determined period. Then antimicrobial activities of these nanofibers will be tested against *Staphylococcus aureus* (RSKK95047), *Escherichia coli* (0157H7)(RSSK232) and *Candida albicans* (DSMZ 5817) according to slightly modified version of AATCC test method 100-2004.

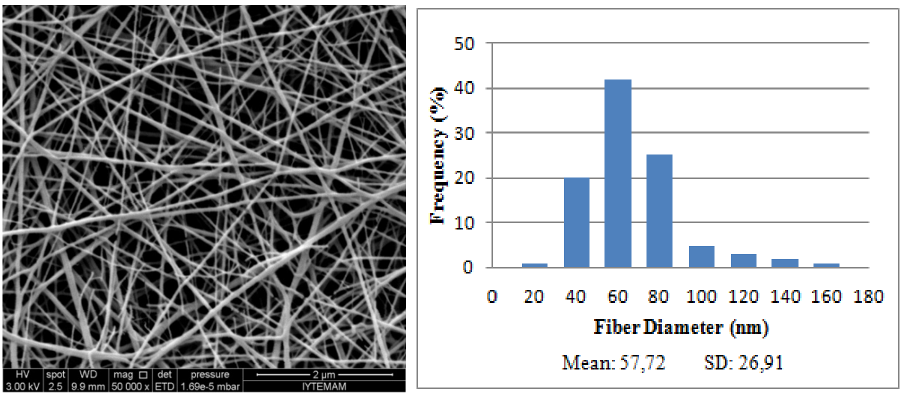

Figure 1.SEM images of PA 6 nanofibers and diameter distribution

The authors acknowledge the support of DUAG Natural Compounds Research and Development Company.

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Key Words: Nanofiber, polyamide 6, liquidambar orientalis, antimicrobial activity

References

[1] Subbiah T., Bhat G.S., Tock R.W., Parameswaran S., Ramkumar S.S., 2005, J of App Polymer Science, V 96, 557–569

[2] Pan Y.J., Chuang W.S., Lin C.Y., Chu C.H., 2011, Advanced Mat. Res., V 287-290, 2626-2629
[3] Heikkilä P., Harlin A., 2008, European Polymer Journal, 44, 3067
[4] Nirmala R., Nam K.T., Park S-J., Shin Y-S., Navamathavand R., Kim H.Y., 2010, App. Surface Sci. 256, 6318
[5] Ding B, Li C., Miyauchi Y., Kuwaki O., Shiratori S., 2006, Nanotechnology, 17, 3685
[6] Balta A.B., 2010, MSc thesis, İzmir Institute of Technology, 137 p

COMPOSITE NANOFIBRES STRUCTURES FOR BONE REGENERATION

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The generation of the three dimensional scaffolds supporting cell in-growth and proliferation have become an increasingly active area of research. In this context, the design of fibrous structures with tailored, biomimetic geometries for the application as implants can be appropriate [1]. Electrospinning is able to appropriate design of effective-in-clinical-use, biomimetic scaffolds due the high enhance of the surface as well as ultrathin fibres [2].

The composites of polymers and ceramics are preparing for the increasing of efficiency of fibrous structure in the field of biomaterials and tissue engineering applications. Composite scaffolds have been in-vivo proved as an appropriate for the reconstruction of multi-tissue organs, tissue interfaces and structural tissues, including bone [3]. Hydroxyapatite (HA) is a major inorganic component of bone and teeth. The structures containing HA have been characterized by high potentiality for cell proliferation, better mechanical properties than scaffolds without HA. Fibrous structures containing HA and PLA or its copolymers could be an ideal biomaterials scaffolds having good osteoconductivity, osteoinductivity, biodegradability [4].

The main purpose of project No.WND-POIG.01.03.01-00-007/08 “BIOGRATEX - Biodegradable fibrous products” is to develop several innovative solutions for application in medicine, hygiene products industry, agriculture, and filtration. The main aspect of the project is to design the scaffolds for bones regeneration differing in composition and structure.

Nonwoven structures have been electrospun of the biodegradable copolyesters with addition of nano – sized hydroxyapatite. Polymers were obtained from Centre of Polymer and Carbon Materials, Polish Academy of Sciences, Zabrze/Poland.

The electrospinning processing parameters and concentration of polymer in solution influence on the fibres diameter were determined. The usable parameters of selected nonwovens and the effect of radiation sterilization dose for nonwoven usable parameters will be presented.

SEM microphotographs were made on a Nova NanoSEM 230 scanning electron microscope (FEI Company) and on scanning microscope JSM-5200 LV (Jeol).SEM microphotographs of selected electrospun nanofibers structures are shown in Figure 1.

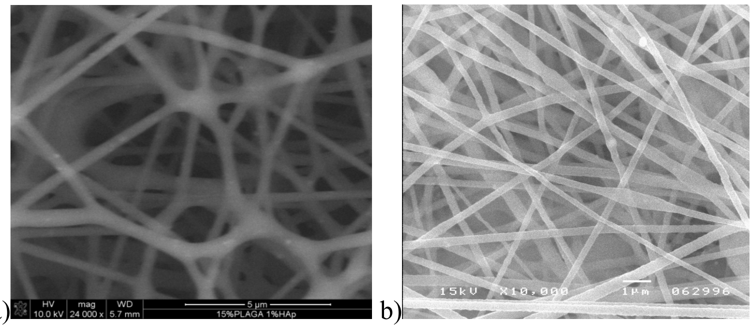
a)  b)

Figure 1. SEM microphotographs of electrospun nanofibers structures with addition of nano-sized hydroxyapatite: a) Sample 1 (magnification x 24000); b) Sample 2 (magnification x 10000)

Key Words: Electrospinning, biodegradable copolyesters, hydroxyapatite

References

[1] Lannutti, J. Reneker, D. Ma, T. Tomasko, D. Farson, D., 2007, Electrospinning for tissue engineering scaffolds, Science and Engineering, 27(3), 504-9

[2] Huang, ZM. Zhang, YZ. Kotaki, M. Ramakrishn,S., A Review on Polymer Nanofibres by Electrospinning and Their Applications in Nanocomposites, 2003, Composites Science and Technology, 63(15), 2223-53

[3] Cui, W. Zhou,Y.Chang, J., 2010, Electrospun nanofibrous materials for tissue engineering and drug delivery, Sci. Technol. Adv. Mater., 11(1), 1-11

[4] Ramakrishna, S. Mayer, J. Wintermantel, E. Leong, K.W., 2001, Biomedical applications of polymer-composite materials: a review, Composites Science and Technology, 61(9), 1189-1224

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BIOMATERIALS AND BIOMEDICAL APPLICATIONS

CHOICE AND EVALUATION OF BUFFER SYSTEMS TO REALIZE A PH NEUTRAL DEGRADATION OF POLYGLYCOLIC ACID (PGA)

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Introduction:
Resorbable polymers are established since several decades in biomedical applications. The most frequently used resorbable polymers are still the aliphatic polyesters polylactides (PLA), polyglycolid (PGA) and polycaprolactone (PCL) homo- and copolymers. Resorbable polymers are used as implants whenever the device shall fulfill its function for just a certain period of time. Besides their current main use as degradable sutures, aliphatic polyesters are also interesting materials for osteosynthesis and drug delivery systems as well as scaffold structures for the tissue engineering approach. [8, 9, 6] Their main advantages are avoidance of a second operation to remove the device, a slow transfer of load from the degrading polymer onto the regenerating tissue respectively the consistent drug release over the degradation time.

The mechanism of polyester degradation has been investigated extensively over the past 20 years and is well known today. [5, 4, 7] First water diffuses into the polymer. Polymer chains then are degraded by hydrolytic scission of ester linkages in the polymer backbone by creating carboxylic end groups. [8, 9] These acidic carboxyl end groups decrease the pH of the near surrounding of the implant. This pH drop is one of the main concerns regarding the use of aliphatic polyesters for implants as a low pH may cause inflammation in the host tissue. The incorporation of neutralizing bases or buffer systems into the polyesters has the potential to overcome these effects. Some research groups have already investigated the incorporation of such additives to aliphatic polyesters in order to realize a pH neutral degradation. [1, 2, 3]

In some cases the pH drop occurred delayed but it could not avoided in total. Furthermore all results are based on injection or compression moulded parts respectively foils. The incorporation of buffer systems into fibers was not investigated yet.

Material and Methods:

In order to develop a pH neutral degrading fibre, a requirement profile for buffer systems was set up at first. A choice of buffer systems was carried out on the basis of a literature research. During compounding and melt spinning the polymer and the buffer system undergo a thermal load. Thus, the influence of the thermal load to the capacity of the buffer system was evaluated within a pretrial test series. The dosage of the buffer systems was calculated on the basis of the Henderson–Hasselbalch equation. The most promising buffer systems will be used for compounding and spinning trials.

Results and Discussion:

Regarding the requirement profile the buffer system properties buffer range and buffer capacity, the processability of the buffer system via melt spinning as well as the biocompatibility of the buffer system were taken into consideration. Among other buffer systems HEPES / HEPES NA was found to be a promising candidate. This assumption was confirmed by the results of a pretrial test series in which both the thermostability and the buffer capacity were tested (see Figure 1 and Figure 2)

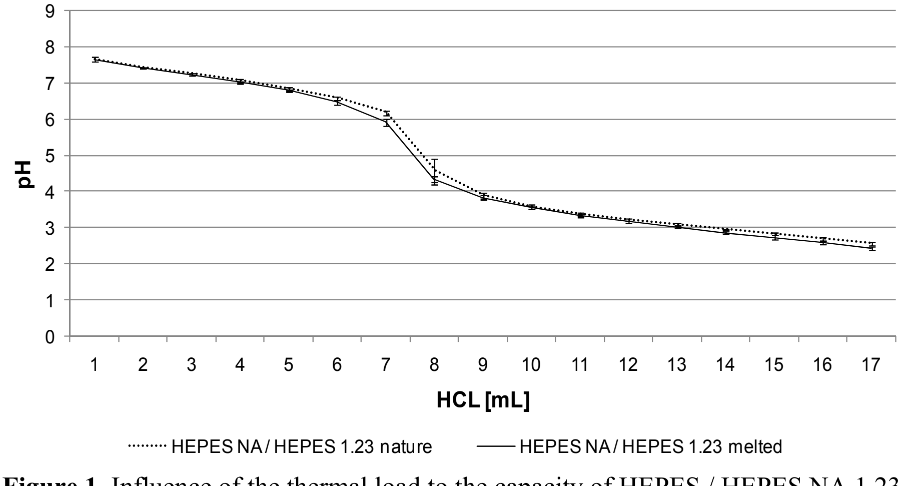

Figure 1. Influence of the thermal load to the capacity of HEPES / HEPES NA 1.23

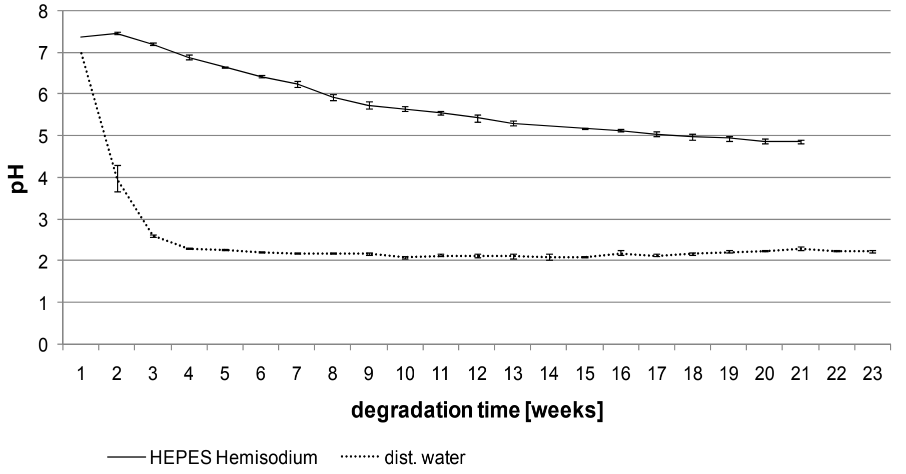

Figure 2. Changes in pH of the dissolution media during degradation of PGA at 37°C under static conditions

In order to adjust the buffer system to a pH of 7.4 and according to the Henderson–Hasselbalch equation $\frac{[HEPES\ NA]}{[HEPES]} = 10^{pH - pKaHEPES(37°C)}$ the ratio HEPES NA / HEPES needs to be 1.23. In the next steps the actual compounding and afterwards the spinning will take place.

Key Words: Aliphatic polyesters, polyglycolide, degradation products, buffer system, neutral degradation

References

[1] Ehrenfried L.M., Patel M.H., Cameron R.E., 2008, The effect of tri-calcium phosphate (tcp) addition on the degradation of polylactide-co-glycolide (plga), Journal of Materials Science: Materials in Medicine, V:19(1):459–466

[2] Heidemann W, Jeschkeit-Schubbert S., Ruffieux K., Fischer J.H., Jung H., Krueger G., Wintermantel E., Gerlach K.L., 2002, Ph-stabilization of predegraded pdlla by an admixture of water-soluble sodiumhydrogenphosphate–results of an in vitro-and in vivo-study, Biomaterials, V:23(17):3567–3574

[3] Li S., Girod-Holland S.,Vert M., 1996, Hydrolytic degradation of poly (-lactic acid) in the presence of caffeine base, Journal of controlled release, V:40(1-2):41–53

[4] Pitt C.G., Chasalow FI, Hibionada YM, Klimas DM, Schindler A., 1981, Aliphatic polyesters. i. the degradation of poly (e-caprolactone) in vivo, Journal of Applied Polymer Science, V:26(11):3779–3787

[5] Pitt GG, Gratzl MM, Kimmel GL, Surles J., Sohindler A., 1981, Aliphatic polyesters ii. the degradation of poly (dl-lactide), poly ([epsilon]-caprolactone) and their copolymers in vivo, Biomaterials, 2(4):215–220

[6] Planck H., 1993, Kunststoffe und Elastomere in der Medizin, Stuttgart, Berlin, Köln, Kohlhammer

[7] Therin M., Christel P., Li S., Garreau H., Vert M., 1992, In vivo degradation of massive poly ([alpha]-hydroxy acids): Validation of in vitro findings. Biomaterials, V:13(9):594–600

[8] Wintermantel E., Ha S.W., 1998, Biokompatible Werkstoffe und Bauweisen : Implantate für Medizin und Umwelt, Berlin, Heidelberg, Tokio, New York, Barcelona, Budapest, Hongkong, London, Mailand, Paris, Singapur, Springer

[9] Wintermantel E., Ha S.W., 2009, Medizintechnik Life Science Engineering, Berlin, Heidelberg, Springer

INVESTIGATION OF FIBRINOGEN ADSORPTION ONTO POLYETHYLENE TERPHTHALATE USING QCM-D

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During last 60 year's many different approaches were introduced to improve biocompatibility respectively haemocompaibilty of polymer surfaces used for production of medical devices. One of the most important tasks in these developments is among others also an accurate analytical approach in determination of the haemocompatibility of polymeric materials' surfaces. A widely recognized and accepted in-vitro method for blood compatibility determination still does not exist. In consequence, a wide variety of different systems are currently applied in the development of new biomaterials [1]. Recently have been presented a very promising new approach for the identification of biomaterials' haemocompatibility using quartz crystal microbalance with dissipation unit (QCM-D) [2-4].

In this research Quartz Crystal Microbalance with Dissipation monitoring apparatus, QCM-D was used for blood protein fibrinogen adsorption and plasma clot formation studies. Surface bound fibrinogen has been shown to have a key role in the adhesion of platelets to artificial surfaces, and platelet adhesion to artificial surfaces is mediated exclusively by surface-bound fibrinogen and does not seem to involve the other plasma adhesion proteins [5]. Therefore biomaterials with low affinity to fibrinogen are of great interest and QCM-D is appropriate tool for monitoring the protein adsorption. Quartz crystal microbalance with dissipation unit (QCM-D) is one of a few techniques that give direct information about the adsorption process in situ. It is based on the change in resonance frequency of a thin AT-cut piezoelectric quartz crystal disk that oscillates in the shear mode when AC voltage is applied across electrodes. The resonant frequency changes with the mass deposited on the crystal surface, rendering QCM a very sensitive mass sensor [2].

On Figure 1 fibrinogen adsorption monitored by QCM-D onto differently modified model PET surfaces is represented.

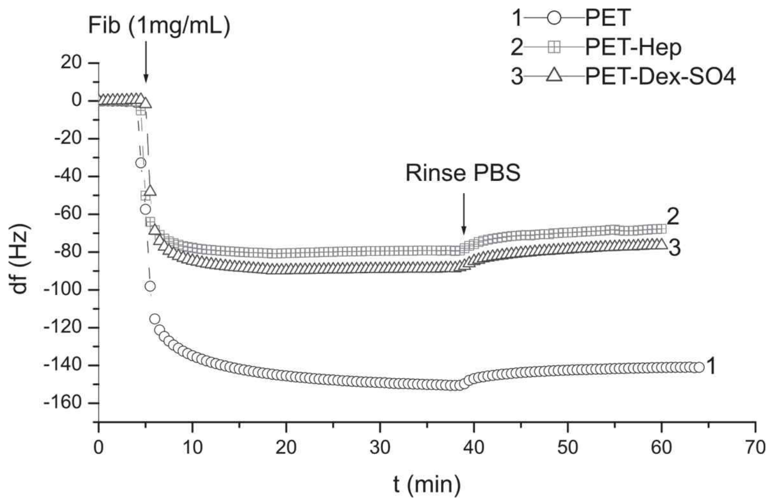

Figure 1. Frequency changes (at third overtone) during fibrinogen adsorption onto non-modified (PET) and anticoagulant coated (Heparin, Dextran Sulphate) PET surfaces monitored by QCM-D (times of fibrinogen additions, as well as rinsing with buffer are market by arrows)

Differences between the fibrinogen adhered to the surfaces treated with anticoagulants and non-treated PET surfaces are significant.

The results showed that QCM-D is a valuable tool for investigation of the surface activities of different surfaces and is a well suited technique for protein adsorption studies. The main drawback of QCM-D is its limitation to model surfaces, which often differ from the real surfaces.

Key Words: Haemocompatibility, QCM-D, PET, anticoagulants, fibrinogen, coagulation time

References

[1] Wang J, Pan CJ, Huang N, Sun H, Yang P, Leng YX, et al., 2005, Surface characterization and blood compatibility of poly(ethylene terephthalate) modified by plasma surface grafting, Surface & Coatings Technology,V:196:307-11

[2] Doliska A, Strnad S, Stana J, Martinelli E, Ribitsch V, Stana-Kleinschek K., 2011, In Vitro Haemocompatibility Evaluation of PET Surfaces using the Quartz Crystal Microbalance Technique, Journal of Biomaterials Science, Polymer edition

[3] Andersson M, Andersson J, Sellborn A, Berglin M, Nilsson B, Elwing H., 2005, Quartz crystal microbalance-with dissipation

monitoring (QCM-D) for real time measurements of blood coagulation density and immune complement activation on artificial surfaces, Biosensors and Bioelectronics,V:21

[4] Andersson M, Sellborn A, Fant C, Gretzer C, Elwing H., 2002, Acoustic of blood plasma on solid surfaces, Journal of Biomater Sci Polymer Edn, Vol:13:907

[5] Weber N, Wendel HP, Kohn J., 2005, Formation of viscoelastic protein layers on polymeric surfaces relevant to platelet adhesion, Journal of Biomedical Materials Research Part A, V:72A:420-7

BACTERIOSTATIC PLA/CHITOSAN COMPOSITE FILMS

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Recently people have started to search for less toxic and more effective antimicrobial agents. During these investigations, chitosan obtained from chitin of insects has become an attractive agent for antibacterial application, because of its lower cost, biocompatibility, biodegradability and high antimicrobial activity. It has been shown to be useful in many different areas-as antimicrobial compound, as a flocculating agent in wastewater treatment, as a hydrating agent and more recently as a pharmaceutical agent. Due to the positive charge on the C-2 of the glucosamine monomer below pH 6, chitosan can blind to the negatively charged bacteria cell. When the chitosan interacts with the membrane of the bacteria cell it increase the cell permeability [1-5]. Chitosan is very suitable to use with Poly(lactic acid) (PLA) polymer matrix which is also biocompatibility and biodegradability. PLA has started to use in medical application such as sutures, meshes and wound dressings [6]. In order to minimize the risk of device-related infections, the antimicrobial PLA/chitosan composites can be used. In this paper, chitosan particles were mixed into the poly (lactic acid) matrix in the percentage range of 1, 3 and 5 wt% and thin films were obtained by melt-extrusion process. Then, these films were tested for their antibacterial activity against Staphyloccocus aureus and their thermal and mechanical characteristics were determined.

The polymer granulates was PLA 6201 D from Naturawork. The chitosan particles were purchased from Acros organics. Films were produced by using a DSM Xplore 15 ml micro-compounder. Polymers and chitosan particles were fed and then mixed into the micro-compounder at a temperature of 200^{o}C and a screw speed of 100 rpm for 15 minutes. Chitosan particles and PLA at the percentage of 1, 3, 5 %(wt). The neat PLA films were prepared in a similar way. The thermal properties of the films were evaluated with Differential scanning calorimeter (DSC) and thermo gravimetric analysis (TGA). The TGA scans were performed in a nitrogen atmosphere between 20^{o}C and 700^{o}C with the heating rate of 10^{o}C/min. TGA plots for both neat PLA films and composite films were shown that the addition of chitosan particles caused slight decrease of the thermal stability. To determine the thermal characteristic and crystalline structure of the films, DSC was used. The samples were heated at a rate of 10^{o}C/min from -20^{o}C to 220^{o}C and then cooling with the rate of 20^{o}C/min and then heated again According to DSC results, the glass transition temperatures and melting temperatures didn't significantly changed, but the crystalline ratio of the films increased with the filler content. The mechanical properties of the films determined by using Instron 5567 tensile tester according to ASTM D882-10. The mechanical properties decrease with filler content. This can be related with the decrease in homogeneity of the films. When the distribution of the fillers was not the homogeneity along the film, weak points were occurred and these weak points caused decrease in mechanical properties. Bacterial activity of the films was evaluated against Staphyloccocus aurues by an AATCC test method 147-2004. Inoculum solution was applied in five streaks on the sterile agar plate. The samples were placed in intimate contact with the agar. The agar plates were incubated at 37 ^{o}C for 18 hours. After 18 hours, the agar plates were checked and bacteriostatic effect of PLA/chitosan film against Staphylococcu aureus was determined. When the bacteria touch the composite surface, they were dead (Figure1).

Table 1. Thermal and mechanical properties of films

Sample	Tg (^{o}C)	Tm (^{o}C)	Xc (%)	Tensile stress (MPa)	Tensile strain (%)	Modulus (MPa)
PLA neat	60.96	168.15	40.09	9.257	21.3	20549.020
PLA/Chitosan 1	60.87	168.60	45.08	6.259	6.2	930.123
PLA/Chitosan 3	60.68	168.44	45.96	5.368	8.3	688.610
PLA/Chitosan 5	60.85	168.70	45.56	4.715	8.2	714.999

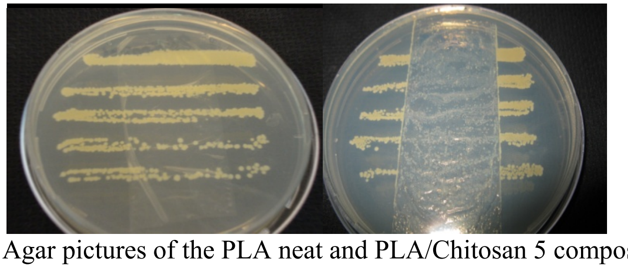

Figure 1. Agar pictures of the PLA neat and PLA/Chitosan 5 composite film.

In this study, we have investigated the preparation of bacteriostatic PLA/Chitosan films by the melt-spinning method. The thermal and mechanical properties of these films were determined. Finally, antibacterial activity of the produced films was searched according to the ASTM E2149-01 standard. Test results show that composite films were bacteriostatic effect. In addition, the increase of filler content causes noticeable difference on the tensile properties of the fibers. The homogeneity of the distribution should be increased.

Key Words: Chitosan, poly (lactic acid), antibacterial, films

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References

[1] Rabea E.I., Badawy M.E.T., Stevens C.V., Smagghe G., Steurbauth W., 2003, Biomacromolecules, V:4(6), p:1458
[2] Kim C.H., Choi J.W., Chun H., 1997, J Polym Bull, V: 38, p:387
[3] Aiedeh K., Taha M.O. 2001, Eur J Pharm Sci, V:13, p:259
[4] Pascual E., Julia M.R., 2001, J Biotechnol.,V:89, p:289
[5] Strand S.P., Varum K.M., Ostgaard K., 2003, Colloids Surf B, V:27, p:71
[6] Cai H., Dave V., Gross R.A., Mccarthy S.P., 1996, J Poly Sci B poly phys,V:34, p:2701.

USE OF THYME AS A NATURAL DYE IN WOOL DYEING AND EVALUATION OF THE ANTIMICROBIAL EFFECT

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Natural dyes can be named as the oldest chemicals used in coloration of textile goods. Its ancient applications are now become popular again because of the demand of human being to natural based materials. This encouraging tendency to the natural dyes make the scientists focus on the use of natural dyes and the properties of it. Owing to this, in this study thyme as a natural dye was used in wool dyeing with different mordants and also with no mordants. Afterwards the color efficiencies and color values of the dyed samples were collected. Washing fastnesses were evaluated too. Differently, in this study the antimicrobial effect of this natural dye after dyeing process was investigated too for only undyed and dyed without mordant samples. For this aim the antimicrobial properties of the fabrics undyed and dyed without mordant were analyzed with AATCC Test Method 100. As gram-positive bacteria, *Staphylococcus aureus was selected*. An undyed sample was used as a control and there was no bacterial reduction observed in control samples however use of thyme as a natural dye for wool fabrics' dyeing caused significant bacterial reduction in comparison to the control surface. As a result, it was observed that addition to good colors and satisfying fastnesses, an antimicrobial effect was also obtained with the use of thyme as a natural dyestuff.

TEXTILE IMPLANTS

EFFECT OF SOLVENTS AND SHRINKING AGENTS ON PET BASED VASCULAR GRAFTS

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ABSTRACT
Basic textile structures of woven and knitted fabrics are widely used in vascular graft manufacturing because of their mechanical properties useful for blood transfer in cardiac flow conditions. Polyester is generally the main material used in available grafts. Therefore, vascular grafts' performance depends on structural varieties in fiber yarn and fabric.

Vascular grafts used in this study were manufactured from the PET based yarns with same linear density but different fiber fineness by means of double layer (trunk) weaving principle. Besides, these fabrics were compacted with different solvents and shrinking agent to investigate the changes in water permeability, tenacity and elongation properties. Results showed some challenging issues about the process.

Key Words: Vascular graft, chemical compaction, PET, fiber fineness, water permeability

DESIGN ASPECTS OF FIBROUS, IMPLANTABLE MEDICAL DEVICES

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The general requirements for the design of medical devices are mostly described in EN-ISO 9001 and EN-ISO 13485 Standards. However, they are too general and detailed method for each new-designed medical devices is necessary to implement each time.

The research carries out at the Technical University/Lodz is aimed to design the optimal structure of knitted hernia and urogynecological implants as well as their modification by nano-layer of fluoropolymer [1-6]. The urinary incontinence treatments and vaginal wall reconstructions are one of the most often surgical procedures in urogynecology, whereas, in a case of general surgery, hernia treatment (both by standard or low-invasive – laparoscopic procedures) shows annually the highest numbers of surgeries [7-9].

The idea of the study is to design the biomimetic knitted structures taking into the account preliminary identified risks connected with the anatomical localization of the implant as well as potential complications estimated on base of adverse events of clinically used medical devices [6].

The detailed requirements for designing new-elaborated knitted, implantable medical devices will be explained based on the research on elaboration of ultra-light textile implants technology for using in urogynecology and in the low-invasive procedures of hernia treatments.

The aspects of risk analysis and risk managements (acc. EN-ISO 14971:2009 Standard), requirements for designing process of implant models and prototypes (acc. EN-ISO 14630:2009 and other standards harmonized with EU Directives 93/42/EEC and 2007/47EC), accelerated ageing (acc. ASTM F 1980:2002 Standard) and biocompatibility studies (acc. guidance of EN-ISO 10993-1:2009 Standard) as well as verification and validation processes will be present.

The research was carried out within developmental project No. N R08 0018 06 “Elaboration of Ultra-Light Textile Implants Technology for Using in Urogynecology and in the Procedures of Hernia Treatments” funded by the National Centre for Research and Development.

Key Words: Fibrous implants, urogynecology, hernioplasty

References

[1] Struszczyk M.H., Kopias K., Golczyk K., Kowalski K., Three-Dimensional, Knitted Implant For Connective Tissue Reconstructions, PL Patent application No. P 394623, 2011

[2] Kostanek K., Struszczyk M. H., Krucińska I., Urbańska-Domagała W., Puchalski M., 2011, Method Of Modification Of Three-Dimensional Implant For Low-Invasive Hernia Treatment, PL Patent application No. P-395988

[3] Struszczyk M.H., Komisarczyk A., Krucinska I., Kowalski K., Kopias K., 2011, Ultra-Light Knitted Structures For Application In Urologinecology And General Surgery – Optimization Of Structure, FiberMed11 Proceedings, ed. P. Talvenmaa, ISBN 978-952-15-2607-15-2607-7

[4] Kostanek K., Struszczyk M.H., Urbańska-Domagała W., Krucińska I., 2011, Surface Modification Of The Implantable Knitted Structures For Potential Application In Laparoscopic Hernia Treatments, FiberMed11 Proceedings, ed. P. Talvenmaa, ISBN 978-952-15-2607-15-2607-7

[5] Struszczyk M. H., Gutowska A., Kowalski K., Kopias K., Pałys B., Komisarczyk A., Krucińska I., 2011, Ultralight Knitted Structures For The Application In Urologinecology And General Surgery – Optimization Of The Structure In Aspects Of Physical Parameters, Fibres & Textiles in Eastern Europe, No. 5 (88), 92-98

[6] Struszczyk M.H., et al., 2010, Aspects Of The Risk Analysis In Designing Of Textile Medical Devices For Use In Urogynecology And General Surgeries, Proceedings of the IXth International Conference Knitt Tech 2010, Rydzyna/Poland

[7] Birnbaum H.G., et al., 2004, Cost Of Stress Urinary Incontinence: A Claims Data Analysis, Pharmacoeconomics, 22, 95-105

[8] Wilson L. et al., 2001, Annual Direct Cost Of Urinary Incontinence, Obstet. & Gynaecol., 98, 398-406

[9] Awad S.S. et al., 2004, Current Approaches To Inguinal Hernia Repair, Am. J. Surg., 188, 16

MECHANICAL BEHAVIOUR OF FIBROUS BRAIDED STRUCTURES FOR ARTIFICIAL KNEE LIGAMENTS

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Introduction

The main function of knee ligaments is to connect femur to the tibia as well as to control and guide the movement of the joint. These ligaments are responsible for the transmission of forces to the various components in order to avoid joint and musculoskeletal system damages [1]. The knee joints easily suffer from injuries because they have to carry the full weight of the body. The most commonly observed knee injury occurs due to the damage of anterior cruciate ligaments (ACL), which are the weakest knee ligaments. Due to the increasing sport activities all over the world, the need for the reconstruction of damaged ligaments has grown tremendously. According to the literature, there exist various approaches for the repair or replacement of ACL, using the knowledge generated in this field since 1980[2]. In recent times, a great deal of reseach has been directed towards developing artificial grafts for ACL reconstructions. However, it is extremely necessary that the new structuresshould be able to execute the same functions as performed by human ligaments [3]. One of the research trends explored within the last few years is the use of braided fibrous materials as artificial grafts due to their mechanical behaviour and the possibility to design fibrous arrangements, which can mimic the one shown by natural ligaments. The present paper describes the research work being done by Fibrous Materials Research Group (FMRG) at University of Minho to study the mechanical behavior of braided fibrous structures to be used as artificial ligaments, mainly for the ACL.

Methods

A vertical braiding machine was used to produce different types of braided fibrous structures including circular braids axially reinforced by other circular braids. A 160 dtex multi-filament polyamide yarn was used in all braided structures. The braids were produced by varying the number of axially introduced (or inner) braids (3, 5 and 7) as well as the number of yarns used in the inner braids (4, 5 and 6). The details of the braided structures developed are listed in Table 1. The braids were characterized for tensile properties in a Hounsfield N-5000 universal testing machine according to NP EN ISO 2062:1993 standard at a crosshead speed of 100 mm/min using 50 cm gauge length.

Table 1. Details of produced braided structures

Type of Braided Structure	Type and liner density of braiding yarns	No of yarns in the outer braid	Number of axially introduced inner braids	Number of yarns in inner braids	Sample Codes
Braided structure axially reinforced with inner braids	Polyamide multi-filament, 160 dtex	15	3	4 yarns	Core_4Y_3B
				5 yarns	Core_5Y_3B
				6 yarns	Core_6Y_3B
			5	4 yarns	Core_4Y_5B
				5 yarns	Core_5Y_5B
				6 yarns	Core_6Y_4B
			7	4 yarns	Core_4Y_7B
				5 yarns	Core_5Y_7B
				6 yarns	Core_6Y_7B

Results and Discussion

The load-elongation curves for the developed braided structures are provided in Figure 1. Figure 2 shows the influence of number of inner braids as well as the number of yarns used to produce them on the braking load of developed structures.

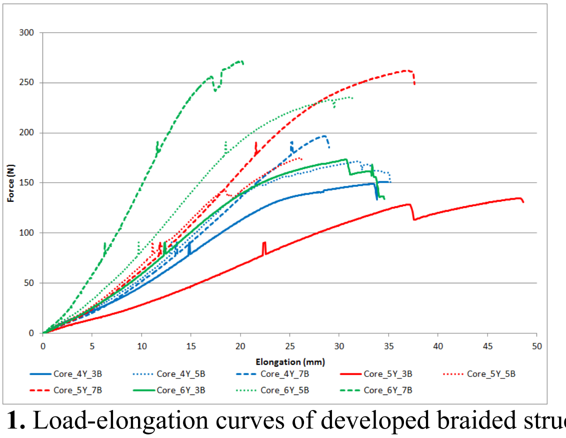

Figure 1. Load-elongation curves of developed braided structures

It is very clear from Figure 2 that the breaking force of the developed structures improved strongly with the increase in the number of inner braids and also with the number of yarns used in the inner braids.

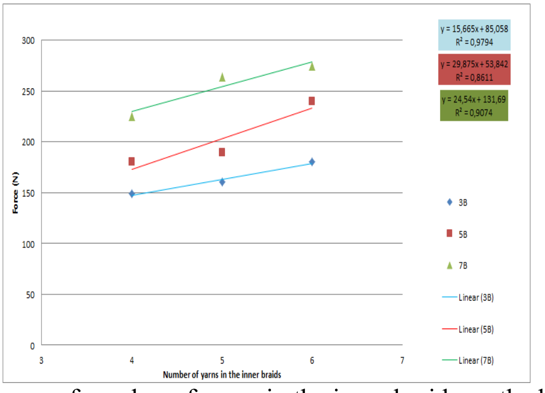

Figure 2. Influence of number of yarns in the inner braids on the breaking force

However, this improvement is accompanied by a decrease in the breaking elongation. It can be noticed that the braided structure developed using 7 braids in the core and each produced using 5 yarns (Core_5Y_7B) provides better tensile properties (in terms of both breaking force and elongation) than the others. Moreover, the tensile curve of this braided structure mimics the one shown by natural ACL. Since the diameter of this braid (0.6 mm) is much lesser than the natural ACL (11 mm), there is a huge possibility to achieve the breaking load of natural ACL by increasing the number of inner braids as well as the number of yarns used in the inner braids.

Conclusion

The specially designed braided fibrous structures developed in this research i.e., circular braids axially reinforced with braided structures present a great potential to be used as artificial grafts in ACL reconstruction, since the results show extremely interesting mechanical behaviour and possibility to achieve high breaking loads with small diameters.

References

[1] Freeman J., 2009, Bone and tissue regeneration insights – tissue engineering options for ligament healing, Libertas Academica Ltd, p.13-23

[2] Vieira A., Guedes R., Marques A., 2009, Development of ligament tissue biodegradable devices: A review, Journal of Biomechanics, Portugal

[3] Ettry S., Roccavilla F., Seedhom B., 2000, Abrasion of artificial ligaments: a simulative study, J OrthopSci, p. 481-48

SELVEDGE FREE WOVEN NARROW FABRICS FOR MEDICAL APPLICATIONS

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Introduction

There is no adequate supply of individual patient-friendly, non-ageing implants. The narrow weaving technology gives the opportunity to fulfill such a demand. With its unique technique it is possible to produce fabrics without structural defects like knitted selvedges. Narrow woven fabrics have the opportunity to be used as implants providing a defined structure and porosity and therefore defined mechanical and medical properties.

Woven Implants for Grafts, Spinal Disk and Ligament

As demonstration, three applications are chosen for the use of narrow woven fabrics. Tubular woven narrow fabrics are developed for the use as stents and ligaments. Stents must be impermeable, flexible and resilient. Ligaments need a great tensile strength in longitudinal direction. Multilayer woven narrow fabrics are developed for the use as spinal disk and repair of the anulus fibrosus. They need a defined dimension, porosity and mechanical properties. An overview on the applications is given in Fig.1.

The applications have to fit individually on every complex model and type, sometimes with and without bifurcations. The narrow weaving technology can master all these challenges, but a realisation has not been launched yet.

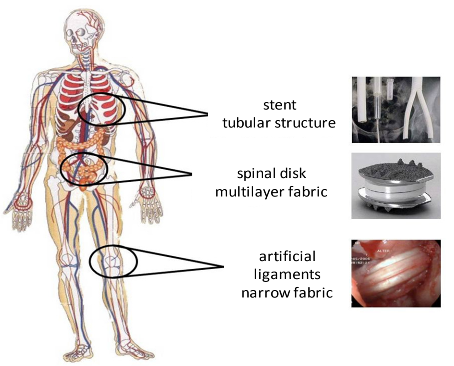

Figure1. Chosen application for narrow woven fabrics

Approach

For every application, the same method was used consisting of the following four steps.

1. Elaboration of the implant's requirements
2. Transfer of the requirement into a fabric construction
3. Production of functional models
4. Testing of the functional models

For the implant requirement, literature search and discussion with experts was used to obtain a catalogue of demands that needs to fulfil by the functional model. The transfer of the requirements into a fabric construction was done with help of textile designers, textile engineers and visualisation software. All functional models are woven on narrow weaving machines at ITA, Test are preformed at ITA-labs or at collaboration partners.

Results

Intervertebral discs consist of an exterior fibre ring (anulus fibrosus) and a central gelatinious core (nucleus pulposus). During a disc herniation, a rupture of the ring occurs and the core can be pushed into the spinal canal and cause pain and other discomforts. Available implants close the defect but don't support the regeneration of the ring. Therefore the functional model for such an implant needs to close the defect and also support the regeneration of the anulus fibrosus. To achieve this goal a multilayer narrow velvet fabric is produced which consists of a soluble (PLA) and a non-soluble (PVDF) material, see Fig.2. The soluble material should promote the formation of new tissue, while the non-soluble material takes over the mechanical function. Tests of the functional models show useable results.

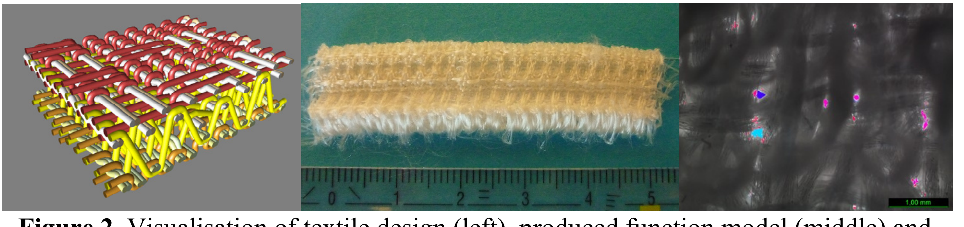

Figure.2. Visualisation of textile design (left), produced function model (middle) and measurement of porosity (right) of a narrow woven fabric for the use as sealing of anulus fibrosus

As example for the ligament the tubular weave was made of biocompatible polyester yarn. The stress strain characteristics show that the produced fabrics are in the range of natural cruciate ligaments. Furthermore changes in weft density have a major influence on stress strain characteristics. Therefore, this parameter can be used to individualize the characteristics of the implant and make them more suitable for the patient needs, e.g. young sportsmen need a different implant than older men.

Conclusion

The production of implants by narrow weaving technology is possible. The tests show a general usability of narrow woven fabrics for the chosen applications. By changing weaving parameters, properties, e.g. mechanical or medical, can be adapted. Further development and research is needed to come up with a full usable implant. Therefore a customization of implants depending on patient needs is possible.

Acknowledgements

We thank the Forschungsvereinigung Forschungskuratorium Textil e.V. for the financal support of the research project AiF-No. 16322 N, (Wirkkantenfreie 3D-Bandgewebe - Entwicklung von Funktionsmodellen für die Medizintechnik), which occurred in the program for the sponsorship of the Industriellen Gemeinschaftsforschung (IGF) from funds of the Bundesministerium für Wirtschaft und Technologie (BMWi) through the Arbeitsgemeinschaft industrieller Forschungsvereinigungen e.V. (AiF)

Key Words: Narrow fabrics, implant, graft, spinal disk, ligament

COMFORT AND HYGIENIC TEXTILES

MEDITISS: HEALTHCARE MATTRESS TICKING FABRICS

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Introduction

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

Analyses and Discussions

A) Allergy reduction effect

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

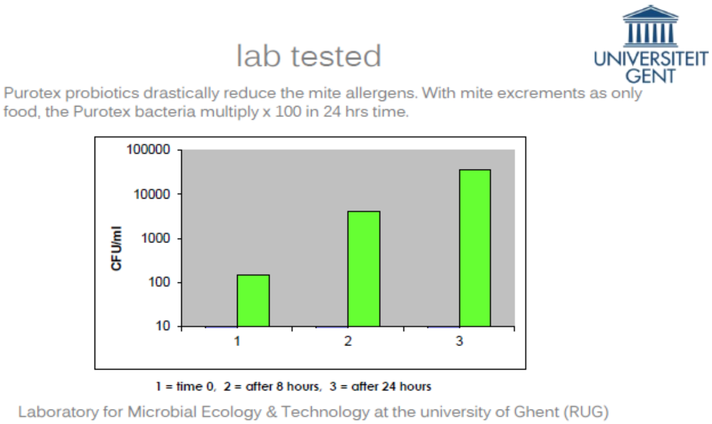


Figure1. The test results of Purotex® in the ecosystem.

B) <u>Waterproof effect</u>

This is known application for many years in industry. With the PU film lamination the system is:

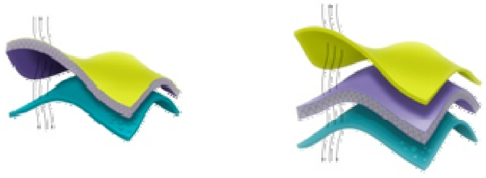
Breathable: 700-2000g/m²/24h (ASTM E-96)

Waterproof: > 10.000 mm (ISO811)

C) <u>Heat Management and Comfort-pressure reilef effect</u>

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

(a)



(b) **(c)**

Figure2. (a) Cairfull®, 3D knitted fabric **(b)** Cairfull® Meditiss, Top layer: 3D knit, Bottom layer: PU Membrane **(c)** Cairfull® Inside, Top layer: Ultra soft knit, Middle layer: 3D knit, Bottom layer: PU Membrane

Conclusion

We combined 3D knitting technology, active probiotics and waterproof functionalities with lamination technology and finalise with the Meditiss product "Protect".

This product is also Ökotex 100 Class-1 certificate that you can use for healthcare and babycare applications. And the **Cairfull®** product has been awarded as "High Product Quality Winner" in Interzum2007 and the **Purotex®** has been awarded as "Best of the Best" in Interzum2009.

For further steps we developed our Meditiss range with four different applications:

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

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

References

[1] http://www.interzum-award.com/43.html
[2] http://www.interzum-award.com/182.html
[3] http://www.bekaerttextiles.com/en/brands-17.htm

NEW ASPECTS OF COMFORT IN HEALTHCARE TEXTILES

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In today's complex and highly technical world of work, numerous tasks require workers, especially in health care environments, to show a very high level of concentration which must be maintained for a considerable period of time. Since these tasks which require (cognitive) concentration are often associated with a high degree of responsibility, a deterioration in mental performance can have serious consequences, sometimes with implications for people's health or even survival. Typical mistakes include missed information, slower reaction times, delayed or possibly even incorrect decisions, e.g. in the operating theatre or in the pharmaceutical industry, where medicines are prepared in clean room conditions. This is why it is vitally important to have reliable information about how people perform in realistic working or stressful situations. In jobs where special uniforms or personal protection equipment have to be worn, the main priority is usually to protect either the wearer or the product. Until now, there have only been tests available for investigating the protective properties of clothing, or how comfortable it is to wear, rather than for finding out the effect of clothing on mental performance and therefore how it affects people's work. This was the starting point for the ergonomic study with cleanroom and OP theatre clothing that is described here. In carrying out a difficult task, what is called the working memory plays an important role. It consists of a phonological (auditory) and a visual-spatial sub-system. It was exactly these sub-systems that were measured in this series of investigations, using computer-assisted occupational physiology tests [1]. The test method that was employed in investigating mental performance was specially developed at Hohenstein and is based on internationally recognised and standardised test systems used in occupational psychology. A key role is played by the Stressbox which was developed at the Institute and has been installed in a clean room where the climatic conditions are kept constant (Figure 1). Inside the Stressbox, the volunteers were protected from external optical or acoustic disturbance which simulates a single-factor stress situation, i.e. a job where the challenge is almost entirely mental and not physical as it is often the case in health care situations. Two series of tests were carried out to compare different clean room or operating theatre clothing systems (disposable and reusable) with regard to the ability of the wearers to concentrate and the frequency with which they made mistakes. The two parameters for concentration were tested, *divided attention* (multitasking) and *long-term selective attention* (vigilance). The tests are designed so that even if you do them repeatedly there is no learning effect. The findings presented here show that wearing operating theatre and clean room clothing can have a significant effect on the ability of employees to concentrate. In a production setting, this can have health-related, quality-related and economic consequences. The effect of textiles or other external influences on mental performance is therefore of great importance in many other sectors, e.g. sport fabrics or military uniform. The Hohenstein system for testing mental performance is an ideal way of measuring outcomes where the focus is only on cognitive capability.

Figure 1. Test person in Hohenstein Stressbox

Another important aspect for specialized healthcare textiles is the adhesion and dehesion of molecules to/from the fabric. In a first study, we examined the interaction of sweat odour molecules with fabrics. The odour components are already recognized by the human nose as unpleasant at very low concentrations. Depending on fiber type, fabric type and finish, odours can be perceived on fabrics even after washing. Among the substances responsible for the smell of sweat are mainly short-chain fatty acids, sulphur-containing compounds and steroidal substances. Intensity and characteristics of sweat odour are defined by the activity profile of the individual, sweat fluid production and especially the composition of the individual skin flora. So far there have been only few scientific studies about the smell of sweat and textiles. The lack of data is mainly due to the lack of a suitable artificial sweat, which allows quantification. In addition, field tests are expensive and often poorly reproducible. To close this gap, an artificial sweat odour was developed at the Hohenstein Institutes. This artificial sweat allows the examination of adhesion and detachment of sweat odour molecules to and from textiles. In combination with odour testers clear data on the binding of sweat can be obtained. In addition, the removal of sweat odour e.g. by washing procedures can be examined.

Key Words: Mental capacity, concentration, sweat odour, sweat molecule adhesion

References

[1] Baddeley A.D., Working Memory, Oxford, Clarendon

MODIFICATION OF TURKEY'S CALCIUM CARBONATES AND THEIR APPLICATION ON BREATHABLE TEXTILE STRUCTURES

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Research Problem/Hypothesis

In recent years in the plastics industry, calcium carbonate's one of the growing application area is breathable films. Before mixing into plastic materials, the calcium carbonate surface must be coated with appropriate chemicals. Calcium carbonate is usually coated with stearic acid or its salts. The quality of the coating affects the, compounding and film generation conditions and mechanical and barrier properties of the final product to a large extent. For this reason, coating of calcium carbonate has to be performed properly when to be used in breathable film applications. In this study, coatings were done using wet and/or dry methods with different coating chemicals and distribution of calcium carbonate particles in polymer matrix phase and water vapor permeability of the films was evaluated.

Literature

Calcium carbonate being one of the most abundant minerals in nature, which is available in 4 different qualities (marble, limestone, chalk and travertine) in nature, has been produced according to two methods, i.e., ground (GCC) and precipitated calcium carbonate (PCC) and used frequently in a wide range of applications including paper, paint, food, ceramic, construction, ink, adhesive, drug, cable, and plastic industries [1-2]. Calcium carbonate is traditionally used in plastics as bulking agent to substitute the expensive polymers [3]. It is difficult to distribute calcium carbonate homogeneously in plastic materials since it has a hydrophilic and a lyophilic character. Therefore, calcium carbonate to be used in plastic industry is coated generally with stearic acid and its salts. One of the recent developing application fields of calcium carbonate in plastics industry is breathable films. Breathable films have many microvoids, which permit to pass water vapor but do not allow the water passage [4-5]. Breathable films are used in many fields such as roof covering, greenhouse coverings, bandages, surgical clothes, sports wear, children's and adult diapers and sanitary towels [6-9].

Results and Discussion

Firstly, characterizations of different commercially available calcium carbonates and polymer/calcium carbonate compounds were done using DSC, TGA, BET, XRD, FTIR, and SEM. The amount of coating in commercial products was found to be ranging between 1-2 wt.% and most of the calcium carbonate particles were < 1 μm. Polyolefine/calcium carbonate compounds contain 40-50 wt.% calcium carbonate and water vapor permeability values of the films provided were varying between 3400-4000 g/m^2/day.

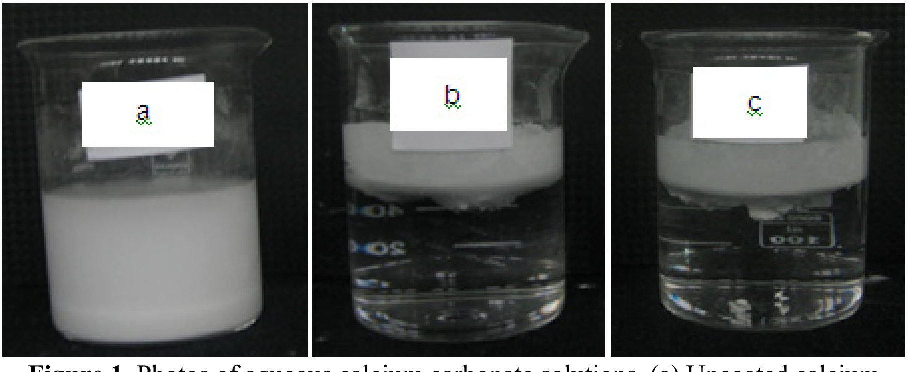

Figure 1. Photos of aqueous calcium carbonate solutions. (a) Uncoated calcium carbonate, (b) Coated calcium carbonate, (c) Coated breathable film grade calcium carbonate.

Key Words: Breathable films, Polyethylene compounds, Calcium carbonate, Water vapor permeability

References

[1] F. Garcia, N. Le Bolay, C. Frances, 2002, Changes of surface and volume properties of calcite during a batch wet grinding process, Chem. Eng. J., 85, 177–187

[2]http://www.ima-eu.org/fileadmin/downloads/publications/factsheets /Calcium_Carbonate_Mineral_Factsheet_ EN_.pdf

[3] Hankook M., 1995, In particulate-filled polymer composites. In:Rothon, R. (Ed.), Longman Scientific & Technical. Essex, UK

[4] http://www.imerys-perfmins.com/pdf/Pma124pl.pdf

[5] Calcium carbonate in polyolefines, Technical information on plastics, R4-01 Review, Omya AG

[6] G. Morieras, 2001, Baby boom market for fillers, Industrial Minerals, 29-33
[7] T. R. Thomas, 1998, The next generation of backsheet technologies, IDEA Conference Proceedings
[8] T. Koshimizu, 1997, Breathable diaper trends, Nonwovens World ENA Show Issue. 59-62
[9] A review of microporous films and their applications, 1999, Nonwovens Markets, 5-6

CYCLODEXTRIN-GRAFTED CELLULOSE

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Cyclodextrins (CDs) can form inclusion complexes with a wide variety of molecules making them very attractive in different areas. In this communication we will report on the physico-chemical characterization of cellulose modified with CDs by means of infra-red spectroscopy (FTIR), cross polarization magic angle spinning solid state nuclear magnetic resonance (CP-MAS NMR), polarized optical microscopy (POM) and thermal gravimetric analysis (TGA). Both FTIR and CP-MAS NMR indicate that CDs are chemically attached to cellulose backbone through the formation of ester bonds. Furthermore, the CD-grafted cellulose was dissolved in a "superphosphoric" acid solution but, despite the increase of hydrophilicity due to the modification, POM reveled that cellulose was less soluble when compared to the unmodified polymer. The formation of a complex CD-cellulose network is hypothesized.

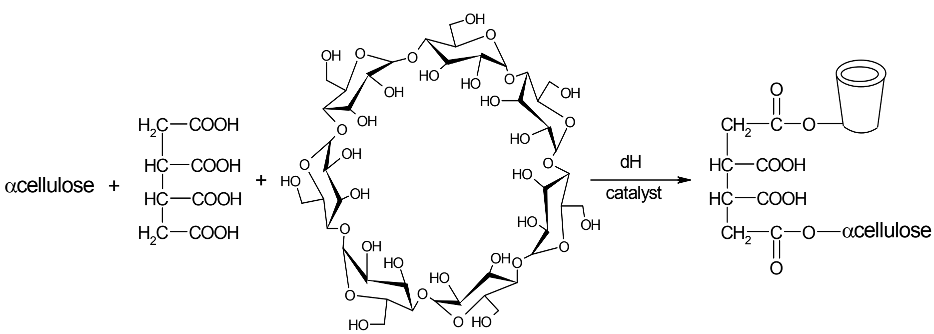

Figure 1. Schematic representation of the esterification reaction between cellulose and CDs via the polycarboxilic tetraacid, BTCA. The reaction occurs at high temperatures in the presence of catalyst.

HOSPITAL INFECTIONS AND ANTIMICROBIAL TEXTILES

POLYMER STABILIZED SILVER PARTICLES FOR ANTIMICROBIAL FUNCTIONALIZATION OF TEXTILES

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Silver particles from nanometer size up to the size of several hundred nanometers can be prepared in aqueous solutions which are suitable for textile treatment.

For stabilization but also for size control of silver particles polymeric stabilizers are used. Also different reductive agents and process temperatures are investigated, to find the most suitable process parameters. Process temperatures are set in the range of room temperature up to 160°C, for which an autoclave is necessary to manage solvothermal process conditions with high pressure.

As linear polymer stabilizers polymers as polyvinylamine, polyethylenamine and polyvinylpyrollidone are used. Beside linear polymers also dendrimers are used as stabilizer. It was clearly seen that the type of polymer, its molecular weight and the dendrimer generation have a significant influence on the stability of the silver containing solution but also on the antimicrobial properties tested against different types of bacteria.

After application onto different textile materials and thermal fixation the textiles contain a significant high antibacterial property. However not every developed system contains the same good washing fastness under household washing conditions. In conclusion not every silver particle containing solution is useful to prepare antimicrobial textiles. This presentation will evaluate different silver particle solution and their production process to guide the applier to the most useful recipe.

Key Words: Silver, nanoparticles, microparticles, dendrimers

REDUCING THE INCIDENCE OF HOSPITAL INFECTIONS: THE RESULT OF A EUROPEAN CLINICAL STUDY WITH MEDICAL

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The medical industry is challenged by the presence of microorganisms and the negative effects they cause. Textiles act as a microbial harbour and offer ideal conditions for the proliferation of microorganisms that may be harmful to humans, particularly in a hospital environment. Nosocomial infections are a serious issue for healthcare facilities where, in Europe, more than 2 million patients are diagnosed with hospital-acquired infections each year. Contaminated bed linen is alone responsible for 17% of all nosocomial infections. A permanent antimicrobial technology for the treatment of hospital textiles has been developed by Devan in cooperation with other partners. Particular attention has been paid to durability to stringent hospital laundry standards. Textiles treated with this novel antimicrobial technology has been tested *in vivo* in hospital environments through 50 industrial laundry cycles. Results were validated by l'Institut Pasteur de Lille in the context of the European-funded research programme "FlexiFunBar".

The clinical trials correlate well with simulated studies undertaken in the past and clearly shows that textiles that are suitably protected with a permanent antimicrobial finish have a significantly lower bioburden and will present less of a risk in the patient environment. In addition, no negative aspects are seen on laundering the textiles. These data generated by partners in the FlexiFunBar projects, medical and industrial laboratories represent some of the most extensive microbiological work performed on antimicrobial treated textiles for use in the medical community.

We thank the European Commission for the financial support, FLEXIFUNBAR contract n° 505864 IP-SME-FP6."

Key Words: Antimicrobial, hospital, infections, clinical trail

THE ROLE OF TEXTILES IN CHAINS OF INFECTION

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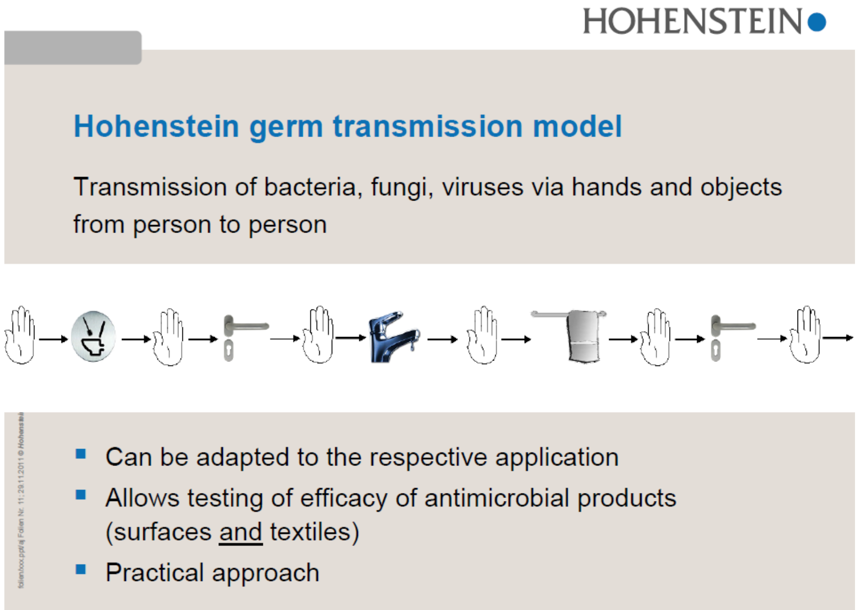
In domestic as well as in medical environments, pathogens (bacteria, fungi and viruses) are often transferred by direct contact with contaminated surfaces from person-to-person. Scientific studies show, that plastics, metals or textiles pose a significant risk of infection because of pathogen survival over a long period of time. Hereby, the minimal infective dose of the pathogen is crucial.

There are several studies showing textiles to play an important role in the transmission of nosocomial or medically important pathogens, like bacteria and fungi [1-3]. But currently there are only few scientific publications that deal with viral pathogens on fabrics [4], although viruses are responsible for severe nosocomial and community acquired infections [1]. Against this background, the Hohenstein Institutes revealed in experiments that textiles are a suitable substrate for the persistence of viruses. Furthermore, our studies have addressed the infection risks of bacterial, fungal and viral pathogens associated with clothing and household linens in home and everyday life settings as well as the role of laundry [5]. As especially a warm and humid environment supports pathogen growth and proliferation, it is important to know, which role fabrics (e.g. towels, sponges or mops) play as vehicles for infectious agents and which requirements laundry detergents have to meet for breaking the chain of infection from pathogen-loaded textiles.

Textiles with antimicrobial properties are becoming increasingly important in maintaining hygiene for breaking chains of infection. These textiles are particularly suitable in health care facilities, such as hospitals, nursing homes or doctor´s practices [6], as well as in private homes for the care of ill or elderly people. Supplementary to the common methodology, a highly sensitive test system for antiviral activity was established [7]. First results show that antimicrobial textiles with high activity against bacteria are often ineffective against viruses. The Hohenstein Institutes currently develop textiles with antiviral activity based on virucidal finishes. Our *in vitro* results are encouraging to reduce virus concentration on textiles and thus infections in health care, although the efficacy has only been shown on the lab level so far.

Therefore, Hohenstein Institutes developed a germ transmission model in a recent research project, which for the first time can be used to simulate pathogenic pathways in daily life situations (see Figure). Although textiles with proven antibacterial, antifungal and antiviral activities cannot replace conventional hygiene measures, studies using this model can support to open up new markets for this group of textiles. The transmission model allows showing where antimicrobially equipped surfaces and textiles can be a useful tool to contribute to the prevention of transmission and breaking chains of infection, in practice.



Key Words: Nosocomial infection, antimicrobial textile, transmission, laundry

References

[1] Bloomfield S., Exner M., Fara G.M., et al., 2008, Prevention of the spread of infection--the need for a family-centred approach to hygiene promotion, Euro Surveill, 13 (22)
[2] Borkow G., Gabbay J., 2008, Biocidal textiles can help fight nosocomial infections, Med Hypotheses, V:70, 990-4

[3] Neely A.N., Orloff M.M., 2001, Survival of Some Medically Important Fungi on Hospital Fabrics and Plastics, J Clin Microbiol, 39 (9), 3360-1
[4] Turner R., Shehab Z., Osborne K., et al., 1982, Shedding and survival of herpes simplex virus from 'fever blisters', Pediatrics, 70 (4), 547-9
[5] Hammer T.R., Mucha H., Gerhardts A., et al., 2011, Risks of spread of community-aquired infections by textiles in domestic laundry, Proceedings FiberMed 11, International Conference on Fibrous Products in Medical and Health Care, 28-30 June Tampere, Finland
[6] Bearman G.M.L., Rosato A., Elam K., et al., 2010, Cross-Over Trial to Determine the Efficacy of Antimicrobial Surgical Scrubs Study Report, p: 1-34
[7] Gerhardts A., Hammer T.R., Höfer D., 2011, Virus transmission by textiles and infection control in health care, Proceedings FiberMed 11, International Conference on Fibrous Products in Medical and Health Care, 28-30 June, Tampere, Finland

PRESSURE GARMENTS

DESIGN OF KNITTED CORSETS FOR SPINE

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Innovations in textiles technologies and medicine led to the development of a huge range of medical products, engineered to meet specific needs, for medical and surgical applications. Knitted fabrics have found their applicability in the medical field due to their particular properties, such as: softness, flexibility, formability, air/moisture permeability, all combined in one product if required.

Electronic flat knitting technology provides good technical potential of producing medical textiles, as the machines have the capability of: knitting to anatomical shapes, inserting elastic yarns, producing high surface qualities on machine of fine gauge.

Corsets are medical devices which offer correction, support or protection of the spine, in case of scoliosis, asymmetry of chest or deficient vertebral position.

This paper aims at presenting a technical solution of producing the knitted orthosis, also called corset for the spine, in a single stage on the knitting machine. Compared to the commercial existing products, which contain mainly synthetic yarns, the proposed knitted fabric is using mainly natural wool yarns in combination with rubber covered by polyester.

The presented corsets are designed to be successfully used to treat spinal disorders. The degree of compression produced by such products for a period of time is determined by the complex interaction between four factors: physical and elastic properties of the orthosis, its size and shape, technological design of the product and activities carried out by the patient. In order to control its properties, to meet the end use requirements, the predetermined values of these parameters, should be achieved.

Orthosis are made from extensible fabrics, combined with rigid parts, in order to restrict the patient movement. The knitted fabric has been manufactured on Stoll CMS 530 E 6.2 computer controlled flat knitting machine, based on a program designed on M1 pattern station (Figure 1).

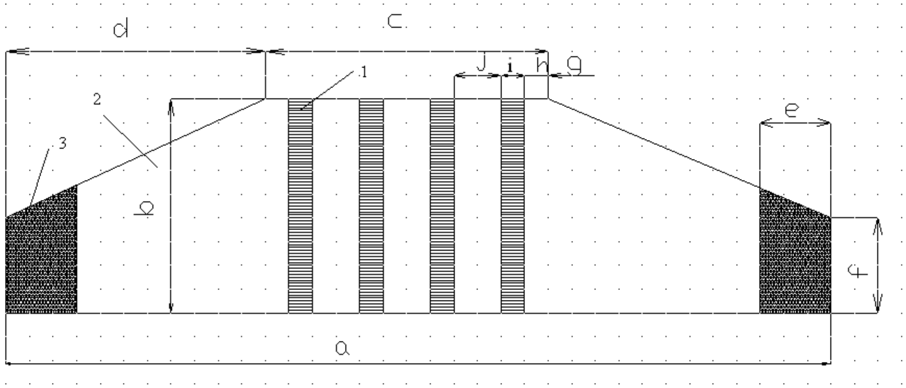

Figure 1. Knitted corset

Properties of the knitted fabrics, like: extensibility, elongation, comfort are discussed in connection to the product end use. A mathematic model is proposed for the pressure values calculation, considering specific body dimensions.

Key Words: Knitted fabrics, pressure, corset, spine

References

[1] Brancel M., MD, 2010, Orthopaedic Anatomy for Primary Care, 14th ed.1 ver. 1.0, US

[2] Flour M., 2008, Creative Compression Treatment in Challenging Situations, The International Journal of Lower Extremity Wounds, Vol.7 Number 2, 68-74

[3] Podoleanu C., Maggi R., Brignole M., Croci F., 2006, Lower Limb and Abdominal Compression Bandages Prevent Progressive Orthostatic Hypotension in Elderly Persons, Journal of the American College of Cardiology, Vol. 48, No. 7

[4] Drake R., Volg W.A., Adam W.A.M., MB, 2010, *Gray's Anatomy for Students,* Edition Elsevier, Inc. Saunders, North Carolina, www.elsevierhealth.com

[5] Legner M., 2004, Technical textiles produced on Stoll machines, Stoll GmbH., Germany

EFFECT OF LAUNDRY CYCLES ON PRESSURE CHARACTERISTICS OF MEDICAL COMPRESSION STOCKINGS

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All manufacturing sectors try to solve recent problems with innovational approach by the reason of increasing technological developments. For this subject technical textiles are a shining star of textile sector due to using specific areas and showing very good performance. Technical textiles have a remarkable market share (25-30%) in conventional textile and garment industry sectors [1]. Due to covering the expectations of different using areas and providing better added value than the other textile products, technical textiles are more interesting and demandable manufacturing areas. Technical textiles can be classified into 12 main groups depending upon their application areas such as: agrotech, buildtech, clothtech, jeotech, hometech, indutech, medtech, mobiltech, packtech, sportech and oekotech [2].

Medtech is a major growth area within the technical textiles industry and the demand of medtech has increased significantly in parallel with the technological developments, because of the increase of people's expectations in the quality of life. Medical textiles can be used in many different internal and external applications in medical, healthcare and hygiene applications [3]. One of these products is medical compression stockings.

Medical stockings help the natural pump mechanism of the muscles in the leg to improve circulation. They can be used to prevent as well as treat a number of conditions that affect the circulation in the body. They commonly used to prevent especially varicose veins [1]. Also they are used during the treatment period of some diseases like chronic venous insufficiency, venous ulcer, deep vein thrombosis, lymphedema and lipedema [4]. Other usages of medical stockings are to prevent oedemas occurring after childbirth and some surgery like cardiovascular surgery and to support during very long journeys and some sport activities. Particularly around 50% of 40-50 years old population has only a problem with varicose veins [1]. Aging population of the developed countries and increasing healthy life expectations of people raise the importance of medical stockings.

Medical stockings perform the treatment of diseased leg or arm with a pressure that is confirming to standards. The most important part of the treatments is to perform gradient pressure values on different points. The pressure should be applied with a decreasing compression effect from the ankle to the thigh in order to support blood return to heart.

The pressure characteristics of medical stockings are directly related to the production parameters. It is so important to achieve a constant pressure characteristic even during using, even after a number of laundry cycles. Otherwise different pressure profile affect the treatment period negatively. In this study, the effect of laundry process on pressure characteristics of medical compression stockings was investigated. For this aim, pressure profiles of various medical stockings were tested before and after laundry and the variation of pressure characteristics were determined. The measurements were performed on a newly developed compression measuring device and obtained data were statistically evaluated.

Key Words: Medical textiles, compression stockings, laundry process, pressure profile, varicose vein

References:

[1] Oğlakcıoğlu N., Marmaralı A., 2009, Compression Stockings and Pressure Therapy, Electronic Journal of Textile Technologies, V:3(3): 84-94
[2] Horrocks A.R. and Anand S.C., 2000, Handbook of Technical Textiles, Woodhead Publishing Limited
[3] Czajka R., 2005, Development of Medical Textile Market, Fibres & Textiles in Eastern Europe, V:13(1): 13-15
[4] Wienert V., Gerlach G., Kahle B., Marshall M., Rabe E., Stenger D., Stücker M., Waldermann F. and Zabel M., 2008, Medical Compression Stocking, JDDG: Journal der Deutschen Dermatologischen Gesellschaft, V:6(5): 410-415

DESIGN OF A BODY SHAPER WITH OPTIMUM PRESSURE ON THE BODY

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Most body shapers are designed to beatify the figure of a woman by compression on different body parts to required shapes. The most common one of them is girdle. In this study, it is aimed to design a body shaper for the abdominal part of the body with controlled pressure application to the body. Classical girdles are produced primarily as a functional garment and for this reason comfort and aesthetics have been sacrificed. It was aimed to design a body shaper for the abdominal part of the body that will provide comfortable pressure to the body while shaping it. The ease of use and durability have also been considered. The samples were produced on Santoni seamless knitting machines and pressure measurements were made.

PROTECTIVE TEXTILES

DESIGN AND DEVELOPMENT OF BIOACTIVE TEXTILE NANO-FILTERS FOR LEGIONELLA CONTROL

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In this investigation we intend to perform innovative work to reduce or even tackle a serious problem affecting people's health, air contamination by Legionella.

Legionnaires´ disease or legionellosis arose due to human alteration of the environment, Legionella species can be found in aquatic environments, water warm and hot, and humid places, such as cooling towers, spas, among others [1, 2]. This is an infectious disease caused by bacteria belonging to the genus Legionella. The mode of transmission varies with the variety of bacteria but the disease is usually transmitted through inhalation of aerosols as carriers of small bacteria to the lungs, allowing its deposition in the alveoli. The infection caused by Legionella pneumophila is known to have two different forms, the legionnaire's disease is a form of pneumonia caused by an acute bacterial infection and Pontiac fever is a less severe form of the disease, causes a flu-like acute pain. The rate of infection is increases in people with impaired (insufficient) immune systems. This means that healthy young people are rarely infected with Legionella. Factors that increase the likelihood (probability) of infection by disease are: tobacco, certain cancers, excessive alcohol consumption, age over 50 years, among others [2, 3, 4, 5].

To reduce the multiplication of Legionella pneumophila and the associated risk of Legionnaires' disease should be taken measures to prevent and control physical, chemical and microbiological, in order to promote and maintain clean surfaces of water systems and air. One of the systems used for purification of air filtration consists in the separation and capture of particles of any kind. The filters need technical requirements that are a balance between three key parameters: the filter efficiency, pressure drop and the durability of the filter. The level of filtration efficiency is determined by the field of application, or with the ability to obtain clean air. The fibrous filtration media is the most used in air filtration, these media may be cellulosic or non-synthetic fabrics [6]. Textiles are used in a variety of filtration processes, wet and dry, allowing both increases the purity of the filtered material and the recovery of solids [7].

The aim of this work is develop an air purification system by producing anti-microbial agents to fight Legionella assets. For the development of this project will be used new materials (nano-materials) and textile structures (nonwovens) bioactive so as to control or prevent the action of these microbial agents.

Key Words: Legionella, nonwovens, nano-materials, electrospinning, filtration

References

[1] Infections T.E., 2005, European Guidelines for Control and Preservation of Travel Associated Legionaires' Disease
[2] The Determination of Legionella Bacteria in Waters and Others, Environmental Samples - Part 1, 2005, Ratinale of Surveying and Sampling Environment Agency
[3] Mavridou A., Smeti E., Mandilara G., Pappa O., Plakadonaki S., Grispou E., et.al., 2008, Prevalence Study of Legionella spp. Constamination in Greek hospitals, International Journal of Environmental Health Reseach, V:18, p:295-304
[4] Borella P., Montagna M.T., Romano-Spica V., Stampi S., Stancanelli G., Triassi M., et al., 2004, Legionella Infection Risk from Domestic Hot Water, Emerging Infectious Diseases, V:10
[5] Health C. F., 2010, Code of Practice and Control odf Legionnaires´disease
[6] Luftfilterbau (s.d.), Obtained from http://www.luftfilterbau.de on March 03, 2011
[7] Duquesne S., Magniez C., Camino G., 1997, Multifuncional Barriers for Flexile Structure, Springe Series in Materials Science

THE USE OF ELECTROMAGNETIC SHIELDING TEXTILES IN MEDICAL APPLICATIONS

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Electromagnetic radiation is known to have harmful effects for human health. The damage which occurs in human body because of being subjected to the electromagnetic radiation is among the subjects which the professionals consider most significant and make investigations to solve this problem.

Human beings can be subjected to electromagnetic radiation in their daily or professional lives. Being subjected to electromagnetic radiation in professional life can cause high risks for health. Medical personnel working with devices emitting electromagnetic waves, such as some of the monitoring systems, are subjected to electromagnetic radiation which is known to be harmful for health. [1]. Electromagnetic radiation is known to have harmful effects also for human health. When an electromagnetic wave enters the organism, it causes heat to come out by vibrating the molecules. Similarly, when an electromagnetic wave enters the human body, they cause the inhibition of DNA and RNA regeneration in the cell and also support the cancer cell formation by causing abnormal chemical reactions, increasing the risk for leukaemia and other cancer types. The damage which occurs in human body because of being subjected to the electromagnetic radiation is among the subjects which the professionals consider most significant and make investigations to solve this problem. [2]

To prevent the negative effects of electromagnetic waves on human beings, shielding is necessary. Electromagnetic shielding can be described as prevention of electromagnetic radiation transmission by a material. [3] Electromagnetic shielding can also be described as the restriction of the effect of electromagnetic fields between two areas. [4] Electromagnetic shielding provides the protection of human beings from the hazardous effects of electromagnetic radiation. Regardsless of its type and structure, a shielding material is characterized by its shielding effectiveness. [5] Electromagnetic shielding effectiveness depends not only on the type of the shielding material, but also on the distance between the wave source and the material and the structural properties of the material. [6] A high shielding effectiveness value adresses to a good protection level against electromagnetic waves. [7]

In this paper, the use of shielding textiles in medical applications were discussed. The effect of various production parameters of woven fabrics such as weft density, unit weight, thickness and conductive yarn count, on the shielding effectiveness of woven fabrics, for the purpose of protection from the hazardous effects of electromagnetic waves emitted by the medical devices in 3-6 GHz frequency range were investigated.

Key Words: Electromangentic radiation, medical devices, conductive textiles, electromagnetic shielding, shielding textiles

References

[1] Kanser Etiyolojisi, 188, Kısım 2, whqlibdoc.who.int/publications/.../ 9789283204237_tur_p105-188.pdf
[2] Su C.I., Chern, J.T., 2004, Effect of Stainless Steel Containing Fabrics on Electromagnetic Shielding Effectiveness, Textile Research Journal, Vol:74 (51)
[3] Das A., Kothari V.K., Kothari A., Kumar, A., 2009, Effect Of Various Parameters On Emse Of Textile Fabrics, Indian Journal of Fibre&Textile Research, Vol:34, 144-148 p.
[4] Ersoy M.S., Önder E., 2008, Shielding Textiles Against Electromagnetic Radiation, Nonwoven Technical Textiles, V:18, 52-61p.
[5] Aniolczyk H., Koprowska J., Mamrot P., Lichawska J., 2004, Application of Electroconductive Textiles as Electromagnetic Shields in Physiotherapy, Fibres and Textiles in Eastern Europe, Vol:12, No.4 (48)
[6] Perumalraj R., Dasaradan B.S., 2009, Electromagnetic Shielding Effectiveness of Copper Core Yarn Knitted Fabrics, Indian Journal of Fibre & Textile Research, Vol. 34, 149-154 p.
[7] Von Klemperer C.J., Maharaj D., 2009, Composite Electromagnetic Shielding Materials for Aerospace Applications, Composite Structures, V:91, 467-472 p.

APPLICATION OF VALUE STREAM MAPPING METHOD IN MEDICAL TEXTILE PRODUCTION

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Abstract
Value steam mapping (VSM) is a lean manufacturing technique and it has emerged as the preferred way to support and implement the lean approach [1,2,3]. Manufacturing companies create value stream maps to identify where there is waste in manufacturing processes, and to help find ways to eliminate that waste. In this study, an application for analysing and eleminating the lead times in apparel production stages was taken part. Current production steps of a patient lifting band was observed with a lean manufacturing viewpoint. A new system was designed for future production periods. All these arrangements have been identified with value stream mapping method.

Key Words: Value stream mapping, patient transport lifting, medical textile production, current and future state map, idle time

Introduction
Technical textiles are one of the faster growing sectors of the global textile industry. The world textile industry is moving rapidly toward the manufacture of high-added value textile structures and products such as medical textiles, protective textiles and smart textiles. Textile materials used in the medical and applied healthcare and hygiene sectors are an important and growing part of the textile industry. Patient transport liftings are also one of these products [4].

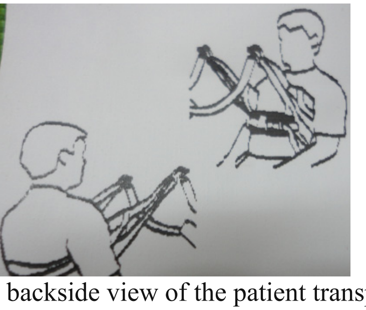

Figure 1. Front and backside view of the patient transport lifting sample

Lifting a person demands confidence. The patient must feel assured that the lift functions the way it is supposed to and that the assisting caregiver has the right knowledge. There are many advantages with an overhead lift. Naturally, the combination of function and safety, being able to lift a patient without the risk of injury to either the patient or the caregiver, is most important. Nearness, simplicity and versatility are other advantages [5].

In this study, apparel product stages of one kind of patient transport liftings (shown in Figure 1) was examined and analyzed for determining the idle times and loss in value. Value stream mapping, was used as tools.

Value stream mapping is an enterprise improvement tool to help in visualizing the entire production process, representing both material and information flow. Defined value stream as collection of all activities value added as well as non-value added that are required to bring a product or a group of products that use the same resources through the main flows (Shown in figure 2), from raw material to the end customers [3,6,7].

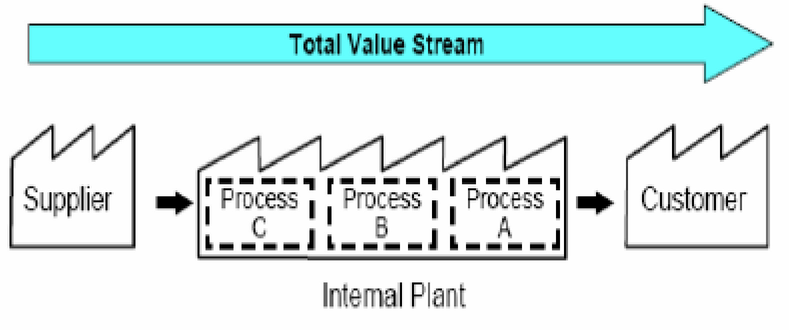

Figure 2. Symbolic representation of a sample value stream map

At least four steps to address the wastes using value steam mapping [7].

- Use icons to identity processes (Step 1)
- Record the data (E.g. cycle time (CT), change over time (CO), utilization time (UT), throughput, setup time), for processes in value stream maps (Step 2)
- Analyze materials use and need in a "materials line" for value stream maps (Step 2)

- Find Lean and opportunities in future state value stream maps. (Step 3 and 4)

As results of this study some redevelopments were proposed and a new production line designed. These developments are about idle times, overstocks and needless transportations.

References

[1] Grewal C.S., 2008, An initiative to implement lean manufacturing using value stream mapping, International Journal of Manufacturing Technology Management, V:15(3–4), p:404–417

[2] Sahoo A.K., Singh N.K., Shankar R., Tiwari M.K., 2008, Lean philosophy: implementation in a forging company, International Journal of Advanced Manufacturing Technology, Vol:36(5–6), p:451–462

[3] Singh B., Garg S.K., Sharma S.K., 2011, Value stream mapping: literature review and implications for Indian industry, International Journal of Advanced Manufacturing Technology, Vol. 53, p:799–809

[4] Czajka R., 2005, Development of Medical Textile Market, Fibres&Textiles in Eastern Europe, Vol.13, No.1 (49), p:13-15

[5] www.liko.se; 10.12.2011

[6] Schwarz P., Pannes D. K., Nathan M., Reimer J. H., Kleespies A., Kuhn N., Rupp A., N. P.Zügel, 2011, Lean processes for optimizing OR capacity utilization: prospective analysis before and after implementation of value stream mapping (VSM), Langenbecks Archives of Surgery, Vol. 396, p:1047–1053

[7]http://www.clothingtraining.org.hk/webpage/hkrita-psm/Training Materials/Value%20Stream%20Mappaing.pdf , 05.12.2011

APPLICATION OF ENCAPSULATED PHOTOCHROMIC DYE FOR UV PROTECTIVE TEXTILE MATERIALS

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In recent years, the amount of UV radiation received at the surface increases with the thickness of the stratospheric ozone layer. The risk of skin disease such as skin burn, photoaging etc. increases with the amount of UV light that reaches the earth [1]. Skin diseases also depend on the sun exposure in childhood and a large part of a person's lifetime UV exposures occur during childhood [2]. The penetration of ultraviolet (UV) radiation leads to damage DNA in human skin [3]. Especially skin burn patients should stay away from UV radiation. Apart from sun avoidance and use of sunscreens, clothing is considered to be a very important tool for UV protection. Besides the constructional parameters of the fabrics, color is one of the most important parameters that influence UV protection of textiles [4-6].

UV radiation is a small part of the electromagnetic spectrum within the wavelength of 200 nm to 400 nm. Textile dyes can absorb specific wavelengths of the visible spectrum that corresponds to 400 and 700 nm of wavelength [7], on the other hand photochromic dyes have different absorption properties. Photochromism is the phenomenon whereby the absorption spectrum of a molecule or crystal changes reversibly when the sample is irradiated by UV light. A colorless compound changes its molecular structure to a quasi-stable colored structure when irradiated; colored structure can then return to the colorless structure, when the irradiation stops [8, 9].

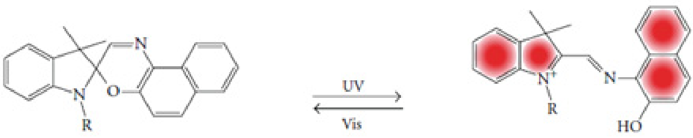

Figure 1. Schematic representation of photochromism mechanism [9]

It was reported that photochromic dyes also have a UV protection function [9, 10] since they absorbs the UV light. However, there is no study on UV protective properties of photochromic dyes although the application of these dyes on textile is studied by a number of authors [10-13]. In this study, UV protection and color properties of photochromic dye are mentioned.

This study has been performed in the scope of the bilateral project with University of Maribor, Slovenia and Ege University, Turkey. A spirooxazine based photochromic dye was encapsulated by an oil-in-water emulsion, solvent evaporation method [14] by the Slovenian partner. The main purpose of the study is to investigate the application parameters of the encapsulated photochromic dyes on cotton fabrics for optimum UV protection. Color changing effects and UPF factors were studied depending on the application recipe.

The encapsulated photochromic dyes were applied by both printing and padding method. Different binder types were used. In order to test the durability of the applications, consecutive laundry washings were carried out for 5 and 10 cycles by TS 5720 EN ISO 6330 standard. UV protection factor (UPF) values of the samples were measured with SDL Atlas M284 device according to standard AS/NZ 4399:1996.

In order to investigate the color formation of the samples, color measurements of the samples were carried out by a portable spectrophotometer (Gretag Macbeth Eye-One) in a UV cabinet (UVP-UV2/PCR) under UV light exposure.

It was observed that UV protection and color properties of the fabrics showed differences depending on binder types and application methods. The photochromic fabrics had higher UPF values than the untreated fabric even after 10 washing. It was concluded that encapsulated photochromic dyes can be used for the production of UV protective textile materials.

Acknowledgement

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Key Words: UV protection, textile, color, photochromic dyes, durability

References

[1] Boucher O., 2010, Stratospheric ozone, ultraviolet radiation and climate change, Weather, Vol. 65, No. 4, 105-110

[2] Saraiya M., Glanz K., Briss P.A., Nichols P., White C. et al., 2004, Interventions to Prevent Skin Cancer by Reducing Exposure to Ultraviolet Radiation, Am J Prev Med, 27(5), 422-466

[3] Girard P.M., Francesconi S., Pozzebon M., Graindorge D., Rochette P., Drouin R., Sage E., 2011, UVA-induced damage to DNA and proteins: direct versus indirect photochemical processes, J. Phys.: Conf. Ser., 261 012002

[4] Gambichler T., Avermaete A., Bader A., Altmeyer P. Hoffmann K., 2001, Ultraviolet protection by summer textiles: Ultraviolet transmission measurements verified by determination of the minimal erythema dose with solar-simulated radiation, Bri. J. of Der., 144, 484-489

[5] Hoffmann K., Laperre J., Avermaete A., Altmeyer P., Gambichler T., 2001, Defined UV Protection by Apparel Textiles, Arch Derm., 137, 1089-1094

[6] Dubrovski P.D., Golob D., 2009, Effects of woven fabric construction and color on ultraviolet protection, Text Res J., 79, 351–359

[7] Van den Keybus C., Laperre J., Roelandts R., 2005, Protection from visible light by commonly used textiles is not predicted by ultraviolet protection, J Am Acad Dermatol., 54 (1), 86-93

[8] Organic Photochromic and Thermochromic Compounds, 1999, Vol. 1 & 2, Eds C J C Crano and R J Guglielmetti, New York: Kluwer Academic ⁄ Plenum Publishers

[9] El-Shishtawy R., 2009, Functional Dyes and Some Hi-Tech Applications, Int. J. Photoenergy, 1-21

[10] Cheng T., Lin T., Fang J., Brady R., 2007, Photochromic Wool Fabrics from a Hybrid Silica Coating, Textile Research Journal, 77(12), 923-928

[11] Son Y., Park Y., Park S., Shin C., Kim S., 2007, Exhaustion studies of spiroxazine dye having reactive anchor on polyamide fibers and its photochromic properties, Dyes and Pigments, 73, 76-80

[12] Billah S.M.R., Christie R.M., Shamey R., 2008, Direct coloration of textiles with photochromic dyes, Part 1: Application of spiroindolinonaphthoxazines as disperse dyes to polyester, nylon and acrylic fabrics, Color. Technol,124, 223-228

[13] Aldib M., Christie R.M., 2011, Textile applications of photochromic dyes. Part 4: application of commercial photochromic dyes as disperse dyes to polyester by exhaust dyeing, Color. Technol., 127, 282–287

[14] Feczkó T., Varga O., Kovács M., Vidóczy T., Voncina B., 2011, Preparation and characterization of photochromic poly(methyl methacrylate) and ethyl cellulose nanocapsules containing a spirooxazine dye, J. of Photochem. and Photobio. A: Chemistry, 222, 293– 298