

University of Zagreb Faculty of Textile Technology



BOOK OF ABSTRACTS

**13th International
Scientific – Professional Symposium
TEXTILE SCIENCE & ECONOMY**

University of Zagreb Faculty of Textile Technology

**TEXTILE SCIENCE AND
ECONOMY
CHINESE-CROATIAN FORUM
BOOK OF ABSTRACTS**

13th International Scientific – Professional Symposium

**Innovation, Design and Digitalization in the
Textile and Leather Sector**



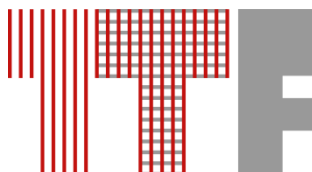
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Assist. Prof. Emilija Zdraveva, Ph.D., Prof. Budimir Mijović, Ph.D.

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Prof. Martinia Ira Glogar, Ph.D.

Contact address:

University of Zagreb
Faculty of Textile Technology
Prilaz baruna Filipovića 28a
CRO-10000 Zagreb
☎: +(385) (1) 3712500
✉: tzg2020@tff.unizg.hr
<http://tzg.tff.unizg.hr/?lang=en>
<http://tzg.tff.unizg.hr/>

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Editor's word

13th scientific-professional symposium Textile Science and Economy 2020 – TSE 2020, which was postponed due to the pandemic caused by the COVID-19 virus, was held on September 18, 2020, organized by the University of Zagreb Faculty of Textile Technology. Given the unfavourable epidemiological situation in many countries around the world, including the Republic of Croatia, the Symposium was held as a video conference.

This year's symposium is organized as a CHINESE-CROATIAN FORUM, encouraged by the established scientific and bilateral cooperation between the scientists from the University of Zagreb Faculty of Textile Technology and the Zhejiang University as well the College of Textile and Clothing Engineering, Soochow University in China. In this sense, we have further chosen the Confucius institute at the University of Zagreb as a partner in the organization of the Symposium. The main role of the Confucius institute in Croatia is to promote the Chinese language and culture, thus to strengthen the economic bond between the Republic of Croatia and the People's Republic of China. The technical support for the organization of the videoconference was provided by the Croatian Academic and Research Network. On this occasion, I would like to thank our partners for their contribution. This year's symposium was held under the auspices of the umbrella state institutions, one international and other Croatian associations, important for the Textile and Leather sector, which I would also like to thank. I want to particularly thank all the distinguished guests and senior government officials for their presence, welcome speeches and their support.

The main topic of the symposium was "Innovation, Design and Digitization in the Textile and Leather Sector", which is also promoted by the strategies of the European Union and has also opened the possibility of presenting the latest scientific and technological achievements, the potential for their commercialization and development trends through an interdisciplinary approach at the global level, as directions for future Textile and Leather sector's development. The Conference was held simultaneously within three virtual rooms:

VIRTUAL ROOM 1 - a central room where invited lectures were held.

VIRTUAL ROOM 2 - a room where several national scientific projects by our esteemed professors were presented, as well as economic block, where presentations of company representatives and promotional activities of companies from the Textile and Leather sector were held. Some of the former students of the University of Zagreb Faculty of Textile Technology, also presented themselves as successful young entrepreneurs.

VIRTUAL ROOM 3 - PhD students' room, where both students' presentations from the University of Zagreb Faculty of Textile Technology and other participating Institutions were held.

14 invited lectures were held by eminent scientific and professional experts from seven countries, who have given lectures on nowadays' hot scientific research topics, on the economic sector challenges during the global pandemic, and some guidelines for a possible growth. The same are based on the implementation of innovations in the development processes, important for the economy, digitalization of business processes, networking as well as challenges and opportunities of the digital age, in terms of global economy. The economy of the 21st century is facing new challenges in the field of entire business digital transformation, as well as product development, based on innovation. The digital transformation implies a thorough and fast transformation of the business, processes, capabilities and models, with the aim to fully exploit the possibilities of digital technologies and their impact on the economy, but also on the society as a whole. Within this respect, special attention was given to China, as the world's largest market and economic superpower of the 21st century. I would like to thank them all, as well as all other participant in two other virtual rooms. My special thanks go also to all sponsors and donation partners, which have supported the realization of the video conference in this extremely difficult time of the economy sector.

Numerous scientists and experts from the international scientific community and the Republic of Croatia, as well as prominent experts, have contributed to the symposium by submitting their scientific, review or professional papers. We have accepted a total of 55 papers, out of which 21 are

submitted by the PhD students, enrolled in the doctoral study Textile Science and Technology at the University of Zagreb Faculty of Textile Technology. Among those, several are coming from the Technical University of Lodz in Poland and the University of Zagreb Faculty of Electrical Engineering and Computing. In this sense, Symposium accompanies the edition of the Book of Proceedings, as well as the Book of Abstracts in the online edition with open access. I would like to thank all the authors and co-authors of the papers for their contribution, as well as the Scientific Committee and our distinguished scientists from the International Review Committee, who have contributed with their expertise, to the Proceedings compilation of scientific, review and professional papers, covering relevant research topics.

Given that this year's Symposium was held as an international video conference for the first time, in addition to the numerous participants who actively participated in the symposium realization within the virtual rooms, public monitoring of the video conference was provided via a live stream through TSE 2020 official website, TTF official website and You Tube channels. The video conference was followed by more than 700 participants from a number of countries around the world, from the international academic community, the economic sector, state institutions and participants from the field of vocational education, Textile and leather sector.

I would like to thank all the participants for their presence and I do hope it was beneficial for them. I also hope that this event will positively contribute to the visibility of the entire activity of the University of Zagreb Faculty of Textile Technology in the international academic community, as well as in the economic sector. I would sincerely like to thank the Faculty management for their trust, support and help and finally, my great thanks to all my dear colleagues from the organizing committee for all the support, enthusiasm and effort invested in the organization of the first international video conference organized by the University of Zagreb Faculty of Textile Technology.

Zagreb, September 18th, 2020.

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Prof. Slavenka Petrak, Ph.D.



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INVITED LECTURES

BODY ODOUR AND SMELL RELATED PROPERTIES OF DIFFERENT FIBRES AND FIBER BLENDS

Xungai WANG

Abstract: In this talk, I will introduce the significance of odour or smell management for textiles and a new odour detection system developed at Deakin University. The system enables us to quantitatively evaluate the odour sorption and desorption performance of different fibre samples. The odour detection system was used to compare the odour retention performance of different fibre samples and as well as fabrics of different fibre blends, such as wool/polyester blends with different blend ratios. It was found that wool had the highest odour sorption capacity among all the tested fibre types. Fabrics containing 20% wool had substantially reduced odour intensity compared to 100% polyester. The body odour retention properties of the 20/80 wool/polyester blend and the 100% polyester fabrics were also compared by wear trial, which further confirmed that the wool/polyester blend effectively reduced body odour intensity compared to 100% polyester spaces.

Keywords: Odour, smell, wool, polyester, blends, fabric performance

Author:

Xungai WANG, Alfred Deakin Professor
Pro Vice-Chancellor, Future Fibres
Director, ARC Research Hub for Future Fibres
Institute for Frontier Materials (IFM)

DEAKIN UNIVERSITY
Waurin Ponds Campus, Locked Bag 20000, Geelong, VIC 3220, Australia
Phone: + 61 3 5227 2894
Mob: + 61 419 525 434

E-mail: xungai.wang@deakin.edu.au

FACEMASKS: WEAR OR NOT WEAR - SCIENCES AND FACTS

Henry Yi, LI

Abstract: Up to date, COVID-19 has caused over 29 million infections and over 930,000 deaths as reported by WHO on 18 September 2020. Research findings show that COVID-19 can damage many of the key organs in human body and is a systemic disease. The post effects after recovery from infections are serious. Currently, no effective treatment is available. A vaccine will not be available for many months. More importantly, the COVID-19 protective immunity is short-lasting. Reinfection cases after recovery have been reported in many countries. Herd immunity is questionable. Lock-down measures have caused substantial social and economic damages to many countries. WHO has given warning that it could take 5 years to get COVID-19 pandemic under control. Premature lifting restrictions can cause disasters. As we have seen that the second waves of infections have hit many countries in Europe. Therefore, personal protection is one of key effective measures to reduce infection and get the pandemic under control. However, “Wear or not wear facemask” has become hot debate topic in many countries, particularly in Europe and USA.

In this lecture, a critical and systematic review is performed to exam the sciences behind and the key findings in scientific laboratory based research and clinical investigations, including:

- Viruses shedding and transmission, Viruses landing and contamination, Viruses filtration, Viruses neutralization-inactivation, Wear Facemask and infection modelling, Protection efficiency, Facemask standards and Clinical study results.

Key conclusions were drawn from the critical review of the scientific evidences as listed below:

- Virology: Viral shedding and transmission are mainly by droplets, airborne aerosols and contact transmission.
- Materials: Engineered Facemasks can effectively reduce virus transmission and shape the trend of the pandemic.
- Masks Design: Masks can be re-designed and re-engineered to provide even higher level of protections by considering: (1) Material innovations: pore size and surface energy control; (2) Anti-viral surface functionalization and (3) Mask functional design.
- Standards: More comprehensive testing methods and standards need to be developed for evaluating the performances of facemask.
- Clinical studies: Masking is effective to reduce risk of infections.
- Epidemiology: Pandemic data analysis and modelling have proved that masking is effective and low cost means for controlling the pandemic.

Keywords: COVID-19, SARS-COV-2, facemasks, viruses shedding, transmission, filtration, protection efficiency, masking, infection control, personal protection epidemiology and pandemic control

Author:

Prof. Henry Yi, LI

Professor and Chair, Textile Science and Engineering, School of Materials, The University of Manchester
Manchester M13 9PL, UK

Phone: +(44) (0) 161 306 2676

E-mail: henry.yili@manchester.ac.uk

ENTERING THE WORLD'S BIGGEST MARKET AND WORKING WITH CHINA, THE WORLD'S MANUFACTURING SUPERPOWER OF THE 21st CENTURY

Krešimir JURAK

Abstract: After China adopted the reform and opening-up policy in 1978, its economic development generally includes three periods: a) period of recovery, B) period of the emergence of the private economy and foreign-invested manufacturing industry and c) period of marching towards the international market. Currently, China is the middle of a half-century-long „three-step“ strategy of transforming itself into a leading manufacturing power by the year 2049 in line with the basic guideline of „innovation-driven, quality first, green development, structurally optimizes and human-oriented“ and the basic principle of „market orientation, government guidance, focus on the present, look into the future, overall promotion, key breakthroughs, independent development, opening, and cooperation.“

Since the adoption of the reform and opening-up policy in 1978 many foreign governments, companies, multinational corporations but also individuals tried entering the Chinese market or use Chinese manufacturing potential. Some succeeded and many have failed.

We are going to try to answer what is the real potential of cooperation, but also what are the problems, and what are some possible solutions how to be successful when working with China in the 21st century..

Keywords: China, market, economic development, manufacturing potential, working with China

Author:

Krešimir JURAK, Croatian Director
Confucius Institute at the University of Zagreb
Savska cesta 25, 10000 Zagreb, Croatia
Waurm Ponds Campus, Locked Bag 20000, Geelong, VIC 3220, Australia
Phone: +385 (0)1 48 43 601

E-mail: info@ki.unizg.hr

INNOVATION POTENTIAL OF THE UNIVERSITY OF ZAGREB IN THE FUNCTION OF ECONOMIC DEVELOPMENT OF THE REPUBLIC OF CROATIA

Tomislav Josip, MLINARIĆ

Abstract: Quality use of the scientific-research potential of the University of Zagreb, especially in the field of development of innovative technologies and knowledge transfer, is the fundament for further economic development of the Republic of Croatia.

In order to create a positive environment for such a new approach in solving the whole spectrum of economic and social challenges facing the Republic of Croatia, it is necessary to determine the real human and infrastructural resources for such a concept.

What is the real role of the University of Zagreb in this process is explained in detail in the case study - Key Elements of Institutional Infrastructure of Faculty of Transport and Traffic Sciences for Developing of Innovative Potentials. These key elements are: human resources gathered in research groups, a network of laboratories, ownership of a company, a repository of projects and innovations, research-funded research support programs including a scientific foundation.

It is the University of Zagreb, together with its constituents, that must take on this key role in the development of the economy of the Republic of Croatia, all the more so as it is research oriented, contributing over 50% to the total research output of the country.

Keywords: scientific-research potential, human and infrastructural resources, key elements in knowledge transfer

Author:

Prof. Tomislav Josip, MLINARIĆ, Ph.D., Dean
University of Zagreb
Faculty of Transport and Traffic Sciences
Department of Railway Transport
ZUK Borongaj, Borongajska cesta 83a, 10000 Zagreb
Phone: + 385 1 238 0350

E-mail: tomislav.mlinaric@fpz.unizg.hr

DIGITAL APOCALYPSE AND HOW TO COPE

Tomislav KRIŠTOF

Abstract: Lecture deals with immense shift in human behavior in the digital era, predominantly after 2012., a shift in environmental variables that shape both private and business lives of “global village citizens”. Deals with disruptors that influence how value is generated on markets and shows that 20th centuries mindsets, still active today, cause business deaths. Furthermore the lecture will show light at the end of the tunnel for those who are scared enough to radically change business habits, with some examples in clothing and similar industries.

Keywords: Digital Apocalypse, Digital Marketing, Digital Business, Digital Disruption

Author:

Tomislav KRIŠTOF, Senior Lecturer
Algebra University College
Ilica 242, 10000 Zagreb, Croatia
Phone: +385 1 2222 182

E-mail: tomislav.kristof@racunarstvo.hr

MATERIAL DEVELOPMENT WITH RESPECT TO SUSTAINABLE GROWTH

Davor SABOLIĆ

Abstract: At the end of 2019. company Čateks began to prepare a new Strategic plan for period 2020.-2024. in which new development direction had to be defined for the upcoming period. The aim of development was the implementation of new technological solutions. Great effort was dedicated to sustainability of the future development, where the foundation of all upcoming investments was reconstruction of complete energetic infrastructure with purpose of optimization in consumption of gas, electricity and water, but also reduction of all polluting emissions in order to have a green component.

Strategic development was planned in two directions: development of new material for combat uniforms with newly developed camouflaged patterns, and development of multifunctional flame retardant fabric (project which was submitted for financing from IRI-2 in cooperation with TTF). The reason for this route was simply based on current market situation, where we detected the lack of good technologically developed fabrics with specific technical qualities.

We see today the trend where many companies try to develop so called „Smart textiles“, but this story lasts for many years now, and besides some new ideas and patents, we still didn't get commercial products which would satisfy market with both price and quality. Our opinion is that it would be better to drive our basic research into development of materials which will contribute to reduction of consumption of energy and raw materials, as well as reduction in negative impact on environment. Therefore we think it is necessary to produce products that will last longer (at least 2 years), which can be maintained normally (washing on lower temperatures using nonaggressive washing powders). Besides decrease in consumption, we would also achieve reduction in accumulating textile waste which is also becoming a huge problem.

Based on current situation – global pandemic which has induced ruthless demand for any product that can protect You from the virus, company has directed a part of its resources into development of antivirus materials. It will for sure be a third direction of our development, with purpose to enter the market with antivirus materials which will be used for the production of protective coveralls, gowns, mattress covers and many other products certified by all necessary healthcare norms. The goal is to produce a reusable products which can be maintained normally (in this case sterilised), and which are not going to burden tight healthcare system budgets in the long run..

Keywords: Čateks, material development, sustainable growth

Author:

Davor SABOLIĆ, General manager
ČATEKS d.d. ČAKOVEC
Zrinsko-Frankopanska 25
40000 ČAKOVEC
Phone: + 385 40 379 400

E-mail: d.sabolic@cateks.hr

COMMERCIALIZATION OF INNOVATION

Neven MARKOVIĆ

Abstract: Commercialization of innovations is a complex set of activities necessary to transform innovation, the results of the R&D process, into a ready-to-market product. The role of innovation is extremely important in modern society, crucial in social and economic development, necessary for the survival, growth and development of a company, institutions, industries, societies, countries... *Modern society influences the process of innovation creation and realization by innovation activities. Investing in science and innovation leads to new insights, which are the generator of economic development, so the ratio of investment and growth of the national economy is generally proportional. Commercialization of innovation is also defined as the inclusion of innovation in legal transactions. The main activities are technical and technological improvement of innovation, public presentation, protection as industrial property rights and marketing activities. We will detail each of these activities with examples.*

Keywords: innovation, commercialization

Author:

Neven Marković
The secretary of the Croatian Association of Innovators
Trg žrtava fašizma 14, Zagreb
Ilica 242, 10000 Zagreb, Croatia
Phone: +385 1 4612 517
Fax: + 385 1 4662 680

E-mail: info@savez-inovatora-zagreba.hr

131 DAYS IN CHINA: DESIGN & METHODS

Edit CSANÁK

Abstract: The lecture focuses on the methodology of working with International students in China. The speaker has been working at Jiangnan University in China (Wuhan, Hubei province) in the School of Design as an International teacher – (Visiting professor) for one semester before the Pandemic; in the academic year 2018/19.

The lecture introduces the methodology of three subjects which the lecturer held at the major Graphic Design. These are Design Method, Graphic Design and Visual Word, and Image Creation and Animation. The lecture briefly introduces the key elements of the Teaching and Assessment Plan and the practical work with students with the introduction of selected works. Students had to work on different projects, creating a conceptual solution on a specific topic related to graphic design, preparing both textual and artistic contents, both developing their manual and intellectual skills, working freehand, and with computers.

The lecture will also introduce the life with students, the exhibitions, and some joint activities taken together with the community of International Teachers at the Jungian university, and in beloved Wuhan.

Keywords: design, methodology, student activities, visiting professor, Wuhan, China

Author:

Prof. Edit CSANÁK, Ph.D.

Product Design Institute, Rejtő Sándor Faculty of Light Industry and Environmental Engineering, Óbuda University
Doberdó út 6, 1034 Budapest, Hungary

Phone: +36 1 666 5930

Mobile: +36 30 667 3639

E-mail: csanak.edit@rkk.uni-obuda.hu

PRINCIPLES OF ACTIVE ILLUMINATION 3D RECONSTRUCTION SYSTEMS - APPLICATION EXAMPLES

Tomislav PRIBANIĆ

Abstract: In this work we briefly explore the camera-based 3D reconstruction system that have been researched and developed within a computer vision field. In particular we focus on two 3D reconstruction system examples which use an additional active illumination during its operation. After presenting the main idea behind camera modeling and 3D reconstruction, we introduce 3D motion capture system and show examples of using it in the context of biomechanical human motion analyses. Alternatives to calibrate 3D motion capture systems are shown too. Next, the 3D scanning using structured light strategy is concisely explained. Representative examples of structured light patterns for static and dynamics scenes are mentioned and the key features of developed 3D structured light system are revealed. On the basis of the previous research results, an ongoing research of developing solutions for anthropometric measurements is shortly mentioned.

Keywords: 3D reconstruction, human motion capture, structured light, anthropometric measurements

Author:

Prof. Tomislav PRIBANIĆ, Ph.D.
University of Zagreb Faculty of Electrical Engineering and Computing
Unska 3, 10 000 Zagreb, CROATIA
Phone: + 385 1 6129 999

E-mail: tomislav.pribanic@fer.hr

INNOVATIONS AND THEIR COMMERCIALIZATION IN ENTREPRENEURSHIP: INNOVATION LEADS TO ENTREPRENEURSHIP

Ghadi ALI

Abstract: Innovation leads to entrepreneurship, there is no doubt creativity, innovation is important engines in the global economy, and nowadays there is a need for focusing on creativity and entrepreneurship because there is growing attention based on that, to build new knowledge.

since we are still work in pandemic shadow, we will immediately notice that a lot of businesses find themselves in challenging situations if they don't invest in creativity and turn the challenge to a great opportunity in crisis time, and from my perspective, I believe that all the business/entrepreneurs need to take time to think out of the box to present innovation and they need to adopt the new brilliant strategy and use the tools of technology channels to help them communicate with their customers, employees, stockholder, with full of transparency and hope.

In this report, I will share with you more about entrepreneurship meaning, because I believe that Entrepreneurship is more than an act of starting a new business, and how you can deliver your ideas and turn them to reality and I will provide the best advice to help you join the business game changer and shape your business future..

Keywords: innovation, entrepreneurship, creativity, economy, technology, business

Author:

Ghadi Ali
Entrepreneur/Creative director/Brand consultant
Jeddah, Saudi Arabia
<http://luxurydes.com/about/>

E-mail: ghadi@luxurydes.com

CHANGES IN FABRIC ELASTICITY IN RESPONSE TO STERILIZATION WITH OZONE GAS

Uwe REISCHL

Abstract: A limited supply of personal protective equipment (PPE) in the current COVID-19 pandemic has led to frequent unsafe reuse of protective clothing by healthcare workers and the public. The application of ozone gas to sterilize PPEs before reuse has been proposed. However, the potential damage caused to the fabric materials has not been reported in the scientific literature. A study was conducted to investigate changes in the elasticity of eight combinations of fabric materials exposed to ozone gas under controlled laboratory conditions. No evidence of material degradation was found. The results of this study suggest that the use of ozone gas to sterilize PPEs can be effective and may allow persons to reuse their equipment multiple times.

Keywords: ozone sterilization, PPE reuse, fabric elasticity

Author:

Prof. Uwe Reischl, Ph.D, MD
Boise State University, Boise, USA
Department of Community and Environmental Health
College of Health Sciences
1910 University Drive, Boise, Idaho 83725-1835

E-mail: ureischl@boisestate.edu

TRENDS AND CHALLENGES IN DIGITALIZATION OF FASHION INDUSTRY

Gordan SMUĐ

Abstract: Digitalization is process that involves all segments of fashion business and one of the main drivers of Industry 4.0. Understanding global business and technology trends, facing challenges and innovating the production is guideline of transforming companies into digital era. The System as we knew it is broken! There are several reasons why Corona pandemic impacted the fashion market and set new trends and business models. Apart from global economic uncertainty from existing businesses, market evolved and brought new opportunities like e-commerce which took prime in reaching the customers during global lockdown. How digitalization is impacting the world and what does it mean for existing business models? Fashion, as global bussines, is not an exemption as it is undergoing a complete digital transformation. Digital technologies have not been widely adopted yet by the industry but the digitalization of information and the connectivity that we have become accustomed to are molding the future of Fashion. Digitalization is possible thanks to technology. 10 years ago, technology was a constraint. We had a lot of great ideas, but we were not able to implement them, either because technology was limited, or because it was too costly. Today, digital technology is an enabler towards a digital and smart world. And it is possible thanks to 4 main factors: Cloud, mobility, IoT and Artificial Intelligence.

With industry 4.0, factories will be at the heart of the value chain and propel a new digitalized life cycle for products, for the benefit of consumers. It represent a lot of opportunities for fashion & apparel companies. With Industry 4.0, mass production leaves more and more room for large scale personalized, and profitable manufacturing, with greater quality and no added costs or delays. Moreover, thanks to digitalization, IoT, connectivity, companies can easily switch back and forth from mass-production to one of the four manufacturing models that require more agility, require more information in order to respond in real-time to a changing demand. The finely-tuned combination of machines and software allow us to deliver value-added services and support customers at a highly strategic level. With this combination of software and hardware we master all data coming our solutions and can exploit the most efficient and impactful manner. Industry 4.0 is all about bringing a new level of collaboration along the product lifecyle, making sure all stakeholders speak the same language, everyone use the same data, the same parameters, etc. It provides real-time connections between creative teams and product development teams, smart factories, suppliers and consumers.. all in all, total visibility and transparency within the value chain. So Industry 4.0 is all about bringing a new level of collaboration along the product lifecyle, making sure all stakeholders speak the same language, everyone use the same data, the same parameters, etc. It provides real-time connections between creative teams and product development teams, smart factories, suppliers and consumers.. all in all, total visibility and transparency within the value chain

Keywords: fashion, digitalization, technology, process, industry 4.0, Lectra

Author:

Gordan SMUĐ
Lectra Regional Account manager
Lectra Deutschland GmbH, Glavna podružnica Zagreb
Buzinski prilaz 10, Zagreb, Croatia
Phone: + 385 1 3906 842

E-mail: g.smudj@lectra.com

RECYCLING OF TEXTILE WASTE USING THE EXAMPLE OF FEASIBILITY STUDY FOR CONSTRUCTION OF PLANT FOR RECYCLING (TPTW - TECHNOLOGICAL POSTINDUSTRIAL TEXTILE WASTE)

Sead ARSLANAGIĆ

Abstract: Textile waste, including Technological Postindustrial Textile Waste (herein after as TPTW) is burdening landfills and garbage dumps and is threatening the health and the environment. TPTW is routinely generated in the textile industry and is a ballast due to its need for disposal. Disposal of TPTW is mostly improvised, as there are no adequate operators. Our team of experts has received an offer from a renowned textile company from Bosnia and Herzegovina for development of feasibility study with the aim of finding an efficient and comprehensive solution for the issue of TPTW. During the preparation phase, analysis of the quantities and structure of the content was developed. This included analysis of the best technologies, too. Upon comparison of multiple models, the team has chosen recycling of TPTW with the aim of production of thermal insulation boards for construction (TIB). Due to insufficient quantities of TPTW, purchase of additional quantities from the supplier is anticipated, in order to achieve threshold of profitability. The study has shown that no by products are formed, and there is no additional pressure on waste and environment. The planned thermal insulation boards are ecologically friendly and financially acceptable, and the project is financially viable, with a short repayment time and continued profitability. The study has managed to use value properties of TPTW and create new social value from the waste, using the key principle of circular economy.

Keywords: textile, waste, recycling, thermal insulation

Author:

Sead Arslanagić
Independent consultant for ecology
Trg Nezavisnosti 6/5, 71000 Sarajevo, Bosnia and Herzegovina
Phone: +387 61 156 895

E-mail: arslanagicsejo@gmail.com

DIGITAL TEXTILE PRINTING - INNOVATIVE DIRECTIONS FOR FUTURE DEVELOPMENT

Martinia Ira GLOGAR

Abstract: Technology originally developed for graphic applications enters the world of textiles and breaks down the constraints that existed primarily in the creative part of production and impeded the design freedoms afforded by digital technology, due to the characteristics of analogue technologies and sample preparation processes, existed. Now, without the expensive and time-consuming preparatory phase that involves preparing samples and templates in analogue printing with a limited number of colors and patterns, digital printing with the ability to reproduce patterns of unlimited shapes and color numbers, provides the ability to respond to market demands extremely quickly, with immediate intervention design, design personalization, uniqueness, individuality with significant savings in water and energy, and pollution reduction, making digital printing a more environmentally friendly technology than analogue. These advantages justify the considerable research and development work that is continuously invested in finding optimal solutions to the constraints and issues that, despite the great advantages and recognition of digital technology in the world of apparel, still hinder its full commercialization. Due to the complex interaction of the specific surface structural characteristics of textiles as a substrate, the requirements on the composition and rheological properties of printing inks, and the technology of droplet formation, there are still numerous problems that need to be addressed. Digital InkJet technology is a graphical multicolor image reproduction technology, originally developed for homogeneous, uniform surface structures such as paper. However, textiles as a unique, heterogeneous, three-dimensional form have their own surface regularities, completely different from homogeneous paper or plastic structures. Previous research on similar topics has confirmed that it is precisely the fundamental mechanisms that define print quality that have not been fully elucidated, and the role of the surface structure of textile material has only recently been recognized as one of the fundamental factors for print quality and the achievement of an optimal color gamut. Therefore, any study of the influence of surface structural characteristics of textile materials on the formed shape, degree of deformation and spillage of the droplets on the surface of textile materials and penetration of printing ink droplets into the structure of textiles, contributes to the understanding of these fundamental mechanisms. A specific problem is the porosity of the textile material, which causes a certain loss of information in the reproduction, since the penetration of printing ink into the deeper layers of the textile substrate as well as the loss of printing ink on porous parts cannot be prevented. All this speaks in favour of the great possibilities of developing and applying InkJet technology in textile printing, despite all the difficulties and problems that still exist.

Through this topic, a part of a comprehensive systematic study of the mechanisms of interaction of printing ink droplets with specific surface structure of textile materials will be presented, as well as the application of the innovative textile pre-treatment methods (low-pressure plasma pre-treatment, cationization, modifications of cotton by dendrimers and chitosan).

Keywords: digital textile printing, pre-treatment, modification, innovative solutions

Author:

Prof. Martinia Ira Glogar, Ph.D.
University of Zagreb Faculty of Textile Technology
Prilaz baruna Filipovića 28 a, 10000 Zagreb, Croatia
Tel.: +385 1 3712 557

E-mail: martinia.glogar@ttf.hr



ABSTRACT OF ORIGINAL SCIENTIFIC PAPERS

EVALUATION OF USAGE QUALITY OF WEFT KNITTED FABRICS MADE OF VISCOSE FIBRES

Antoneta TOMLJENVIĆ; Zlatko VRLJIČAK; Juro ŽIVIČNJAK; Mateja VLAINIĆ
& Ivana BONIĆ

Abstract: Knitwear that are worn in direct contact with the skin, are often made of man-made artificial fibres from cellulose. In this paper four different circular weft double jersey knitted fabrics made of standard single viscose ring spun yarn, viscose rotor and air-jet spun yarns, and SiroSpun® ring two-play yarn of the same linear density were used. The usage quality of raw and finished knitted fabrics were evaluated and their applicability assessed. Along with the basic characterization of yarns, testing of mass per unit area, thickness and number of wales and courses per unit length of knitted fabrics were carried out. Knitwear usage quality were evaluated by determination of breaking strength and elongation, dimensional change and spirality after laundering, permeability of fabrics to air, their propensity to surface pilling and abrasion resistance, all according to the standardized test methods.

Keywords: viscose knitwear, double jersey, usage quality, textile testing

Authors:

Prof. Antoneta TOMLJENVIĆ, Ph.D. (corresponding author);
Prof. Zlatko VRLJIČAK, Ph.D.; Juro ŽIVIČNJAK; Mateja VLAINIĆ; Ivana BONIĆ
University of Zagreb Faculty of Textile Technology
Prilaz baruna Filipovića 28a, HR-10000 Zagreb, Croatia
Phone: +385 1 3712522 Fax: +385 1 37712599
Phone: +385 1 3712578 Fax: +385 1 37712599
Phone: +385 1 3712524 Fax: +385 1 37712599

E-mail: antoneta.tomljenovic@tff.unizg.hr
E-mail: zlatko.vrljicak@tff.unizg.hr
E-mail: juro.zivicnjak@tff.unizg.hr
E-mail: matea.vlainic@gmail.com
E-mail: ivanabonic@gmail.com

THE INFLUENCE OF AGING ON TENSILE PROPERTIES OF KNOTTED YARNS

Ivana SALOPEK ČUBRIĆ & Antonija PETROV

Abstract: For a number of human activities, a knowledge on yarn knotting techniques is extremely important in order to ensure high level of safety. This paper focuses at investigation of knotted yarns used for scouting, but can also be applied for similar activities, like mountain climbing. In the introductory part of the paper is given a review of the scouting activity and importance of yarn knotting. It is followed by results of previous investigation. The main objective of the present paper is to examine the tensile properties of knotted yarns, i.e. yarns that are tied to various scouting knots. The investigations are carried out on knotted yarns in 4 different states: (a) in dry state, (b) in dry state, after exposure to aging in water, c) in wet state, after exposure to aging in water, (d) in dry state after 100 cycles of abrasion and (e) in dry state after 300 cycles of abrasion. The results obtained are compared and conclusions are drawn. The importance of the presented examination is evident in the fact that knowledge on the tensile properties of targeted samples is essential for the preservation of personal and general safety of the individuals who use them.

Keywords: yarn, tensile properties, aging, wet state, dry state, abrasion

Authors:

Assoc. Prof. Ivana SALOPEK ČUBRIĆ, Ph.D. (corresponding author)
University of Zagreb Faculty of Textile Technology
Prilaz baruna Filipovica 28a, 10000 Zagreb, Croatia
Phone: +385 1 37 12 573

E-mail: ivana.salopek@unizg.ttf.hr

Antonija PETROV, mag. ing. techn. text.
Diadema d.o.o.
Ante Starčevića 11d, 10 360 Sesvete
Phone: +385 91 584 72 60

E-mail: petrov.antonija@gmail.com

CHARACTERIZATION OF YARNS USED TO MAINTAIN DENTAL HEALTH

Ivana SALOPEK ČUBRIĆ & Martina CVETKO

Abstract: The concept of Oral Health-Related Quality of Life (OHRQOL) has evolved in recent decades, largely thanks to western European countries and the USA. The goal of modern dentistry is not only to improve oral health, but also to improve the overall quality of life of patients. Important role in this segment has the textile industry, due to the fact that specific yarns, called “floss”, are produced and used to clean teeth from plaque, bacteria and food debris. The first uses of such yarns were dominantly focused at use of spun yarns produced of natural fibres. Nowadays, natural materials have lost their importance due to the complexity of processing into dental floss, high costs and restricted physical properties.

The research presented in this paper focuses at investigation of properties of yarns available at the market and comparison of their properties, specifically, yarn fineness, diameter and tensile properties (breaking force and breaking elongation).

Keywords: yarn, filament, breaking force, breaking elongation, dental

Authors:

Assoc. Prof. Ivana SALOPEK ČUBRIĆ, Ph.D. (corresponding author)
University of Zagreb Faculty of Textile Technology
Prilaz baruna Filipovica 28a, 10000 Zagreb, Croatia
Phone: +385 1 37 12 573

E-mail: ivana.salopek@unizg.ttf.hr

MARTINA CVETKO, mag. ing. techn. text.
Boxmark Leather d.o.o.
Gospodarska ulica 12, 42202 Trmovec Bartolovečki, Croatia
Phone: +385 99 517 59 48

E-mail: cvetkomartina.301@gmail.com

PLASMA PRE-TREATMENTS IMPROVES ANTIMICROBIAL PROPERTIES OF BOVINE SPLITTED LEATHER

Sanja ERCEGOVIĆ RAŽIĆ; Jadranka AKALOVIĆ; Tomislav IVANKOVIĆ; Jelena PERAN;
& Katarina IŠTEF

Abstract: This paper presents the application of oxygen and argon plasma pre-treatments in combination with 1,2,3,4 - butantetracarboxylic acid (BTCA) and chitosan, as part of research of pre-treatment processes for bovine leather tanned with various tanning agent. Pre-treatments of leather-tested substrate were conducted using different gases in order to assess different impacts of chemically reactive oxygen and inert argon gas on leather surface properties. The tests were carried out on bovine chrome tanned cleaved leather. Simple drop test was used for testing hydrophilicity of the sample, while the surface morphological changes were analysed using SEM microscopy. In order to examine leather performance in conditions of usage, the permeability of alkaline sweat solution under defined conditions was measured. Antimicrobial efficacy of treated leather sample was tested according to agar diffusion plate test against two bacterial species *Staphylococcus aureus* and *Klebsiella pneumoniae*. Based on the obtained results it can be concluded that applied plasma pre-treatments in optimized process conditions can contribute to the improvement of functional (antimicrobial) properties as well as wearability in conditions of use, primarily intended for footwear insole and similar products.

Keywords: Plasma surface pre-treatments, semi-processed bovine splitted leather, chitosan, SEM analysis, sorption properties, antibacterial activity.

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Authors:

Assoc. prof. Sanja ERCEGOVIĆ RAŽIĆ, Ph.D. (corresponding author)
Jadranka AKALOVIĆ, dipl. ing.; Jelena PERAN, mag.ing.techn.text. PhD student and Katarina IŠTEF, mag.ing.techn.text.
University of Zagreb Faculty of Textile Technology
Prilaz baruna Filipovića 28a, 10 000 Zagreb, Croatia
Phone: +(385) (01) 3712 523 Fax: +(385) (01) 3712 577 E-mail:sanja.ercegovic@tff.unizg.hr
Phone: +(385) (01) 3712 500 E-mail:jadranka.akalovic@tff.unizg.hr

Assist. prof. Tomislav IVANKOVIĆ
University of Zagreb Faculty of Science
Rooseveltov trg 6, 10 000 Zagreb, Croatia
Phone: +(385) (01) 6189 712 Fax: +(385) (01) 4826 260 E-mail: tomislav.ivankovic@biol.pmf.hr

SYNTHETIZED CORN STARCH - ENVIRONMENTALLY ACCEPTABLE FOR COTTON WARP SIZING

Suzana ĐORĐEVIĆ; Dragan ĐORĐEVIĆ; Stana KOVAČEVIĆ & Ivana SCHWARZ

Abstract: This paper investigates newly developed synthesized corn starch for the sizing process, as an environmentally-friendly product used for cotton yarn sizing. The development of such newly synthesized natural starch led to a decrease in its molar mass, which made it easier to dissolve and thus easier to penetrate into the yarn structure and subsequently easier to remove from the fabric. Acrylamide (AA) and 2-hydroxyethyl methacrylate (HEMA) were used as monomers in the corn starch grafting process. The same initiators were used for the more efficient formation of grafted monomers on starch: azobisisobutyronitrile (AIBN), potassium persulfate (KPS) and benzoyl peroxide (BP). Research results and FTIR analysis showed that efficient new synthesized corn starch was obtained. The justification of usage of synthesized corn starch was confirmed, especially initiator AIBN in grafting process with 2-hydroxyethyl methacrylate (HEMA) on starch. Analysis of sized yarns found that coarser single as well as plied yarns adsorb or bind more sizing agents in all cases than finer yarns, which can be explained by a larger capacity in volume, looser structure and a smaller number of twist. After sizing process, the mechanical properties of the yarn changes, the breaking force increases, while the breaking elongation partially decreases. The micrographs of the yarns treated with the new starch have a more compact structure with fibres glued together, as well as great parallelism in the direction of the yarn longitudinal axis. Careful choice of the active agent synthesis process, a valid combination and optimal choice of temperature-time regime, can ensure the proper composition of sizing mass and processing method, which will ensure a high quality and uniform yarn sizing process. Based on the extensive conducted analyses, it can be concluded that there is a qualitative and environmental cost-effectiveness using the synthesized potato starch.

Keywords: synthesized potato starch; cotton yarn; FTIR spectrum; size pick-up; physical-mechanical properties.

Authors:

Prof. Suzana ĐORĐEVIĆ, Ph.D. (corresponding author)
Technological and Artistic Professional School Leskovac, Textile Department
16.000 Leskovac, Serbia
Phone: +(381) (16) 242-569 Fax: +(381) (16) 233 911 E-mail: szn971@yahoo.com

Prof. Dragan ĐORĐEVIĆ, Ph.D.
University of Nis, Faculty of Technology, Textile Department, Bulevar Oslobođenja 124
16.000 Leskovac, Serbia
Phone: +(381) (16) 247 203 Fax: +(381) (16) 242 859 E-mail: drdrag64@yahoo.com

Prof. Stana KOVAČEVIĆ, Ph.D.
University of Zagreb, Faculty of Textile Technology, Department of Textile Design and Management
Prilaz baruna Filipovića 28a, 10 000 Zagreb, Croatia
Phone: +(385) (1) 37 12 575 Fax: +(385) (1) 37 12 500 E-mail: stana.kovacevic@tff.hr

Assis. Prof. Ivana Schwarz, Ph.D.
University of Zagreb, Faculty of Textile Technology, Department of Textile Design and Management
Prilaz baruna Filipovića 28a, 10 000 Zagreb, Croatia
Phone: +(385) (1) 3712 574 Fax: +(385) (1) 37 12 500 E-mail: ivana.schwarz@tff.hr

CHANGES IN FABRIC ELASTICITY IN RESPONSE TO STERILIZATION WITH OZONE

Uwe REISCHL & Budimir MIJOVIĆ

Abstract: A limited supply of personal protective equipment (PPE) in the current COVID-19 pandemic has led to frequent unsafe reuse of protective clothing by healthcare workers and the public. The application of ozone gas to sterilize PPEs before reuse has been proposed. However, the potential damage caused to the fabric materials has not been reported in the scientific literature. A study was conducted to investigate changes in the elasticity of eight combinations of fabric materials exposed to ozone gas under controlled laboratory conditions. No evidence of material degradation was found. The results of this study suggest that the use of ozone gas to sterilize PPEs can be effective and may allow persons to reuse their equipment multiple times.

Keywords: Ozone sterilization, PPE reuse, Fabric elasticity

Authors:

Prof. Uwe REISCHL, Ph.D. (corresponding author)
Boise State University
Department of Community and Environmental Health
1910 University Ave., Boise, Idaho 83725-1835

E-mail: ureisch@boisestate.edu

Prof. Budimir MIJOVIĆ, Ph.D.
University of Zagreb, Faculty of Textile Technology
Prilaz baruna Filipovića 28a, 10 000 Zagreb, Croatia
Phone: +(385) (1) 3712 557 Fax: +(385) (1) 3712 599

E-mail: budimir.mijovic@tff.unizg.hr

THE INFLUENCE OF LIPASE SURFACE MODIFICATION TO POLYESTER CRYSTALLINITY AND ABSORBILITY

Anita TARBUK; Dragan ĐORĐEVIĆ; Sandra FLINČEC GRGAC; Marija KODRIĆ;
Eva MAGOVAC & Ivana ČORAK

Abstract: Poly(ethylene-terephthalate) (PET) fabric has small absorption due to high fibre crystallinity. The alkali hydrolysis and aminolysis, conventional surface modifications, are not eco-friendly. Therefore, the alternative methods have been researched, and the application of enzymes is one of them. In this paper the lipase surface modification of light PET satin woven fabric was performed and compared to alkali hydrolysed one. The degree of crystallinity was calculated from the absorption on 973 cm^{-1} and 1018 cm^{-1} measured on FTIR-ATR, Spectrum 100, PerkinElmer. The liquid moisture management properties: Wetting time, Absorption Rate, Maximum Wetted Radius, Spreading Speed, Accumulative One-way Transport Capability, and Overall (liquid) Moisture Management Capability were determined according to AATCC TM 195-2017 Liquid Moisture Management Properties of Textile Fabrics on Moisture Management Tester (MMT M290 by SDL Atlas). It has been showed that lipase treatment lowers the PET crystallinity from 29.65 to 24.73%, similar as alkali hydrolysis 24.90%. The MMT results showed better absorption, moisture management, indicating better comfort of such treated fabrics.

Keywords: poly(ethylene-terephthalate) (PET), lipase, hydrolysis, crystallinity, liquid moisture management

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Authors:

Assoc. Prof. Anita TARBUK, Ph.D.; Assoc. Prof. Sandra FLINČEC GRGAC, Ph.D.; Eva MAGOVAC, mag. ing.;
Ivana ČORAK, mag. ing.

University of Zagreb Faculty of Textile Technology, Department of Textile Chemistry and Ecology

Prilaz baruna Filipovića 28a, HR-10000 Zagreb, Croatia

Phone: +385 1 3712 500

E-mail: anita.tarbuk@tff.unizg.hr

E-mail: sflincec@tff.unizg.hr

E-mail: eva.magovac@tff.unizg.hr

E-mail: ivana.corak@tff.unizg.hr

Prof. Dragan ĐORĐEVIĆ, Ph.D.; Marija KODRIĆ, M. Tech.

University of Nis, Faculty of Technology, Textile Department

Bulevar Oslobođenja 124, 16000 Leskovac, Serbia

Phone: +381 16 247 203

E-mail: drdrag64@yahoo.com

E-mail: izida50@gmail.com

BIOPROCESSING OF POLYESTER KNITWEAR BY PAPAIN ENZYMES

Dragan ĐORĐEVIĆ; Anita TARBUK; Marija, KODRIĆ; Radica NIČIĆ; Nenad ĆIRKOVIĆ
& Nemanja VUČKOVIĆ

Abstract: The possibilities of the application of commercial papain enzymes from the papaya latex and its application in the modification of polyester knitwear were investigated in this paper. Two types of papain enzymes of corresponding properties were used together with activators to modify the surface morphology of polyester fibres. The polyester knitwear was treated with different temperature, pH, treatment time, and concentration. The optimal papain treatment conditions were identified as a pH 8, at temperature 40°C, for 120 min, and papain concentration of 75 %. The results show that the papain treatments bring adequate effects. Especially, it was to refer to a water penetration, absorption and wetting time. The mechanical indicators are also checked (strength, elongation). Scanning electron microscopy has utilized to the structural and morphological understanding of polyester fibres surface in treated regime. This study confirmed that papain acts as an esterase, hydrolysing ester bonds in polyester fibres in knitwear.

Keywords: polyester knitwear, papain enzyme, papaya latex, mechanical properties, sorption properties.

Authors:

Prof. Dragan ĐORĐEVIĆ, Ph.D. (corresponding author)
University of Nis, Faculty of Technology, Textile Department
Bulevar Oslobođenja 124, 16000 Leskovac, Serbia
Phone: +(381) (16) 247 203 Phone: +(381) (16) 247 203 E-mail: drdrag64@yahoo.com

Assoc. Prof. Anita TARBUK, Ph.D.
University of Zagreb, Faculty of Textile Technology, Department of Textile Chemistry and Ecology
Prilaz baruna Filipovića 28a, 10000 Zagreb, Croatia
Phone: +(385) (1) 37 12 575 Fax: +(385) (1) 37 12 500 E-mail: anita.tarbuk@ttf.hr

Marija KODRIĆ, M. Tech., Ph.D. student
University of Nis, Faculty of Technology, Textile Department
Bulevar Oslobođenja 124, 16000 Leskovac, Serbia
Phone: +(381) (16) 247 203 Phone: +(381) (16) 247 203 E-mail: izida50@gmail.com

Radica NIČIĆ, M. Tech., Ph.D. student
University of Nis, Faculty of Technology, Textile Department
Bulevar Oslobođenja 124, 16000 Leskovac, Serbia
Phone: +(381) (16) 247 203 Phone: +(381) (16) 247 203 E-mail: radicanicic@rocketmail.com

Assist. Prof. Nenad ĆIRKOVIĆ, Ph.D.
University of Nis, Faculty of Technology, Textile Department
Bulevar Oslobođenja 124, 16000 Leskovac, Serbia
Phone: +(381) (16) 247 203 Phone: +(381) (16) 247 203 E-mail: nenadcira@gmail.com

Nemanja VUČKOVIĆ, M. Tech. Ph.D. student
University of Nis, Faculty of Technology, Textile Department
Bulevar Oslobođenja 124, 16000 Leskovac, Serbia
Phone: +(381) (16) 247 203 Phone: +(381) (16) 247 203 E-mail: vucko989@gmail.com

THE OPTIMIZATION OF DI(CYANSTYRYL) DERIVATIVE APPLICATION TO POLYESTER FABRIC AND ITS BLEND

Ivana ČORAK; Tihana DEKANIĆ; Petra KAŠAJ & Anita TARBUK

Abstract: UV protection can be achieved by polyester fabric due to benzene rings in the polymer molecule, but also has small absorption due to high fibre crystallinity. Blended with cotton, hydrophilicity and comfort improves, but UV protection is getting lower. It is well known that optical brightening with fluorescent whitening agents (FWA's) contributes to UV protection, as well as fabric whiteness. In this paper, the new FWA by DyStar, Sera® White P-N, a di(cyanstyryl) derivative, was applied in high concentration range (0.1, 0.5, 1, 5, 10, and 20% owf) on standard polyester and polyester blend with cotton fabrics by WFK for the purpose of optimization. Therefore, the fluorescence of FWA solutions was determined on fluorometer HITACHI F-7000 FL. After fabric treatment with FWA, whiteness (W_{ClE}) according to ISO 105-J02:1997, and tint value and deviation were calculated automatically from the measured remission on a remission spectrophotometer Spectraflash SF 600 PLUS-CT, tt. Datacolor. The UV protection ability was determined according to AS/NZS 4399:1996 using transmission spectrophotometer Cary 50/ Solascreen, Varian.

Keywords: polyester fabric, polyester/cotton blend, fluorescent whitening agent (FWA), whiteness, tint, UV protection

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Authors:

Ivana ČORAK, mag. ing. techn. text.; Assist. Prof. Tihana Dekanić, Ph.D.; Petra Kašaj, univ.bacc.ing.techn.text.;
Assoc. Prof. Anita Tarbuk, Ph.D. (corresponding author)
University of Zagreb Faculty of Textile Technology
Prilaz baruna Filipovića 28a, 10 000, Zagreb
Phone: +385 1 3712 500

E-mail: ivana.corak@tff.unizg.hr
E-mail: tihana.dekanic@tff.unizg.hr
E-mail: anita.tarbuk@tff.unizg.hr

THE INFLUENCE OF MALEIC ACID CONCENTRATION ON THE BINDING OF CHITOSAN WITH COTTON CELLULOSE

Sandra FLINČEC GRGAC; Tea-Dora BIRUŠ; Anita TARBUK; Rajna MALINAR
& Zbigniew DRACZYŃSKI

Abstract: Chitosan is an environmentally friendly agent used to achieve the antimicrobial properties of textiles. Due to the increasing demands on the stability of antimicrobial properties to multiple maintenance cycles, many authors are conducting research to permanently bind chitosan to the textile substrate. Aim of this study was to explore influence and persistence of the processing on cellulose textile substrates with an aqueous solution of chitosan using maleic acids in concentrations of 15 and 25 g/l with sodium hypophosphite monohydrate as catalyst. For the purpose of durability treated fabrics were washed according to ISO 6330:2012. The ability of maleic acid to crosslink chitosan with cellulose was tested before and after maintenance cycles using Fourier infrared spectrometry in the ATR technique (FTIR-ATR). The mechanical properties of the treated fabric were investigated before and after cycles of maintenance in accordance with ISO 13934-1. Maleic acid proved to be good crosslinking agent for chitosan and cellulose, regardless of applied concentration. The mechanical damage is higher in samples treated with a higher concentration of maleic acid due to the sensitivity of cotton to the action of acids.

Keywords: Cellulose, chitosan, maleic acid, FTIR-ATR, mechanical properties

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Authors:

Assoc. Prof. Sandra FLINČEC GRGAC, Ph.D. (corresponding author)
Tea-Dora Biruš, Assoc. Prof. Anita TARBUK, Ph.D., Rajna MALINAR
University of Zagreb Faculty of Textile Technology
Prilaz baruna Filipovića 28a, 10 000 Zagreb, Croatia
Phone: +(385) (01) 4877 355
Phone: +(385) (99) 1936 836
Phone: +(385) (01) 4877 352
Phone: +(385) (01) 4877 359

E-mail: sflincec@tff.hr
E-mail: t.d.birus@gmail.com
E-mail: anita.tarbuk@tff.hr
E-mail: rmalinar@tff.hr

Prof. Zbigniew DRACZYŃSKI, PhD
Faculty of Material Technologies and Textile Design, Technical University of Lodz,
ul. Zeromskiego 116, 90-924 Łódź, Poland

E-mail: zbigniew.draczynski@p.lodz.pl

IMPACT OF WET TREATMENTS ON SHIELD EFFECTIVENESS OF NICKEL/COPPER COATED FABRIC

Tanja PUŠIĆ; Bosiljka ŠARAVANJA; Krešimir MALARIĆ & Silvia BEŠLIĆ

Abstract: Shield properties of nickel/copper coated fabric were analysed before and after wet treatments with liquid detergent labeled for wet treatments of electrically conductive textiles. Nickel/copper coated fabric was treated with a detergent by soaking and tamping procedures. The electromagnetic shield effect of a protective Ni/Cu fabric before and after 1, 3, 5, 7 and 10 treatment cycles was measured at the frequencies of 0.9 GHz, 1.8 GHz and 2.4 GHz. The results have shown that applied procedures of soaking and tamping with a functional detergent over 10 cycles reduced the protective properties of a Ni/Cu coated fabric.

Key words: fabric, shield effect, wet treatments, liquid detergent

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Authors:

Prof. Tanja PUŠIĆ, Ph.D. (corresponding author)
Assist. prof. Bosiljka ŠARAVANJA, Ph.D.
Silvia BEŠLIĆ, mag. ing. techn. text.
University of Zagreb Faculty of Textile Technology
Prilaz baruna Filipovića 28a, HR-10000 Zagreb, Croatia
Phone: +(385) (1) 48 77 354 Fax: +(385) (1) 48 77 354

E-mail: tanja.pusic@tff.unizg.hr
E-mail: bosiljka.saravanja@tff.unizg.hr
E-mail: silvia.beslic@gmail.com

Prof. Krešimir MALARIĆ, Ph.D.
University of Zagreb Faculty of Electrical Engineering and Computing, Zagreb
Unska 3, HR-10000 Zagreb, Croatia
Phone: +(385) (1) 6129 789 Fax: +(385) (1) 6129 789

E-mail: kresimir.malaric@fer.hr

THIN LAYER CHROMATROGRAPHICAL DETERMINATION OF METALS USED AS ANTIBACTERIAL COMPONENTS ON BIODEGRADABLE POLYMERS

Iva REZIĆ; Lela MARTINAGA; Mislav MAJDAK & Maja SOMOGYI ŠKOC

Abstract: Metal and metal oxide nanoparticles provide excellent antimicrobial, water resistance and protective properties so they are today one of the most important antimicrobial reagents in the textile industry. Therefore, extraordinary antimicrobial activity of metals and metal oxides receives significant global interest in the development of new products. The antimicrobial activity of the nanoparticles is the result of their very small diameters, which are far below the range of the microorganisms' dimensions. Such nano-sized metals and metal oxides can interact with both bacterial surfaces and/or with the bacterial core, after they enter inside the bacterial cell showing activity against different microorganisms, including Gram-positive and Gram-negative bacteria, as well as on spores that are resistant to high temperature and high-pressure. Different biodegradable polymers containing nanoparticles in their surface coatings are used in many protective materials. In this work, thin layer chromatography (TLC) was applied as a simple, rapid and effective method for determination of metals in a form of metal ions which are used as efficient antibacterial compounds in protective coatings on biodegradable polymers. The development was performed by acetonitrile: hydrochloric acid: water= 72: 25: 23 (v/v), on thirty different stationary phases. For visualization, NH₃ vapors and UV light (254 and 366 nm) were applied. Results proved that spots of different compounds (namely Ag, Al, Au, Co, Cr, Cu, Fe, Ni, Mn, Pb, Zn and others) can easily be determined. Proposed TLC method is therefore an excellent choice for identification and quantification of many metals used as antimicrobial compounds present in coatings on wide variety of different biodegradable polymers.

Keywords: thin layer chromatography; antibacterial coating; biodegradable polymers; nanoparticles;

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Authors:

Ass. Prof. Iva REZIĆ, Ph.D. Ph.D. (corresponding author)

University of Zagreb Faculty of Textile Technology

Prilaz baruna Filipovića 28a, 10 000 Zagreb, Croatia

Phone: + 00385 1 3712 593

Fax: + 00385 1 3712 599

E-mail: iva.rezic@ttf.hr

Mag. oecoing. Lela MARTINAGA

University of Zagreb Faculty of Textile Technology

Prilaz baruna Filipovića 28a, 10 000 Zagreb, Croatia

Phone: + 00385 1 3712 593

Fax: + 00385 1 3712 599

E-mail: iva.rezic@ttf.hr

Mislav MAJDAK

University of Zagreb Faculty of Textile Technology

Prilaz baruna Filipovića 28a, 10 000 Zagreb, Croatia

Phone: + 00385 1 3712 593

Fax: + 00385 1 3712 599

E-mail: iva.rezic@ttf.hr

Ass. Prof. Maja SOMOGYI ŠKOC, Ph.D.

University of Zagreb Faculty of Textile Technology

Prilaz baruna Filipovića 28a, 10 000 Zagreb, Croatia

Phone: + 00385 1 3712 552

Fax: + 00385 1 3712 599

E-mail: maja.somogyi@ttf.hr

PREDICTION OF BOUNDARY ELONGATION FORCE OF FABRIC IN ELASTIC AREA BY LETHERSICH'S RHEOLOGICAL MODEL

Željko PENAVAL; Diana ŠIMIĆ PENAVAL & Maja BANIČEK

Abstract: Under conditions of use, form and properties of fabrics are constantly changing. Tensile forces cause the appearance of viscoelastic or plastic deformations. Such deformations are undesirable because they reduce the quality of the fabric. During fabric use, deformations should be within the elastic range. In order to avoid plastic deformation in fabric, it should be known in advance at what tensile load such deformations will occur. Depending on the mechanical properties of the fabric, an appropriate rheological model should be fitted that describes well their behavior in action of tensile load. For the purpose of testing the rheological properties of fabrics, raw cotton fabrics in sateen weave were weaved with the same warp density and different weft densities. Based on the experimental results obtained for elongation fabric samples, a rheological model according to Lethersich was set up that describes well the process of elongation cotton fabric and can be used to predict the boundary loads of cotton fabrics after which irreversible deformations occur. Appropriate differential equations for tested fabric samples were solved, resulting in dependence between tensile force and elongation.

Keywords: rheology, Lethersich's model, differential equations of elongation, sateen weave, boundary elongation force

Authors:

Prof. Željko PENAVAL, Ph.D. (corresponding author)
University of Zagreb, Faculty of Textile Technology, Department of Textile Design and Management
Prilaz baruna Filipovića 28a, HR-10000 Zagreb, Croatia
Phone: +(385) (1) 3712 576 Fax: +(385) (1) 3712 533 E-mail: zeljko.penava@ttf.hr

Prof. Diana ŠIMIĆ PENAVAL, Ph.D.
University of Zagreb, Faculty of Civil Engineering, Department of Engineering Mechanics
Fra Andrije Kačića-Miošića 26, HR-10000 Zagreb, Croatia
Phone: +(385) (1) 4639 426 Fax: +(385) (1) 4828 049 E-mail: dianas@grad.hr

Maja BANIČEK, mag. ing. aedif.
University of Zagreb, Faculty of Civil Engineering, Department of Engineering Mechanics
Fra Andrije Kačića-Miošića 26, HR-10000 Zagreb, Croatia
Phone: +(385) (1) 4639 363 Fax: +(385) (1) 4828 049 E-mail: maja.baniccek@grad.unizg.hr

CHARLESTON BEADED DRESS: PRELIMINARY ANALYSIS

Danijela JEMO; Sandra FLINČEC GRGAC; Danijela ERAK & Agneza ŠTAJER

Abstract: Charleston beaded dress restored in the textile conservation-restoration workshop at the University of Dubrovnik is a very interesting and intriguing object. Preliminary analysis conducted prior to conservation-restoration treatment revealed information necessary for a complete understanding of materials, technical characteristics, and its historical background. Microscopic analysis and FTIR-ATR spectroscopy were used to determine types of fiber, both original and those used in previous repairs. FTIR-ATR technique was also used for the analysis of beads that decorate the dress in a very elaborate way.

Keywords: charleston, beaded dress, textile conservation-restoration, FTIR-ATR

Authors:

Danijela JEMO, Ph.D., Assistant Professor (corresponding author)
University of Dubrovnik, Department of Art and Restoration
Branitelja Dubrovnika 41, 20 000, Dubrovnik
Phone: +(385)(20)446032

E-mail: djemo@unidu.hr

Assoc. prof. Sandra FLINČEC GRGAC, Ph. D.
University of Zagreb Faculty of Textile Technology
Prilaz baruna Filipovića 28a, 10 000 Zagreb, Croatia
Phone: +(385) (01) 4877355

E-mail: sflinec@tff.hr

Danijela ERAK, mag. art., professional associate at the University of Dubrovnik
University of Dubrovnik, Department of Art and Restoration
Branitelja Dubrovnika 41, 20 000, Dubrovnik
Phone: +(385)(91)1388011

E-mail: erak.danijela@gmail.com

Agneza ŠTAJER, student
University of Dubrovnik, Department of Art and Restoration
Branitelja Dubrovnika 41, 20 000, Dubrovnik
Phone: +(385)(01)2791595

E-mail: agneza.stajer@unidu.hr

DESIGN AND COMPUTER PATTERN MAKING OF A COLLECTION OF INDIVIDUALIZED MEDICAL UNIFORMS

Katarina ZMEŠKAL & Slavenka PETRAK

Abstract: The subject of research is the issue of clothing size systems defined by different marking systems and linear grading, where the patterns are not sufficiently adapted to different body shapes. The shortcomings of the existing medical uniforms are examined as well as the requirements of individuals, based on a survey among respondents in the health area, in order to obtain guidelines for the design and computer pattern making of functional medical uniforms to adapt to their needs and function with a goal to facilitate their work. Based on all the established results, the design of the new uniforms is designed for different shapes and types of female and male body, with the aim of achieving the best fit of the model in aesthetic and functional sense. The basic patterns necessary for modeling of female and male uniforms were made in the CAD system for computer pattern making and design of clothes. The complete design of computer 3D prototypes of uniforms was performed for different types of male and female body. Also, the results of research present patients evaluation of existing uniforms considering the colors of the uniforms and the appearance of the staff.

Keywords: medical uniform, body shape, functionality, computer clothing design

Authors:

Katarina ZMEŠKAL, mag. ing. des. text. (corresponding author)
University of Zagreb Faculty of Textile Technology
Prilaz Baruna Filipovića 28a, 10000 Zagreb, Croatia
Phone: +385 95 500 8822

E-mail: katarina.zmeskal@gmail.com

Prof. Slavenka PETRAK, Ph.D.
University of Zagreb Faculty of Textile Technology, Department of Clothing Technology
Prilaz Baruna Filipovića 28a, 10000 Zagreb, Croatia
Phone: +385 1 3712 543

E-mail: slavenka.petrak@tff.unizg.hr

ELEMENTS OF TRADITIONAL CHINA IN COMPUTER DESIGN OF AUTHOR'S FASHION CLOTHING COLLECTION

Ana-Marija GUŠA; Slavenka PETRAK & Maja MAHNIĆ NAGLIĆ

Abstract: The paper presents a computer design of a unique textile pattern inspired by traditional Chinese motifs and clothing and the development of an original women fashion clothing collection with application of the created textile pattern in different variations. Using the CAD system for computer design and digital drawing, a unique motif for digital textile printing application was created. A women clothing collection of seven model was designed with all the sketches and technical drawings. During the collection computer design process, possibilities of connecting and applying digital textile patterns to model sketches were investigated. Complete clothing patterns development process was performed using CAD system for 2D/3D clothing design. 3D simulations of clothing models were performed to test the construction and patterns modelling and to analyse impact of textiles with different physical and mechanical properties on shape and visualization of designed clothing models. The designed digital textile pattern was applied to the computer 3D clothing prototypes, where the possibilities of positioning and transformations of textile pattern directly on the 3D prototype were explored with the aim of adapting the pattern to the clothing models form and shape and achieving continuity of motifs on the joining segments. The application of CAD systems in construction preparation process enables the improvement of computer prototypes at different stages without making a real prototype that does not go on sale later, and thus contributes to the sustainability of the clothing industry. The presented development of the pattern for digital printing and its applications directly within the contours of the cutting parts represent a sustainable solution for the negative impact on the environment that traditional methods of clothing and printing production have.

Keywords: computer design, 3D simulation, computer prototype, digital textile pattern

Authors:

Anamarija GUŠA
University of Zagreb Faculty of Textile Technology (corresponding author)
Prilaz baruna Filipovića 28a, 10000 Zagreb, Croatia

E-mail: ana-marija.gusa@tff.hr

Prof. Slavenka PETRAK, Ph.D.
University of Zagreb Faculty of Textile Technology
Prilaz baruna Filipovića 28a, 10000 Zagreb, Croatia
Phone: +(385) (1) 3712 543 Fax: +(385) (1) 3712 599

E-mail: slavenka.petrak@tff.unizg.hr

Maja MAHNIĆ NAGLIĆ, mag. ing. techn. text.
University of Zagreb Faculty of Textile Technology
Prilaz baruna Filipovića 28a, 10000 Zagreb, Croatia
Phone: +(385) (1) 3712 543 Fax: +(385) (1) 3712 599

E-mail: maja.mahnic@tff.hr

INFLUENCE OF SOCIAL MEDIA ON FASHION INNOVATIVENESS

Elena TOMOVSKA

Abstract: Fluent and ever changing fashion is a key concept underpinning the success of clothing products. The individuals' acceptance of certain fashions can be described via their fashion innovativeness. Social media has become a powerful communicating tool for the fashion industry, providing an instant, democratic, user-generated dissemination of fashion trends, particularly with the younger generations. Image-centred social media, such as Instagram are particularly well adopted for fashion communication. This research aims to investigate the influence of Instagram on the acceptance of fashion trends, i.e. on the fashion innovativeness of GenZ. The research used an electronic questionnaire distributed to 120 participants, aged 16 to 23 years. A domain-specific fashion innovativeness scale was used to determine the participants' fashion innovativeness index. A commercially available tool for measuring the reach of global and local fashion influencers was used to comprise a list of influencers used in the research. Cluster analysis was used to identify Instagram influencers impacting fashion innovativeness and the use of Instagram as a fashion information channel.

Keywords: fashion innovativeness, social media, Instagram, Generation Z.

Author:

Dr. Elena TOMOVSKA
Faculty of Technology and Metallurgy, University Ss Cyril and Methodius
Ruger Boskovic 16, 1000 Skopje, R.N. Macedonia
Phone: +(389) (2) 3088 201 Fax: +(389) (2) 3065 389

E-mail: etomovska@tmf.ukim.edu.mk

COMPARASION OF CROATIAN AND CHINESE CLOTHING SIZE SYSTEM WITH REFERENCE TO CHARACTERISTIC BODY PROPORTIONS

Darko UJEVIĆ; Blaženka BRLOBAŠIĆ ŠAJATOVIĆ; Yu BIN & Zhu FEICHAO

Abstract: The paper describes the problem of anthropometric measurement of body sizes with an emphasis on clothing size system and the development and system of clothing size characteristics of Croatia and China Sizing system for male upper clothing is shown for both countries, and differences in the labelling of clothing sizes are listed.

Keywords: clothing size, Croatia, China, body proportions, men's shirt

Authors:

Prof. Darko UJEVIĆ, Ph.D.
Faculty of Textile Technology University of Zagreb
Prilaz baruna Filipovića 28 a, 10 000, Croatia
Phone: +(00385) (1) 3712 541

E-mail: darko.ujevic@tff.hr

Assist. prof. Blaženka BRLOBAŠIĆ ŠAJATOVIĆ, Ph.D. (corresponding author)
Faculty of Textile Technology University of Zagreb
Prilaz baruna Filipovića 28 a, 10 000, Croatia
Phone: +(00385) (1) 3712 561

E-mail: blazenka.brlobasic@tff.hr

LINEN FABRIC DYED WITH FLAVONOID COMPOUNDS EXTRACTED FROM WASTE ONION SKIN

Ana Maria BOČAK; Ružica BRUNŠEK; Anita TARBUK & Ana SUTLOVIĆ

Abstract: The dyeing of linen fabric with natural dye was carried out with flavonoid compounds extracted from onion skin. For this research linen fabric pre-bleaching with hydrogen peroxide, as well as pre-treatment with metallic salts (mordants) on the resulting colouration were studied. Results are presented through the analysis of spectral colour properties (hue (h), chromaticity (C*) and lightness (L*)). Extracted flavonoid derivative has a relatively low substantivity to cellulosic material, therefore the mordant pre-treatment is necessary. Pre-treatment of the linen fabric with metal salts and dyeing process resulted in a wide range of colour hues: greyish (without mordant), yellow-brown (Al), red-brown (Cu) to dark brown (Fe). The values of the all colour hue are in the yellow - orange area (h = 66.62 - 81.84). The bleached fabrics retain approximately the hue value, the chromaticity increases relative to the raw samples, but an increase in the brightness value indicates that the samples obtained more vivid colours. This research contributes to the revitalization of flax fibre, to the use of flavonoids for the dyeing of cellulosic materials and to the use of bio waste as a source of dyes.

Keywords: linen fabric, natural dyes, onion skin, flavonoid compounds

Authors:

Ana Maria BOČAK, student
University of Zagreb Faculty of Textile Technology
Prilaz baruna Filipovića 28a, 10000 Zagreb, Croatia
Phone: +385 99 8143450

E-mail: ana.maria.bocak@tff.hr

Assist. prof. Ružica BRUNŠEK, Ph. D.
University of Zagreb Faculty of Textile Technology
Prilaz baruna Filipovića 28a, 10000 Zagreb, Croatia
Phone: +385 91 2538659

E-mail: ruzica.brunsek@tff.unizg.hr

Assoc. prof. Anita TARBUK, Ph. D.
University of Zagreb Faculty of Textile Technology
Prilaz baruna Filipovića 28a, 10000 Zagreb, Croatia
Phone: +385 91 5067859

E-mail: anita.tarbuk@tff.unizg.hr

Assoc. prof. Ana SUTLOVIĆ, Ph. D. (corresponding author)
University of Zagreb Faculty of Textile Technology
Prilaz baruna Filipovića 28a, 10000 Zagreb, Croatia
Phone: +385 91 5470271

E-mail: ana.sutlovic@tff.unizg.hr



ABSTRACT OF REVIEW PAPERS

POTENTIAL OF HEMP TEXTILE FABRICS IN TERMS OF COMFORT

Snežana STANKOVIĆ; Mateja BIZJAK; Dušan POPOVIĆ & Goran POPARIĆ

Abstract: Traditional applications of hemp fibre for textile products include technical products like ropes and packaging materials, and clothing textile. Modern production offers high added-value products for specific uses such as geotextiles, thermal and acoustic insulation products, filters and composites, and for high-quality clothing sector. Hemp fibres provide high moisture permeability, good thermal and electrical properties, ultraviolet light blocking, anti-microbial and anti-static properties, which is a predisposition to obtain physiologically-friendly textiles. However, there are some limitations of hemp fibre such as low elasticity and low flexibility due to which hemp textile fabrics are characterized by reduced softness and rough handle. These are constraints for wider applications of hemp fabrics as highly comfortable clothing textiles. In this respect, some investigations of comfort properties (both thermal and tactile comfort) properties of a range of hemp based textile materials have been conducted in order to improve their comfort performances. A short review of these investigations is given in this paper.

Keywords: hemp, thermal comfort, tactile comfort, textile fabric, yarn

Authors:

Prof. Dr Snežana STANKOVIĆ (corresponding author)
Faculty of Technology and Metallurgy, University of Belgrade
Karnegijeva 4, 11000 Belgrade, Serbia
Phone: +(381) (11) 3303 857 Fax: +(381) (11) 3370 387

E-mail: stankovic@tmf.bg.ac.rs

Prof. Dr Mateja BIZJAK
Faculty of Natural Science and Engineering, University of Ljubljana
Snežniška 5, 1000 Ljubljana, Slovenia
Phone: +(386) (1) 200 3219 Fax: +(386) (1) 200 3270

E-mail: mateja.bizjak@ntf.uni-lj.si

Prof. Dr Dušan POPOVIĆ; Prof. Dr Goran POPARIĆ
Faculty of Physics, University of Belgrade
Studentski trg 12, 11000 Belgrade, Serbia
Phone: +(381) (11) 2644 961 Fax: +(381) (11) 3282 619
Phone: +(381) (11) 630 152 Fax: +(381) (11) 3282 619

E-mail: dusan@ff.bg.ac.rs
E-mail: Goran_Poparic@ff.bg.ac.rs

AI FOR FASHION

Edit CSANÁK

Abstract: Technology and Artificial Intelligence have a significant impact on all aspects of Fashion, from designing to production and consumption. Fashion has always been a forward-looking phenomenon, willing to adopt new technologies as they emerge. Artificial Intelligence is no exception as it moves as fast as Fashion. The AI has been used in analyzing fashion trends and consumer needs for over a decade. Its impact on style and the enhancement of phenomena as Fast Fashion, is indisputable. The clothing industry 4.0 digitalization is increasingly relying on the use of advanced technology, moving towards its 5.0 version, the use of Artificial Intelligence in the broader scope of activities. However, the study of the short career of Artificial Intelligence in Fashion clearly shows that AI has a significant impact on this phenomenon and the related industry, a considerable player of the global economy. The current situation raises numerous questions about one of the primary cultural phenomena. Some fashion professionals question the current unpredictable social, cultural, economic environment evolving the future of fashion.

Along with the issue of sustainability, several are addressing the issues raised by the application of artificial intelligence. Thus, the examination of the supposed directions, with the prediction of their wither impact, is essential for the development of creative industries. This article attempts to review the current use of AI in the fashion industry and fashion market. This article is part of a study conducted by the Doctoral School of Security Sciences, the Artificial Intelligence Workshop, and the Product Design Institute of Sándor Rejtő Faculty of Light Industry and Environmental Engineering of the Óbuda University Budapest, Hungary.

Keywords: fashion design, digitalization in fashion, AI, artificial intelligence

Author:

Prof. Edit CSANÁK, Ph.D.

Product Design Institute, Rejtő Sándor Faculty of Light Industry and Environmental Engineering, Óbuda University
Doberdó út 6, 1034 Budapest, Hungary

Phone: +(36) (1) 666 5930

Mobile: +(36) (30) 667 3639

E-mail: csanak.edit@rkk.uni-obuda.hu

E-CLOTHING FOR STAGE PERFORMANCES

Snježana FIRŠT ROGALE; Dubravko ROGALE & Daniel ČASAR VELIČAN

Abstract: The development of e-clothing and the integration of various types of technical components have led to more and more talk about the so-called cyber-look. The integration of various types of sensors, LEDs, electronic devices and the like causes more and more attention to be paid not only to the technical functionality but also to the aesthetic component, which is particularly important in the clothing for stage performances. The growing commitment of artists and the desire of all, especially artists, for unique e-clothing, the so-called cyber-look, has contributed to the aesthetic component of e-clothing. The paper will present clothing for stage performances developed in the world, but also clothing designed and developed at the Faculty of Textile Technology at the Department of Clothing Technology. Clothing for stage performances with special light effects is described, which was inspired by Tesla's attributes of refinement, light, remote control, radio control and fascinating presentations, and displayed by the use of a large alphanumeric display with built-in microcomputer

Keywords: e-clothing, Cyber look, stage performance, sensors, Tesla

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Authors:

Prof. Snježana FIRŠT ROGALE, Ph.D.
Prof. Dubravko ROGALE, Ph.D.
Daniel ČASAR VELIČAN, mag.ing. tex. tech. (corresponding author)
Sveučilište u Zagrebu Tekstilno-tehnološki fakultet
Prilaz baruna Filipovića 28a, 10000 Zagreb, Hrvatska
Phone: +(385) (1) 3712553 Fax: +(385) (1) 3712599

E-mail: sfrogale@tff.hr;
E-mail: dubravko.rogale@tff.hr;
E-mail: daniel.casar.velican@tff.hr

THE FOURTH INDUSTRIAL REVOLUTION IN CLOTHING PRODUCTION

Vasilije PETROVIĆ, Gordan SMUĐ, Marija PEŠIĆ, Anita MILOSAVLJEVIĆ,
Marija PETROVIĆ & Jovana STEPANOVIĆ

Abstract: This paper defines the 4.0 Industrial Revolution that is reflected in digitization and interconnection of every machine in the company, every technological component and practically every piece of material that goes through the manufacturing process of garment manufacturing. In order to make the vision of smart textile factory a reality, this paper discusses the needs of investing in research and development, as well as in education of personnel. A “smart factory” concept is explained and it allows links between innovation subject, universities and other educational institutions, industry in the areas of procurement and distribution, as well as state administration and banks. There are 4 key innovative topics highlighted that will shape the textile and apparel industries of the future: advanced materials, digitalization, sustainability and emerging growth markets. The example of the French company Lectra explains the digital transformation of the clothing industry in strengthening brands and manufacturers from design to production. The influence of the generation of Millennials born in 1980-2000 on changes in the fashion market is explained. They make up 20-30% of the world's population, can access the world from their own pocket, seek personal style, and want instant results in production.

Keywords: 4.0 industrial revolution, clothing production, millennials, personalization

Authors:

Vasilije PETROVIĆ (corresponding author)
Marija PEŠIĆ
Marija PETROVIĆ
Anita MILOSAVLJEVIĆ
University of Novi Sad, Technical faculty “Mihajlo Pupin”
Đure Đakovića 66, Zrenjanin 23000, Serbia

E-mail: vlp@eunet.rs

Gordan SMUĐ
Regional Account Manager - Adriatics Region at Lectra
Lectra Deutschland GmbH, Buzin, Buzinski prilaz 10, Zagreb
Phone: +(385) (1) 3906 842

E-mail: g.smudj@lectra.com

Jovana STEPANOVIĆ
University of Nis, Faculty of Technology
Bulevar oslobođenja 124, 16 000 Leskovac, Serbia

CREATIVE THINKING TECHNIQUES - STRATEGIES FOR SUCESSFULL DOCTORAL RESEARCH

Ivana SALOPEK ČUBRIĆ; Ines KATIĆ KRIŽMANČIĆ; Branka TOMIĆ

Abstract: It is widely accepted and confirmed in a number of policies that creativity and use of creative thinking techniques have an important role in almost every segment of scientific research. Despite this, the number of published papers focused at designing scientific processes with the inclusion or consideration of the creative techniques is rather limited, especially in the field of engineering. It is a common opinion that scientific design research should embrace those techniques in order to effectively manage and improve the level of achievements.

In the preparation of this paper, over 50 different creative thinking techniques have been analysed and considered in total. The most appropriate for the doctoral research in the field of textile engineering have been selected for comparative purposes. The paper discusses advantages and disadvantages of selected creative thinking techniques and describes at how those techniques can be used to design practical solutions to scientific research problems. The paper specifically gives guidelines and recommendations for their use in doctoral research in the field of textile technology.

Keywords: creativity, doctoral research, technique, textile, method

Authors:

Assoc. Prof. Ivana SALOPEK ČUBRIĆ, Ph.D. (corresponding author)
University of Zagreb Faculty of Textile Technology
Prilaz baruna Filipovića 28a, 10000 Zagreb, Croatia
Phone: +385 1 37 12 573

E-mail: ivana.salopek@unizg.ttf.hr

Ines KATIĆ KRIŽMANČIĆ, mag. ing. des. text, Ph.D. student
Doctoral study Textile Science and Technology;
University of Zagreb Faculty of Textile Technology
Prilaz baruna Filipovića 28a, 10000 Zagreb, Croatia
Phone.: +385 91 22 94 964

E-mail: ikatickri@ttf.hr

Branka TOMIĆ, mag. ing. des. text., Ph.D. student
Doctoral study Textile Science and Technology
University of Zagreb Faculty of Textile Technology
Prilaz baruna Filipovića 28a, 10000 Zagreb, Croatia
Phone: +385 91 5666 665

E-mail: btomic@ttf.hr



PROFESSIONAL PAPERS

COMPARISON OF ANISOTROPIC PROPERTIES OF WOVEN FABRICS AND KNITTED FABRICS SUBJECTED TO TENSILE LOAD

Željko PENAVAL; Diana ŠIMIĆ PENAVAL & Tea JOVANOVIĆ

Abstract: Theoretical analysis of the behavior of textile materials due to its anisotropic properties is very complex, and experimental testing of mechanical properties of knitted and woven fabrics is carried out. Measuring the stretch of knitted and woven fabrics when tensile forces act in different directions is an effective way to characterize anisotropy and structural changes of textiles. This paper analyzes the effect of anisotropy of knitted and woven fabrics on values of maximum force, maximum elongation, modulus of elasticity, work up to maximum force under action of tensile forces on samples that were cut at different angles to course direction of knitted fabrics, or to weft direction of woven fabrics. In experimental part of paper, samples of double weft knit fabric with 30 tex fineness of single cotton yarn and samples of cotton woven fabric in plain weave were tested. For different cutting angles of samples, curves of relationship between values of tensile forces and elongation to break were experimentally obtained. From the obtained force-elongation curves, modulus of elasticity was experimentally determined and work up to maximum force was calculated.

Keywords: anisotropy, modulus of elasticity, double weft knit fabric, cotton woven fabric, off-axes tensile behavior, maximum force

Authors:

Prof. Željko PENAVAL, PhD. (corresponding author)
University of Zagreb, Faculty of Textile Technology, Department of Textile Design and Management
Prilaz baruna Filipovića 28a, HR-10000 Zagreb, Croatia
Phone: +(385) (1) 3712 576 Fax: +(385) (1) 3712 533 E-mail: zeljko.penava@ttf.hr

Prof. Diana ŠIMIĆ PENAVAL, PhD.
University of Zagreb, Faculty of Civil Engineering, Department of Engineering Mechanics
Fra Andrije Kačića-Miošića 26, HR-10000 Zagreb, Croatia
Phone: +(385) (1) 4639 426 Fax: +(385) (1) 4828 049 E-mail: dianas@grad.hr

Tea JOVANOVIĆ, mag. ing. aedif.
University of Zagreb, Faculty of Textile Technology, Department of Textile Design and Management
Prilaz baruna Filipovića 28a, HR-10000 Zagreb, Croatia
Phone: +(385) (1) 3712 576 Fax: +(385) (1) 3712 533

REFLECTING ON TRADITION THROUGH THE CREATION OF CONTEMPORARY TEXTILE OBJECT IN THE OLD-FASHIONED WAY

Branka TOMIĆ; Ivana SCHWARZ & Koraljka KOVAČ DUGANDŽIĆ

Abstract: In today's modern day, hand weaving has almost fallen into oblivion. This skill traces its roots back to prehistoric times, when the invention of the weaving loom, in a certain way, revolutionized the production of textiles. This principle of the weaving process remained unchanged for thousands of years, until the industrial revolution that automated it and thus initiated the unstoppable development of the technological fabrication process. In addition, weaving used to play an important role in society. In the 21st century, marked by automation and mass production, artificial fabrics and market saturation, hand weaving is almost extinct. In Croatia, besides the above, the negative perception of the domestic textile industry in the society is also present. There is also insufficient interest in the exploitation of natural resources in the form of systematic collection of wool and its industrial processing. The aim of this research is to explore the possibility of creating a textile woven object of contemporary design in an old-fashioned way, thus stimulating reflection on tradition and preservation of cultural heritage and the untapped potential of wool.

Keywords: hand-weaving, weaving loom, wool, textile, spinning, tradition

Authors:

Branka TOMIĆ, mag. ing. des. text. (corresponding author)
University of Zagreb, Faculty of Textile Technology
Prilaz baruna Filipovića 28, 10 000 Zagreb, Croatia
+(385) (91) 5666 665

E-mail: btomic@tff.hr

Assist. Prof. Ivana SCHWARZ, Ph.D.
University of Zagreb, Faculty of Textile Technology
Prilaz baruna Filipovića 28, 10 000 Zagreb, Croatia
+ (385) (1) 3715 574

E-mail: ivana.schwarz@tff.unizg.hr

Assoc. prof. art. Koraljka KOVAČ DUGANDŽIĆ
University of Zagreb, Faculty of Textile Technology
Prilaz baruna Filipovića 28, 10 000 Zagreb, Croatia
+(385) (1) 3712 548

E-mail: koraljka.kovac@tff.unizg.hr

A CREATIVE CONSIDERATION OF RAINWEAR

Dejla RAMIĆ & Belma GUTLIĆ

Abstract: A raincoat generally suggests an expression from which we expect to have an emphasized purpose and to be functional. This research project attempts to open a chapter on the reconsideration of rainwear through a prototype. Although the idea of design leads to originality and a "new" product, the design is often an upgrade to existing information so that the products meet the needs of customers, opportunities and the market more effectively. Creating a whole new form of rainwear is a reaction to the commercial imperative and the need for designers to access a high level of discovery and creative resolution. In this respect, silhouettes, shapes, and potential "feeling" stimulate individuality by rehabilitating problematic figures which most often ignore the principles of aestheticism.

Keywords: raincoat, design, shapes, rainwear

Authors:

Doc.mr. Dejla RAMIĆ (corresponding author)
Univerzitet u Bihaću Tehnički fakultet Bihać
Ulica dr. Irfana Ljubijankića bb 77000 Bihać Bosna i Hercegovina
Phone: +(387) 61 532 515 Fax: +(387) 226 273

E-mail: dejlaramic.tfb@gmail.com

Belma GUTLIĆ
Univerzitet u Bihaću Tehnički fakultet Bihać
Ulica dr. Irfana Ljubijankića bb 77000 Bihać Bosna i Hercegovina
Phone: +(387) 62 875 516

E-mail: belma-gutlic@hotmail.com

STUDY CASE – RECONSTRUCTION OF MEN'S CLOTHING FROM THE SECOND HALF OF THE 16TH CENTURY

Emma IVANKOVIĆ; Katarina Nina SIMONČIČ & Irena ŠABARIĆ

Abstract: The garments of the common people of the Renaissance period haven't been treated with the same care as the fashion of the aristocrats. The visual representations don't show us a clear form in the design of the objects presented, whereas by not preserving the clothes of the ordinary people brings the problem in the documenting of clothing construction. Therefore, further research is more complex. This paper aims to show the connections, but also the differences, in the dressing of the lower and higher classes in the Renaissance by interpreting clothing items in the Giovanni Battista Moroni's portrait „The Tailor“ (1565 – 1570). The book by British clothing historian and costume designer Janet Arnold "Patterns of Fashion: The Cut and Construction of Clothes for Men and Women 1560-1620" (1985) served as a primary source in exploring the construction and method of obtaining the silhouette. Comparing the clothing shapes of certain objects with the Moroni's portrait, one can notice the similarity between the garments of the aristocrats and the tailor.

Keywords: Renaissance, fashion, form, reconstruction, interpretation, clothing.

Authors:

Univ. bacc. ing. des. text. Emma IVANKOVIĆ (corresponding author)
University of Zagreb Faculty of Textile Technology, Department of Fashion Design
Prilaz baruna Filipovića 28a, HR-10000 Zagreb
Phone: +(385) 99 462 1368

E-mail: eivankovi@tff.hr

Assoc. Prof. Katarina Nina SIMONČIČ, Ph.D.
University of Zagreb Faculty of Textile Technology, Department of Fashion Design
Prilaz baruna Filipovića 28a, HR-10000 Zagreb
Phone: +(385) (1) 3712 564

E-mail: katarina.nina.simoncic@tff.hr

Assist. Prof. Irena ŠABARIĆ, Ph.D.
University of Zagreb Faculty of Textile Technology, Department of Fashion Design
Prilaz baruna Filipovića 28a, HR-10000 Zagreb
Phone: + (385) (1) 3712 554

E-mail: irena.sabacic@tff.hr

THE REVIVAL OF GOLD THREAD EMBROIDERY IN THE CONCEPT OF SLOW FASHION

Irena ŠABARIĆ; Franka KARIN & Doriana DUIĆ

Abstract: The subject of this paper is the technique of gold thread embroidery and its implementation in contemporary dress with the goal of reviving this craft. Gold thread embroidery is a type of manual embroidery with golden thread that has been a tradition since the beginning of the 20th century to the present day. Traditional clothing, its preservation and traditional approaches in manufacturing are dying out due to fast fashion which imposes fast-paced changes of fashion trends. Slow fashion can be associated with the cultivation of old crafts and artisanal production with the goal of preserving tradition and cultural value of products. These are also the guidelines towards sustainability of the production and the environment and raising ecological and ethical awareness. The first part of the paper describes the techniques of gold thread embroidery, the methods of embroidering and the types of golden threads in the area of Eastern Slavonia with the emphasis on the technique of gold thread embroidery in Đakovo region. The experimental part of the paper presents the collection of clothing inspired by gold thread embroidery of folklore costumes from the Đakovo region. Designer solutions and patterns of the collection are inspired by tradition and are a good example of slow fashion which proves that designers are interested in old crafts. This means that the revitalization of golden embroidery in the context of slow fashion is increasingly accepted by young designers.

Keywords: slow fashion, folk costumes, Đakovo region, gold thread embroidery, tradition, design

Authors:

Assist. Prof. Irena ŠABARIĆ, Ph.D.

University of Zagreb, Faculty of Textile Technology, Department of Textile Design and Management

Prilaz baruna Filipovića 28a, HR-10000 Zagreb, Croatia

Phone: +(385) (1) 3712 554

Fax: +(385) (1) 3712 599

E-mail: irena.sabacic@tff.unizg.hr

Franka KARIN, mag. ing. techn. text. (corresponding author)

University of Zagreb, Faculty of Textile Technology, Department of Textile Design and Management

Prilaz baruna Filipovića 28a, HR-10000 Zagreb, Croatia

Phone: +(385) (1) 3712 554

Fax: +(385) (1) 3712 599

E-mail: franka.karin@tff.unizg.hr

Doriana DUIĆ, ing. techn. text.

University of Zagreb, Faculty of Textile Technology

Prilaz baruna Filipovića 28a, HR-10000 Zagreb, Croatia

THE INFLUENCE OF CHINESE FOLK COSTUME ON THE DESIGN OF WOMEN'S BUSINESS CLOTHING

Ivan MIHALJEVIĆ; Blaženka BRLOBAŠIĆ ŠAJATOVIĆ & Maja MAHNIĆ NAGLIĆ

Abstract: The paper presents a study of Chinese folk costume with an emphasis on the dresses of the Chinese woman Qipao or Cheongsan. A historical overview of Chinese women's folk costumes is given with an emphasis on its influence of traditional clothing on contemporary design and women's fashion. According to the original design, block patterns of collection clothing models were constructed and modeled. Special emphasis is given to selected materials, clothing and high stylization. The ultimate goal of the work is to make a modern garment based on the study of traditional Chinese folk costumes.

Keywords: China, Folk costume, Construction, Business clothing

Authors:

Ivan MIHALJEVIĆ (corresponding author)
Assist. Prof. Blaženka BRLOBAŠIĆ ŠAJATOVIĆ, Ph.D., Maja MAHNIĆ NAGLIĆ, mag. Ing techn. text.
University of Zagreb, Faculty of Textile Technology
Prilaz baruna Filipovića 28 a, ZIP-10 000, Zagreb
Phone: +(385) (1) 3712 561

E-mail: vmihaljevi1@gmail.com,
E-mail: blazenka.brlobasic@tff.hr,
E-mail: maja.mahnic@tff.hr

CONSTRUCTION OF A MODERN WOMEN'S COSTUME INSPIRED BY MEN'S FASHION

Sara ŠUMANOVIĆ & Renata HRŽENJAK

Abstract: Subject of the following paper is the construction of a modern women's costume inspired by men's fashion in the 90's of the 20th century. The appearance and evolution of women's costume through history, from the end of the 19th century when the ideas about the need for a reform of women's fashion were firstly born, until modern time we live in were explored. Particular emphasis was placed on sociological access to fashion aimed at better understanding of the importance of cultural and political changes affecting development of women's costume. Through the aspect of men's fashion and men's suit collections, the 90s of the 20th century were then analyzed in order to understand the elements that would serve as inspiration for collection. In the experimental part development of collection of a modern women's costume was presented. The construction of pattern as well as one of the suggested models are shown.

Keywords: women's costume, history, changes in society, identity, men's fashion

Authors:

Sara ŠUMANOVIĆ, univ. bacc. ing. text., Assist. Prof. Renata HRŽENJAK, Ph.D. (corresponding author)
University of Zagreb Faculty of Textile Technology

Prilaz baruna Filipovića 28 a, HR-10 000 Zagreb, Croatia

Phone: +(385) (1) 3712 561

Fax: +(385) (1) 3712 599

E-mail: renata.hrzenjak@tff.hr

DESIGNING A KNITWEAR COLLECTION BASED ON MOTIFS AND SYMBOLS OF DYNASTIC CHINA TEXTILES

Valentina FERENČAK; Tena OMEROVIĆ & Vesna Marija POTOČIĆ MATKOVIĆ

Abstract: This paper explores origins and symbolism of dynastic China motifs as basis for contemporary textiles design. A variety of motifs appears in traditional Chinese textiles such as mythical animals, plants, abstract lines and calligraphic signs. Frequently message was sent by the use of motifs and compositions. Several flowers were preferred, like peony, lotus and chrysanthemum. The most preferred animal motifs were dragon, probably the most powerful symbol in China as well as Korea and Japan, together with unicorn, phoenix, lion, crane, and butterfly. Dragon is used over 2000 years in architecture, textile designs, bronzes, and ceramics. After motifs and colours have been studied, sketches, a range of designs, CAD patterns and samples of fabric were produced. The principal textile-patterning techniques associated with representation of mythical animals of dynastic China are embroidery and weaving. However, contemporary textiles collection is made manipulating techniques of knitting and printing because knitting is less used and therefore novel way of developing classic patterns.

Keywords: dragon motif, textiles design, knitting

Authors:

Valentina FERENČAK

University of Zagreb Faculty of Textile Technology
Prilaz baruna Filipovića 28a, 10000 Zagreb, Croatia

Phone: +(385) (1) 3712573

Fax: +(385) (1) 3712533

E-mail: vferencak@tff.hr

Tena OMEROVIĆ

University of Zagreb Faculty of Textile Technology
Prilaz baruna Filipovića 28a, 10000 Zagreb, Croatia

Phone: +(385) (1) 3712573

Fax: +(385) (1) 3712533

E-mail: tomerovic@tff.hr

Assoc. prof. Vesna Marija POTOČIĆ MATKOVIĆ, Ph.D. (corresponding author)

University of Zagreb Faculty of Textile Technology
Prilaz baruna Filipovića 28a, 10000 Zagreb, Croatia

Phone: +(385) (1) 3712573

Fax: +(385) (1) 3712533

E-mail: marija.potocic@tff.hr

LEATHER FURNITURE CUTTING ROOM – INDUSTRY 4.0 WITH LECTRA VERSALIS

Ivan KATIĆ & Slavenka PETRAK

Abstract: Leather is unique distinctive product and a luxurious choice to refine upholstery covering by centuries. Today it remains a noble material with natural-tough-chique look and feel, valorized by customers in search of exclusivity. As a premium material, leather is precious and we need to optimize its use to answer growing customer needs. Manufacturers face strong pressure on price due to increasing competition, especially online. Leather cutting is still heavily manual and although demand remains stable, the cost of labor is increasing due to a decrease in the number of skilled workers, and that is a challenge in an area where skills are a key element in output quality and ultimately, in the company's performance. This paper presents Lectra solution for leather furniture cutting room fully prepared for industry 4.0.

Keywords: Leather, Furniture, Cutting room, Industry 4.0, Lectra

Authors:

Ivan KATIĆ (corresponding author)
Lectra Deutschland GmbH, Glavna podružnica Zagreb
Buzinski prilaz 10, 10000 Zagreb, Croatia
Phone: +(385) (99) 3145362

E-mail: i.katic@lectra.com

Prof. Slavenka Petrak, Ph.D.
University of Zagreb Faculty of Textile Technology, Department of Clothing Technology
Prilaz baruna Filipovića 28a, HR-10000 Zagreb, Croatia
Tel: +(385) (1) 3712 543 Fax: +(385) (1) 3712 599

E-mail: slavenka.petrak@tff.unizg.hr



The Doctoral Students' Section (DSS)

ORIGINAL SCIENTIFIC PAPERS

KNITTING SHORT SOCKS WITH SIRO AND MODAL YARNS

Tea JOVANOVIĆ; Željka PAVLOVIĆ; Miloš LOZO & Zlatko VRLJIČAK

Abstract: Plain socks can be men's, women's or children's. They are essentially made from three yarns. The base yarn is most often cotton or woollen, single or ply, or one of many other yarns with similar shape and fibre composition. Various plain socks which have special uses are developed using the same construction principles as classic plain socks. Therefore, socks for skiers, football, handball, basketball and tennis players are made according to predefined principles with some yarns that have special properties being knitted into certain sock parts. There is a continuous search for the most suitable yarns and yarn properties for all of the above mentioned and similar shapes of plain socks. The focus of this research is on the production of classic winter plain socks with viscose SIRO yarns and modal fibre yarns. Sock samples were made using hosiery machine with a cylinder-bed diameter of 95 mm (3 ¾ inches) which knitted with 108 needles, i.e. it had the E9 gauge. On this type of machine, up to five yarns with total yarn count of 50 to 100 tex are optimally knitted into a row. The described yarns were used to make three samples per each type of plain sock with different base and plated yarns. The base yarns had the yarn count of 20 and 25 tex, the plated PA 156 and 220 dtex and the elastane 54 tex. The masses of produced socks were 19.3 to 23.0 g/pc.

Keywords: classic winter plain socks, modal, viscose, SIRO, polyamide, cotton

Authors:

mag.ing.techn.text. Tea JOVANOVIĆ (corresponding author)
University of Zagreb Faculty of Textile technology
Prilaz baruna Filipovića 28a, 10000 Zagreb, Croatia
Phone: +(385) (01) 3712 578

E-mail: tea.jovanovic@tff.hr

mag.ing.techn.text. Željka PAVLOVIĆ
University of Zagreb Faculty of Textile technology
Prilaz baruna Filipovića 28a, 10000 Zagreb, Croatia
Phone: +(385) (01) 3712 572

E-mail: zeljka.pavlovic@tff.unizg.hr

dipl. inž. Lozo MILOŠ
Hosiery factory 8.Mart d.o.o.
Senčanski put 85, 24000 Subotica, Serbia
Phone: +(381) (24) 55 34 11

E-mail: 8mart@eunet.rs

Prof. Zlatko VRLJIČAK Ph.D.
University of Zagreb Faculty of Textile technology
Prilaz baruna Filipovića 28a, 10000 Zagreb, Croatia
Phone: +(385) (01) 3712 578

E-mail: zlatko.vrljicak@tff.unizg.hr

ENVIRONMENTALLY ACCEPTABLE SYNTHESIS OF NANOPARTICLES FOR THEIR POTENTIAL USE AS TEXTILE COATINGS

Lela MARTINAGA; Sara ČAČKO; Stella HAMILTON;
Ana VRSALOVIĆ PRESEČKI & Iva REZIĆ

Abstract: Nanotechnology is a rapidly growing research area applicable in the textile industry, where nanoparticles integrated in the products can modify the existing materials or result with new product properties. Silver (Ag-) and gold nanoparticles (Au-NPs) are among the most commonly used NPs, and usually serve as coatings on medical textiles due to their antimicrobial properties. Therefore, there is an outgrowing need for the production of Ag- and Au-NPs, and it is necessary to develop a suitable and environmentally acceptable synthesis pathway.

In this work, Ag- and Au-NPs syntheses were performed using glucose as a reductive agent. The influence of the different initial concentration of silver nitrate (AgNO_3), tetrachloroauric acid (HAuCl_4) and glucose was examined in a view of synthesizing the NPs of smallest size.

The result has shown that the initial glucose concentration has a mild impact on both NPs synthesis while the influence of initial AgNO_3 and HAuCl_4 concentration was higher. Smallest Ag-NPs were synthesized using lowest glucose and highest AgNO_3 concentration while the smallest Au-NPs were observed when both glucose and HAuCl_4 were at the lowest or highest tested level.

Keywords: nanoparticles, glucose, environmentally acceptable synthesis, reaction optimization

Authors:

mag. ing. oecoing. Lela MARTINAGA (corresponding author); Assoc. Prof. Iva REZIĆ, Ph.D. Ph.D.
University of Zagreb Faculty of Textile Technology
Prilaz baruna Filipovića 28a, 10 000 Zagreb, Croatia
Phone: +385 1 3712 590; +385 1 371 593 E-mail: lela.pintaric@tff.unizg.hr; iva.rezic@tff.unizg.hr

univ. bacc. ing. oecoing. Sara ČAČKO; univ. bacc. ing. oecoing. Stella HAMILTON; Prof. Ana VRSALOVIĆ PRESEČKI, PhD
University of Zagreb Faculty of Chemical Engineering and Technology
Marulićev trg 19, 10 000 Zagreb, Croatia
Phone: +385 1 4597 157 E-mail: stella.hamilton1@gmail.com; saracacko995@gmail.com;
avrshalov@fkit.hr

NANOBIOCOMPOSITES REINFORCED WITH SPANISH BROOM (*Spartium Junceum L.*) FIBRES

Zorana KOVAČEVIĆ, Sandra BISCHOF, Mizi FAN

Abstract: Tensile strength of natural fibres used as reinforcement in biocomposite material and treated with microwaves show approximately 60 % higher strength compared to conventional treated fibres and 30 % compared to novel osmotic degumming method. Functionalization of fibres was carried out using montmorillonite (MMT) nanoclay particles and citric acid (CA) as an environmentally friendly crosslinker. Effectiveness of the conducted modifications was examined according to the relevant standardized methods used in current industrial and manufacturing processes (testing of morphological, mechanical, chemical and thermal properties of the final composite material). MMT/CA modified fibres show better thermal stability in comparison to the reference fibre (MWR) which is proved by thermogravimetric analysis. Fibre/polymer interface was also positively influenced by MMT/CA fibre modification. Biodegradability of developed composite materials was examined with serine endopeptidase. Concentration of 50 wt.% enzyme reveals very positive result of composite degradation. Additionally, the possibility of residue stem utilization in bioenergy production was investigated. Proximate and ultimate analysis of residues after MW maceration showed increase in content of positive biomass quality indicators.

Keywords: *Spartium junceum L.*, PLA, sustainability, green composites, nanoparticles, flame retardant, biodegradation, bioenergy, solid biofuel.

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Authors:

Zorana KOVACEVIC, Ph.D.; (corresponding author); Prof. Sandra BISCHOF, Ph.D.
University of Zagreb Faculty of Textile Technology
Prilaz baruna Filipovica 28 a, 10000 Zagreb, Croatia
Phone: +385 1 4877 351

E-mail: zorana.kovacevic@ttf.unizg.hr;
E-mail: sbischof@ttf.unizg.hr

Prof Mizi FAN
Brunel University London
Kingston Lane Uxbridge Middlesex UB8 3PH
Phone: +44 (0) 1895 266466

E-mail: mizi.fan@brunel.ac.uk

PROPERTIES OF PA/COTTON YARNS ENHANCED BY THE SIZING PROCESS

Ivana VITLOV; Ivana SCHWARZ; Stana KOVAČEVIĆ & Snježana BRNADA

Abstract: Yarn sizing represents the most complex phase in the fabric production, due to the necessary multidisciplinary approach to the whole process, with the aim of achieving improvement in the yarn physical-mechanical parameters relevant for the further weaving process. Changes of the sizing parameters, of both, the sizing plant and the sizing conditions, greatly influence the sized yarn properties. This research deals with type of yarn (PA 6.6 / cotton) that are characterized by their abrasion resistance but at the same time by their durability, comfort, lightweight and strength. Despite these remarkable properties, subjecting these yarns to the sizing process enhance their properties relevant for further technological processes of fabrication in order to achieve maximum effects. This research shows the extent to which the sizing process influences the improvement of tested yarns properties and analyse the impact of various size mass concentrations and different sizing processes. The complete analysis is considered in the context of sizing process optimization and overall justification and acceptability.

Keywords: sizing process, size concentration, yarn properties, PA/cotton yarn.

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Authors:

M. Sc. Ivana VITLOV
School of Applied Arts and Design
Perivoj V. Nazora 3/3, 23000 Zadar, Croatia

E-mail: ivana.vitlov@skole.hr

Assist. Prof. Ivana SCHWARZ, Ph. D. (corresponding author)
University of Zagreb Faculty of Textile Technology
Prilaz baruna Filipovića 28a, 10000 Zagreb, Croatia

E-mail: ivana.schwarz@tff.unizg.hr

Prof. Stana KOVAČEVIĆ, Ph. D.
University of Zagreb Faculty of Textile Technology
Prilaz baruna Filipovića 28a, 10000 Zagreb, Croatia

E-mail: stana.kovacevic@tff.unizg.hr

Assist. Snježana BRNADA, Ph. D.
University of Zagreb Faculty of Textile Technology
Prilaz baruna Filipovića 28a, 10000 Zagreb, Croatia

E-mail: sbrnada@tff.unizg.hr

RESEARCH ON WORKLOAD IN THE TECHNOLOGICAL SEWING PROCESS USING ANSI Z 365 STANDARDS

Snježana KIRIN & Anica HURSA ŠAJATOVIĆ

Abstract: In the technological sewing process, the execution of technological operations is most often performed in a sitting working position. When sewing on the sewing machine, the worker uses the torso and hands to perform machine-hand and auxiliary-manual technological sub-operations, and the feet to achieve the required sewing speed of the sewing machine in machine-hand sewing sub-operations. Due to the physic-mechanical characteristics of the work pieces, careful handling is required, which needs extremely good motoric and tactile abilities of the worker, which are manifested in the mobility and coordination of movements of the fingers, hands, arms and feet. The paper presents a study of workload and musculoskeletal disorders on a sample of 50 workers in the technological sewing process using the ANSI Z 365 questionnaire (American National Standards Institute). According to the survey, the average age of the working population was 48 years, while the average length of employment in this type of work (sewing) was 22 years. The analysis of the questionnaire revealed that 76% of workers felt pain in the neck area, 58% in the left shoulder, 90% in the upper back, 72% in the middle back and 70% in the lower back. Research data show that workers in the sewing process due to their long sitting position with the required high degree of motoric coordination of the body, arms and legs, and because of the high repetitiveness of performing the same movements, feel pain in the cervical spine, shoulders and the entire back area. In order to reduce workload and at the same time pain after many years of working in the sitting position, it is necessary to design a workplace so that the worker can use the proper posture of the body and head when sitting.

Keywords: technological sewing process, workload, ANSI Z 365 standard.

Authors:

Snježana KIRIN, M.Sc. (corresponding author)

Karlovac University of Applied Sciences

J. J. Strossmayer's Square 9, 47000 Karlovac, Croatia

Phone: +(385) (47) 843 581

Fax: +(385) (47) 843 579

E-mail: snjezana.kirin@vuka.hr

Assoc. Prof. Anica HURSA ŠAJATOVIĆ, Ph.D.

University of Zagreb, Faculty of Textile Technology, Department of Clothing Technology

Prilaz baruna Filipovića 28a, HR-10000 Zagreb, Croatia

Phone: +(385) (1) 3712 551

Fax: +(385) (1) 3712 535

E-mail: anica.hursa@tf.unizg.hr

APLICACION OF MICROSCALE COMBUSTION CALORIMETER TO CHARACTERIZE PROTECTIVE PROPERTIES OF BOVINE LEATHER

Franka ŽUVELA BOŠNJAK; Sandra FLINČEC GRGAC & Suzana MIHANOVIĆ

Abstract: The quality and properties of fire resistance are crucial to the selection of leather for the production of protective fire fighting boots, which has a primarily protective role. During fire extinguishing it is exposed to extremely high and low temperatures, chemicals (acids and alkalis), mechanical loads, etc. The properties of fire resistance were tested on two samples of bovine leather (BL1, BL2). Burn resistance test has been carried out in accordance with the requirements of the technical standards for the burn resistance test: HRN EN ISO 15090: 2012, t, 7.3 - Firefighters and rescue services. The mentioned two samples were individually tested according to HRN EN ISO 15025: 2003. The test procedure was carried out by the "Flame Expansion Testing Method". Moreover, in this research used Microscale Combustion Calorimeter (MCC) Govmark, UK because that was designed for produce the maximum heating rate capability similarly the heating rates in fires and give as a lot of flammability parameters. The analysis of physicochemical properties of samples was performed using Fourier transform infrared (FT-IR) spectroscopy. The surface morphology of the samples was studied using a Field Emission Scanning Electron Microscopy (FE-SEM). The measurement of the above samples on MCC was performed according to ASTM D7309. From the obtained HRR results, it is evident that BL1 sample has a better thermal stability than the BL2 sample.

Keywords: bovine leather, fire resistance, MCC analysis, FTIR-ATR, FE-SEM

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Authors:

Dipl.ing. Franka Žuvela Bošnjak
University of Zagreb Faculty of Textile Technology
Study in Varaždin
Hallerova aleja 6
42000 Varaždin
Tel: +(385) (42) 33 06 76

Fax: +(385) (42) 33 04 50

E-mail: franka.zuvela.bosnjak@tff.hr

Assist. Prof. Sandra Flinčec Grgac, PhD.
University of Zagreb Faculty of Textile Technology
Prilaz baruna Filipovića 28a
HR-10000 Zagreb
Tel: +(385) (1) 48 77 358

Fax: +(385) (1) 37 12 599

E-mail: sflincec@tff.hr

Dipl.ing. Suzana Mihanović
Psunj d.o.o.
Kožarska 18,35403, Rešetari
Tel: +(385) (35) 364-215

Fax: +(385) (42) 367-373

E-mail: productioni@viani.hr

RESULTS OF CHITOSAN FIBRES FORMATION BY WET SPINNING METHOD IN A HIGH-EFFICIENCY LABORATORY SET

César Israel HERNÁNDEZ VÁZQUEZ; Zbigniew DRACZYŃSKI & Grzegorz SZPARAGA

Abstract: The chitosan fibres were obtained by a wet spinning method; chitosan solutions were prepared at a chitosan concentration of 6% which based on the dynamic viscosity shown to be the most suitable for spinneret flowing process; for coagulation it was used NaOH at different concentrations (1%, 2%, 4% and 5%) as well as in the stretching bath (0,5 % NaOH), for the final part of the process a rinse bath containing pure ethanol was used to prepare solid fibres. The physicochemical effects of the coagulation bath concentration on composition, morphology, water adsorption, linear density, tensile strength and crystallinity of the prepared fibres were systematically studied by means of Scanning Electron Microscope, Wide angle X-ray scattering, adsorption test and tensile strength test. The results demonstrated that the increase in the coagulation bath concentration of sodium hydroxide resulted in greater fibre's tensile strength, greater water adsorption and greater morphological smoothness of the fibre's surface.

Keywords: Chitosan, Wet spinning, Coagulation bath, Chitosan fibres.

Authors:

M. Eng. César Israel Hernández Vázquez (corresponding author); Prof. Dr Eng Zbigniew DRACZYŃSKI
Lodz University of Technology, Institute of Material Science of Textiles and Polymer Composites
Żeromskiego 116, 90-924 Łódź, Poland
Phone: +48 042 631 33 17

E-mail: cesar.hernandez.1@dokt.p.lodz.pl
E-mail: grzegorz.szparaga@p.lodz.pl
E-mail: zbigniew.draczyński@p.lodz.pl

ASSESSMENT OF THE DEGREE OF ATTACHMENT OF ACID GROUPS TO CHITOSAN FIBERS

Dominik SIKORSKI & Zbigniew DRACZYŃSKI

Abstract: Chitin and chitosan modification products are one of the main directions of research on biodegradable polymers conducted in the team of the Institute of Textile Materials and Polymer Composites of the Lodz University of Technology.

The purpose of this work was to produce and perform physicochemical characterization of chitosan salts as derivatives of formic acid, acetic acid, propionic acid. The implementation of this goal can be used for obtaining chitosan salts in the form of fibers without exposing them to the process of dissolving in water during the formation of the appropriate acid salt. A new, more accurate method was then developed to determine the degree of deacetylation of chitosan using alkacimetric analysis. The physical and chemical properties as well as the rate of chitosan degradation processes depend on the degree of deacetylation and the molecular weight of this polymer. Analysis of the chemical composition of the derivatives obtained confirmed that there is a relationship between the salt formation rate and the chemical structure of organic acid.

Keywords: chitosan, deacetylation, fibres, acetic groups

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Authors:

Msc Eng Dominik Sikorski (corresponding author), Prof. Dr Eng Zbigniew Draczyński
Lodz University of Technology, Institute of Textile Materials and Polymer Composites
Żeromskiego 116 90-924, Łódź, Poland

THE INFLUENCE PHYSICO-CHEMICAL PROPERTIES OF ANTI-REDEPOSITION AGENTS ON THE ZETA POTENTIAL OF WASHED COTTON FABRICS

Ksenija VIŠIĆ & Tanja PUŠIĆ

Abstract: Research in the doctoral thesis includes special additives, anti-redeposition agents (ARA), in the formulation of powder detergent. Various ARA have been selected, and for these purposes carboxymethyl cellulose (CMC) and carboxymethyl starch (CMS) will be presented, the concentration of which is adjusted to washing of cellulose materials at 40 °C, 60 °C and 90 °C. These inhibitors were added to powder detergent and analyzed by washing in hard water. Characterization of standard cotton fabrics after 10 washing cycles with respect to the unwashed ones was made by analyzing the zeta potential of the washed materials and the content of incrustations.

Keywords: detergents, washing, anti-redeposition agents, carboxymethyl cellulose, cellulose materials

Authors :

Ksenija VIŠIĆ, B.Sc. (corresponding author)
University of Zagreb Faculty of Textile Technology
Prilaz baruna Filipovića 28a, 10 000 Zagreb, Croatia
Phone: +(385) (1) 4877 359

E-mail: ksenija.visic@tff.unizg.hr

Prof. Tanja PUŠIĆ, Ph.D.
University of Zagreb Faculty of Textile Technology
Prilaz baruna Filipovića 28a, 10 000 Zagreb, Croatia
Phone: +(385) (1) 4877 354

E-mail: tanja.pusic@tff.unizg.hr

IMPACT OF THE AGING PROCESS ON SODIUM ALGINATE SOLUTIONS WITH THE ADDITION OF LOW MOLECULAR WEIGHT IONIC COMPOUNDS

Nina TARZYŃSKA & Zbigniew DRACZYŃSKI

Abstract: The addition of a small amount of compounds increasing the pH of the solution, such as Na₂CO₃ or NaOH reduces the proportion of unreacted acid groups of the commercially used solution of sodium alginate. For comparative purposes, a compound that did not change the pH of the initial solution - NaCl - was also added. The replacement of non-dissociative alginic acid groups with dissociated groups of sodium alginate reduces the apparent dynamic viscosity of the system, which allows increasing the efficiency of the process of spinning alginate fibers by the wet spinning method.

Keywords: sodium alginate, apparent viscosity, aging process, low molecular weight ionic compounds

Authors:

M. Sc, Eng Nina TARZYŃSKA (corresponding author); Prof. Dr Eng Zbigniew DRACZYŃSKI
Lodz University of Technology, Institute of Material Science of Textiles and Polymer Composites
Żeromskiego 116, 90-924 Łódź, Poland
Phone: +48 042 631 33 17

Fax: +48 042 631 33 18

E-mail: nina.tarzynska@dokt.p.lodz.pl

E-mail: zbigniew.draczyński@p.lodz.pl

ADSORPTION OF CETYLPYRIDINIUM CHLORIDE ON STANDARD POLYESTER FABRIC IN THE ELECTROKINETIC ANALYZER

Katia GRGIĆ & Tanja PUŠIĆ

Abstract: Cationic surfactants are widely used in technological processes because of their functionality and favorable environmental effects. Quaternary ammonium compounds (QAC) are especially distinguished among them due to their antibacterial properties, low toxicity, low skin irritation, poor corrosivity and good environmental stability. The aim of this work is investigation of the adsorption of QAC, cetylpyridinium chloride, on standard woven cotton PES fabric at pH 9.0, 6.0 and 4.0 in an electrokinetic analyzer by measuring the streaming potential.

Keywords: adsorption, polyester fabric, cetylpyridinium chloride, streaming potential

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Authors:

Katia GRGIĆ, BSc (corresponding author)
Prof. Tanja PUŠIĆ, Ph.D
University of Zagreb Faculty of Textile Technology
Prilaz baruna Filipovića 28a, 10000 Zagreb, Croatia
Phone: +(385) (1) 3712 500

E-mail: katia.grgic@tff.hr
E-mail: tpusic@tff.unizg.hr

ANALYSIS OF METAL THREADS IN THE HISTORICAL CROATIAN TEXTILE FROM 17th TO 20th CENTURY

Kristina ŠIMIĆ; Ivo SOLJAČIĆ & Tihana PETROVIĆ LEŠ

Abstract: Metal threads, as decoration on historical Croatian textile, were mostly, used on the liturgical vestments and the festive folk costumes. Various types of metal thread were found, like independent metal threads and metal threads with non-metal textile yarn, in different location on the textile items. Analysis of these metal threads was performed with Scanning Electron Microscope with Energy Dispersive X-ray detector (SEM-EDX). The method was applied as suitable, determining the approximate amount of individual metals in the sample, also investigations of cross-sections along with the surfaces was performed. This method was compared with two other methods, X-Ray Fluorescence Spectroscopy (XRF) and Particle Induced X-Ray Spectroscopy (PIXE).

Keywords: Analysis, metal threads, folk costumes, liturgical vestments, SEM-EDX

Authors:

B. Sc. Kristina ŠIMIĆ (corresponding author)
University of Zagreb. Faculty of Textile Technology. Department of Textile Chemistry and Ecology
Prilaz baruna Filipovića 28a. HR-10000 Zagreb. Croatia
Phone: +(385) (1) 4877 353 Fax: +(385) (1) 4877 354 E-mail: kristina.simic@tff.hr

Prof. emeritus Ivo SOLJAČIĆ. Ph.D.
University of Zagreb. Faculty of Textile Technology. Department of Textile Chemistry and Ecology
Prilaz baruna Filipovića 28a. HR-10000 Zagreb. Croatia
Phone: +(385) (1) 4877 351 Fax: +(385) (1) 4877 354 E-mail: ivo.soljacic@tff.hr

Prof. Tihana Petrović Leš. Ph.D.
University of Zagreb. Faculty of Philosophy. Department of Ethnology and Cultural Anthropology
Ivana Lučića 3. HR-10000 Zagreb. Croatia
Phone: +(385) (1) 4092 129 E-mail: tples@ffzg.hr

APPLYING IMAGE ANALYSIS FOR MEASURING THE DENSITY OF HISTORICAL TEXTILES

Mateo Miguel KODRIČ KESOVIA & Željko PENAVAL

Abstract: The aim of this interdisciplinary research was to develop method of measuring density of yarns of historical textiles based on precisely captured digital micrographs. Such tool will minimize necessary handling of fragile textile artifacts and allow experts of different scientific disciplines (historians, technologists, conservation-restorers, etc.) to quickly and effectively determine key information for technical documentation of historical textiles. It will represent an alternative, but more favorable solution to analyse the yarn density of historical textiles fabrics rather than classical material decomposition method which involves microdestructive separation of individual yarns from fabric structure. The principal hypothesis established in this paper is that there is no difference between results of measuring fabric density with image analysis and with conventional methods. Conducted statistical analysis has proven that all test results for all comparisons showed that significance threshold has a value above ($p > 0.05$), which means that the results of fabric density between manual and proposed method are statistically not significantly different therefore the initial hypothesis is being accepted.

Keywords: historical textiles, fabric density, image analysis, technical documentation, statistical analysis

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Authors:

Mateo Miguel KODRIČ KESOVIA, M.A. (corresponding author)

University of Dubrovnik, Department of Art and Restoration

Branitelja Dubrovnika 41, HR-20000 Dubrovnik, Croatia

Phone: +(385) (20) 446 039

Fax: +(385) (1) 3712 533

E-mail: mmkesov@unidu.hr

Prof. Željko PENAVAL, Ph.D.

University of Zagreb, Faculty of Textile Technology, Department of Textile Design and Management

Prilaz baruna Filipovića 28a, HR-10000 Zagreb, Croatia

Phone: +(385) (1) 3712 576

Fax: +(385) (1) 3712 533

E-mail: zeljko.penava@ttf.hr

TEXTILE DUST GENERATION FROM COTTON AND COTTON/POLYESTER BLEND FABRICS

Rajna MALINAR & Sandra FLINČEC GRGAC

Abstract: Textiles generate large amount of particles, which are possible sources of infections. To explore different factors for dust generation, standard cotton and cotton/polyester blend fabrics were subjected to multiple washing and drying procedures, as base study for future research in reducing particle release in atmosphere. Samples were tested after 1, 5 and 10 washing and drying cycles. The results have shown considerable increase of dust generation within multiple washing and drying cycles. Cotton fabric had significantly higher dust output than cotton/polyester blend fabric due to differences in fibre surface morphology and sequentially higher friction between cotton fibres.

Keywords: cotton fabric; cotton/polyester; particle generation; textile dust; textile care.

Acknowledgments

This work has been supported in part by Croatian Science Foundation under the project UIP-2017-05-8780.

Authors:

Assistant Rajna MALINAR, B. Sc. (corresponding author)
Assoc. Prof. Sandra FLINČEC GRGAC, Ph.D.
University of Zagreb Faculty of Textile Technology
Prilaz baruna Filipovića 28a, 10000 Zagreb, Croatia
E-mail:

E-mail: rmalinar@tff.unizg.hr
E-mail: sflincec@tff.unizg.hr

MODERN KNITTED FABRICS FOR UNDERWEAR

Željka PAVLOVIĆ & Zlatko VRLJIČAK

Abstract: In the total world production, the share of cotton fibres is gradually decreasing, so that new fibres are needed to replace or supplement them. A double bed circular knitting machine with a machine gauge of E17 was used to knit five samples of knitted fabrics in plain double jersey weft knitted structure made of 20 tex yarns. The samples were knitted using cotton, Lyocell, modal, micromodal and viscose yarns. The ring spinning method was used to spin cotton and micromodal yarns, Lyocell yarns were spun using the air-jet spinning method, modal yarns were spun using the rotor spinning method, and viscose yarns were spun using the SIRO spinning method. The structure parameters and the tensile properties were determined for the unfinished and finished knitted fabrics, with emphasis on the percentage of elasticity when the knitted fabric was stretched in the course and wale direction. The mass per unit area of the analysed knitted fabrics ranged from 128 to 180 g/m², while the volume mass ranged from 0.21 to 0.40 g/cm³. All the manufactured and analysed knitted fabrics were compared with cotton knitted fabrics.

Keywords: Knitted fabric, double knit structure, underwear, raw material composition, cotton, modal, micromodal, Lyocell, viscose, SIRO

Acknowledgment: This work was funded by the Croatian Science Foundation, Project IP-2016-06-5278.

Authors:

mag.ing.techn.text. Željka PAVLOVIĆ (corresponding author);
Prof. Zlatko VRLJIČAK Ph.D.
University of Zagreb Faculty of Textile technology
Prilaz baruna Filipovića 28a, 10000 Zagreb, Croatia
Phone: +(385) (01) 3712 572

E-mail: zeljka.pavlovic@tff.unizg.hr

THERMAL INSULATION PROPERTIES OF THE PROTECTIVE VEST TESTED ON A THERMAL MANIKIN IN STATIC MODE

Nikolina JUKL; Snježana FIRŠT ROGALE & Dubravko ROGALE

Abstract: The paper presents a test of thermal insulation of a protective vest in static mode. The vests have the same construction characteristics but differ in the raw material composition of the base fabric. Measurements were performed on a system for testing the thermal properties of clothing called thermal manikin. It is installed in the Department of Clothing Technology of the Faculty of Textile Technology. The test was performed according to the international standard ISO HRN EN ISO 15831. The obtained results were processed by statistical analysis and prove a statistically significant difference between the arithmetic means of the tested protective vests.

Keywords: thermal insulation properties, thermal manikin, protective vest, static mode

Acknowledgements



This paper was written within the Research project HRZZ IP-2018-01-6363: Development and thermal properties of intelligent clothing funded by the Croatian Science Foundation

Authors:

Nikolina JUKL*, mag.ing. tex. tech. (corresponding author)
Prof. Snježana FIRŠT ROGALE, Ph.D.
Prof. Dubravko ROGALE, Ph.D.

University of Zagreb Faculty of Textile Technology**
Prilaz baruna Filipovića 28a, 10000 Zagreb, Hrvatska
Phone: +(385) (1) 3712553 Fax: +(385) (1) 3712599

E-mail: jukl.nikolina@gmail.com;
E-mail: sfrogale@ttf.hr;
E-mail: dubravko.rogale@ttf.hr;

A REVIEW OF RIGID 3D REGISTRATION METHODS

David BOJANIĆ; Kristijan BARTOL; Tomislav PETKOVIĆ; Tomislav PRIBANIĆ

Abstract: 3D registration is a process of aligning multiple three dimensional (3D) data structures (such as point clouds or meshes) and merging them into one consistent and seamless 3D data structure. With the scope of 3D reconstruction, 3D human body scans from multiple views need to be registered into a single point cloud to create a seamless 3D representation. In this work, we provide an overview of rigid 3D registration methods as well as a breakdown of the different parts of its process, namely, detection, description, and matching (if available). We describe the motivation behind the process and explain in detail the different used approaches in determining the aligning transformation.

Keywords: 3D computer vision, 3D registration, keypoint detection, keypoint description, keypoint matching

Acknowledgement

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Authors:

Mag. Math. David Bojanić (corresponding author)
Mag. Ing Kristijan Bartol; Assist. Prof. Tomislav Petković, Ph.D.; Prof. Tomislav Pribanić, Ph.D.
University of Zagreb Faculty of Electrical Engineering and Computing
Unska ul. 3, 10 000 Zagreb, Croatia

E-mail: David.Bojanic@fer.hr
E-mail: tomlav.petkovic.ml@fer.hr

DEVELOPMENT OF A FEMALE BODY TYPES CLASSIFICATION METHOD

Maja MAHNIĆ NAGLIĆ & Slavenka PETRAK

Abstract: The paper presents research on female body anthropometric characteristics, with the purpose of grouping and classifying different body shapes types. Classification is based on the numerical ratio of variables that describe the shape of lateral body curve in longitudinal frontal plane section. The existing methods for classifying the woman's body shape are mainly based on the ratio of the three basic circumference measures, whereby the overall circumference measures do not give a clear picture of the observed body cross section shape, and thus the shape cannot be clearly described. Experimental part of the paper includes defining the variables, i.e. shape indicators that are describing lateral body curve for shape classification and are calculated from a set of body measures determined using a 3D body scanner, which ensures the reliability and objectivity of the method. The study was conducted on a female population sample, whereby statistical data processing showed identification of the three female body shape groups, that significantly differ in defined shape indicators. Based on the analysis of the particular indicators influence on a belonging to a certain body type, a method for the classification of female body shapes was developed.

Keywords: female body types, 3D body scanner, lateral body curve, classification method

Authors:

Maja MAHNIĆ NAGLIĆ, mag. ing. techn. text. (corresponding author)
University of Zagreb Faculty of Textile Technology
Prilaz baruna Filipovića 28a, 10 000 Zagreb, Croatia
Phone: +(385) (1) 3712 543

E-mail: maja.mahnic@tff.hr

Prof. Slavenka PETRAK, Ph.D.
University of Zagreb Faculty of Textile Technology
Prilaz baruna Filipovića 28a, 10 000 Zagreb, Croatia
Phone: +(385) (1) 3712 543

E-mail: slavenka.petrak@tff.unizg.hr

DESIGNIG OF FUNCTIONAL GARMENT ITEM FOR PEOPLE WITH DISABILITIES

Marija NAKIĆ & Slavica BOGOVIĆ

Abstract: The sitting position is very common in daily life. Therefore, all clothing applied for this position should be comfortable. This is particularly important for disabled people who are restricted to the sitting position for their entire life due to their disabilities. These are people who suffer from paraplegia, multiple sclerosis or some injuries, and who have limited mobility using wheelchairs. This paper presents research on improving clothing design, adjusted to the special needs and demands of an individual, through the application of new technologies. In that respect, taking measurements is very important, as is the virtual simulation of garment fitting as the result of cuts adapted to the sitting position.

Also, the research refers particularly to a functional garment item which could be a base for a garment model designed for disabled people.

Keywords: disabled people, wheelchair users, functional clothing, 3D scanning, virtual garment simulation

Authors:

MSc Marija NAKIĆ (corresponding author)
University of Zagreb, Faculty of Textile Technology
Phone: +387 63 329 324

E-mail: mnakic13@gmail.com

Assoc. Prof. Slavica BOGOVIĆ, Ph.D.
University of Zagreb, Faculty of Textile Technology
Prilaz baruna Filipovića 28a, 10 000 Zagreb, Croatia
Phone+385 1 3712 543 Fax: +385 1 3712 557

E-mail: slavica.bogovic@tff.unizfg.hr



The Doctoral Students' Section (DSS)

PROFESSIONAL PAPERS

MODIFICATION OF COTTON FABRIC WITH CROSS - LINKED AND GRAFTED GELATINE

Anna BEDNAROWICZ & Zbigniew DRACZYŃSKI

Abstract: The aim of this study was to compare effects of two types of surface modification of cotton fabric using gelatine. One of the used methods was to cross-link gelatine on the surface of the cotton product, while the other was to graft gelatine on the surface of the product. Commercially available gelatine was used, which in one case was crosslinked with glutaraldehyde, while in the other it was grafted onto the fabric by modifying its surface with citric acid. To confirm the modification, the FTIR ATR technique was used and colour tests were carried out with the use of dyes used for dyeing protein products. In addition, the sorption properties of modified fabrics were also checked.

Keywords: gelatine, cellulosic textiles, glutaraldehyde, citric acid, grafting, cross-linking

Authors:

M. Sc, Eng Anna BEDNAROWICZ (corresponding author)
Prof. Dr Eng Zbigniew DRACZYŃSKI
Institute of Material Science of Textiles and Polymer Composites
Żeromskiego 116, 90-924 Łódź, Poland
Phone: +48 042 631 33 17 Fax: +48 042 631 33 18

E-mail: anna.bednarowicz@dokt.p.lodz.pl

INNOVATION OF BAUHAUS TEXTILE DESIGNERS AS INPIRATION FOR CONTEMPORARY TEXTILE DESIGN

Ines KATIĆ KRIŽMANČIĆ; Koraljka KOVAČ DUGANDŽIĆ & Martinia Ira GLOGAR

Abstract: Bauhaus, College of design and architecture, has been inspiring for more than a hundred years after its founding. Today the word Bauhaus isn't longer translated, it became an international concept and brand. During its opening the program, based on the Constitution of the Weimar Republic, enabled women unrestricted freedom of education. However, deeply rooted gender conditionality, majority of female students enrolled directly to the textile workshop. Student and later head of the textile workshops Ms. Otti Berger, originally from Croatian Baranja, is credited that the original workshop of "making pictures in textiles" has grown into a textile research workshop with an aim of tight collaboration with industry. The designers of the new age are just as revolutionary as well as former students of the Bauhaus. They are exploring, breaking stereotypes, creating new materials, joining science, biological engineering, technology and art. Inspired by the work of Bauhaus Textile workshop and with a desire to revitalize Croatian textile industry, a mini collection of useful objects was created. Collection was made in the combination of silk woven fabric and some leather details.

Keywords: bauhaus, textile designers, bauhaus students, influence of Bauhaus, contemporary textile design

Authors:

Ines Katić Križmančić, mag. ing. des text, Ph.D. student (corresponding author)
University of Zagreb Faculty of Textile Technology
Prilaz baruna Filipovića 28 a, 10000 Zagreb, Croatia
Tel.: +385 91 229 4964

E-mail: ikatickri@tff.hr

Assoc. prof. art. Koraljka Kovač Dugandžić
University of Zagreb Faculty of Textile Technology
Prilaz baruna Filipovića 28 a, 10000 Zagreb, Croatia
Tel.: +385 1 3712 548

E-mail: koraljka.kovac@tff.hr

Prof. Martinia Ira Glogar, Ph.D.
University of Zagreb Faculty of Textile Technology
Prilaz baruna Filipovića 28 a, 10000 Zagreb, Croatia
Tel.: +385 1 3712 557

E-mail: martinia.glogar@tff.hr

AGRO-WASTE AND EASILY RENEWABLE PLANTS AS SOURCES FOR NATURAL SILK DYES

Anja LUDAŠ; Suzana VIDEK & Ana SUTLOVIĆ

Abstract: In this paper, the possibility of using wastes and readily renewable vegetable raw materials as a source of natural dyes for silk is examined. The following plants were used: camomile flowers, onion skins, walnut and ash bark. Considering they are dyes from the group of mordant dyes, potassium aluminium sulphate dodecahydrate, copper(II) sulphate pentahydrate, iron(II) sulphate heptahydrate are used as mordant. Silk was chosen as the material because of the tradition in Croatia and the attempt to revitalize cultivation. Results of this research are presented through the analysis of CIELAB colour values based on spectrophotometric measurement. The final colour map was used to colouring silk scarves inspired by circles in grain. Bio-wastes have the attention of researchers as a source of natural textile dyes due to their ecological background, abundance and availability at minimal costs.

Keywords: natural dyes, silk fabric, mordant, wastes, camomile, onion, ash, walnut

Authors:

Assistant Anja LUDAŠ, B. Sc. (corresponding author)
University of Zagreb Faculty of Textile Technology
Prilaz baruna Filipovića 28a, 10000 Zagreb, Croatia
Phone: +385 91 7317993

E-mail: anja.ludas@tff.unizg.hr

Suzana VIDEK, B. Sc.
University of Zagreb Faculty of Textile Technology
Prilaz baruna Filipovića 28a, 10000 Zagreb, Croatia
Phone: +385 91 1619 087

E-mail: suzanavidek@gmail.com

Assoc. prof. Ana SUTLOVIĆ, Ph.D.
University of Zagreb Faculty of Textile Technology
Prilaz baruna Filipovića 28a, 10000 Zagreb, Croatia
Phone: +385 91 5470271

E-mail: ana.sutlovic@tff.unizg.hr



**Presentation of Selected Scientific Projects of the
University of Zagreb Faculty of Textile Technology**



DEVELOPMENT AND THERMAL PROPERTIES OF INTELLIGENT CLOTHING

Project leader: Prof. Dubravko Rogale, Ph.D.

Project associates: Prof. Siniša Fajt, Ph.D., Prof. Snježana Firšt Rogale, Ph.D., Prof. Antoneta Tomljenović, Ph.D., Assist. Prof. Željko Knezić, Ph.D., Assist. Prof. Kristina Krulić Himmerleisch, Ph.D., Assist. Prof. Emilija Zdraveva, Ph.D. and Ph.D. students: Martina Bobovčan Marcelić, Daniel Časar Veličan, Nikolina Jukl

Duration: 1 January 2019 - 31 December 2022

Value: 828.100,00 HRK

The scientific area and field: Technical sciences, Textile technology

Keywords: intelligent clothing, prototype, sensors, actuators, microcontrollers, thermal properties, welding methods

Abstract: A team of scientists of the Faculty of Textile Technology is dealing with the development of intelligent clothing with adaptive thermal insulation properties. They have developed and patented two generations of prototypes where sensors monitor the state of the outdoor environment and the microclimate of intelligent clothing. The integrated computer interprets the existing situation, and it makes decisions about necessary changes so that the article of clothing intelligently responds and automatically adapts its thermal properties in accordance with the environment and physical activities of the wearer. Initial research activities and development have shown the justification of introducing the concept of intelligent clothing, while prototypes and parts of metrology equipment have been recognized by the innovation community with awards. The objectives of this project are to improve the architecture of the sensor-computer-actuator system, to design new ergonomically shaped segmented thermal insulation chambers and technical subsystems using high-tech welding methods, and to create a new generation of intelligent clothing prototypes. The operation and characteristics of the technical subsystems and the reaction rate of intelligent

clothing will be investigated. A new research laboratory for complete measurements of thermal properties of clothing shall also be established. The integration of metrology subsystems will be performed in the new climatic chamber. On the basis of these research activities, the final optimization of the reactions of intelligent clothing will be performed, and its properties in changing environmental conditions under laboratory conditions and during physical activities of the wearer will be determined. The final objective of this project is to create a sophisticated prototype, to study the properties of new kinds of intelligent clothing, and to establish a new laboratory for testing the thermal properties of all types of clothing.



Acknowledgment

This presentation was funded by the Croatian Science Foundation through the project IP-2018-01-6363 Development and thermal properties of intelligent clothing (ThermIC).



COMFORT AND ANTIMICROBIAL PROPERTIES OF TEXTILES AND FOOTWEAR (IP-2016-06-5278)

Project leader: Prof. Zenun Skenderi, Ph.D.

Project associates: Prof. Alka Mihelić-Bogdanić, Ph.D., Prof. Zlatko Vrljičak, Ph.D., Prof. Antoneta Tomljenović, Ph.D., Assoc. prof. Sanja Ercegović Ražić, Ph.D., Assoc. prof. Dragana Kopitar, Ph.D., Assist. prof. Tomislav Ivanković, Ph.D. Jadranka Akalović, dipl. ing. Prof. Luboš Hes, Ph.D., Technical University of Liberec, Beti Rogina Car, Ph.D. Assist. prof. Ivana Špelić, Ph.D., Željka Pavlović, mag.ing.techn.text. Franka Žuvela Bošnjak, mag.ing.techn.text. Suzana Mihanović, dipl. inž., Jelena Peran, mag.ing.techn.text., Juro Živičnjak, mag.ing.techn.text., Ivan Kraljević, mag.ing.techn.text., Tariq Mansoor, Ph.D. Student of Technical University of Liberec

Duration: 1 March, 2017 – 29 February, 2022

Value: 624,100 kn

The scientific area and field: Technical, Textile technology

Keywords: Textile, knitted fabric, socks, regenerated cellulose fibers, footwear, leather, comfort, antimicrobial properties, Viscose, Modal, Tencel, cotton, PES

Abstract: Comfort of textiles for making garments worn next to the skin, for a specific type and level of activity and environmental condition is mainly determined by the type of raw material, type of yarn and knitted fabric structure. To differentiate the level of comfort and to propose a greater benefit, knitted fabrics made from single tricot yarns (ring-spun, rotor-spun and aerodynamic), SIRO yarn are used. Yarns (ring, rotor and air-jet) are spun from regenerated cellulosic fibres: Viscose, Tencel, Modal and micro Modal fibres. Knitted fabrics for making clothing are knitted in rib construction, while hosiery are made in plain jersey, in plated construction, multiple plated and jacquard construction. Polyamide multifilament yarn is added to knitted fabrics for making hosiery (socks).

In addition to the basic structural and tensile characteristics of yarns, knitted fabrics and socks, the thermophysiological properties (thermal and water vapour resistance using Sweating Guarded Hot Plate, and Foot model) of raw and finished samples are examined. Investigations of antimicrobial treatments of knitted fabrics against pathogenic bacteria include achieving satisfactory level of antimicrobial protection, good stability under daily use and care. Knitted fabric samples are antimicrobially treated using commercial available as well as new agents applied to the material by conventional finishing procedures and using plasma as a new environmentally friendly technology in the treatment of textile materials. Leather (for front side, lining and insole) and samples of other materials for the footwear samples are tested for the properties of thermophysiological comfort as well as parameters of thermophysiological comfort.

Antimicrobial activity of knitted fabrics and leather are determined according to 3 types of bacteria (*A. baumannii*, *S. aureus* and *E. coli*). On a number of samples of leather, the Comet test will be carried out (quick detection of damage and repair in a DNA molecule).

The evaluation of performance and functional characteristics of knitted fabric, leather and multi-layered material constructions by defining durability and stability of the performed treatments of materials by simulating the conditions of application and use (by implementing repeated cycles of washing and drying, abrasion, bending and assessing colour fastness rate to different influences) will be performed.

Acknowledgment

This presentation has been fully supported by the Croatian Science Foundation under project No. IP-2016-06-5278 Comfort and antimicrobial properties of textiles and footwear.



CUSTOM TAILORED FIBROUS SCAFFOLD PROTOTYPE FOR TISSUE CELLS CULTURE VIA COMBINED ELECTROSPINNING

Project leader: Prof. Budimir Mijović, Ph.D.

Project associates: prof. Emi Govorčin Bajsić, Ph.D., Mirna Tominac Trcin, Ph.D., prof. Tamara Holjevac Grgurić, Ph.D., assoc. prof. Igor Slivac, Ph.D., assist. prof. Emilija Zdraveva, Ph.D., Ivana Vrgoč Zimić, BSc, Tamara Dolenc, BSc, prof. Iva Dekaris, Ph.D., prof. Xungai Wang, Ph.D.

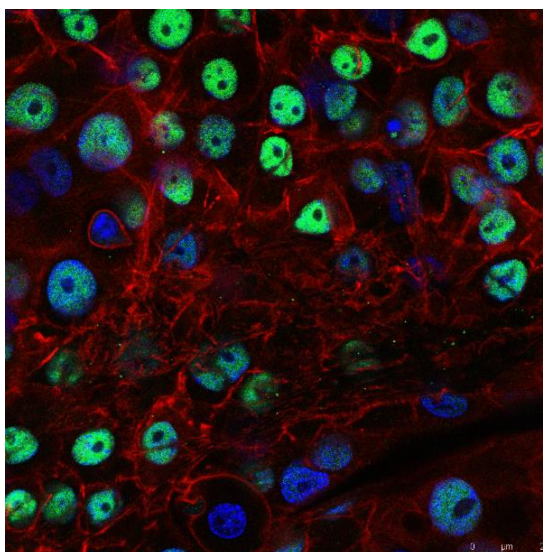
Duration: 48 months

Value: 969.700,94 HRK

The scientific area and field: interdisciplinary field

Keywords: electrospun scaffolds, tissue engineering, antibiotic, TiO₂, Anti-VEGF, limbal stem cells, immunocytochemistry

Abstract: This project focuses on the development of electrospun cells scaffolds for tissue engineering, thus contributes in the problem of donors scarcity in traditional organ transplant surgery. Scaffolds should mimic the native cells surrounding, support cells adhesion, cells penetration and homogenous colonization. The technique of electrospinning is advantageous due to versatility in materials selection, fibers diameter and morphology control and complex compositions fabrication with the addition of nanomaterials to the polymer solutions or melts. The project offers solution to fabrication of electrospun scaffolds with dual structure overcoming the drawback of scaffolds intrinsic 2D structure. The final goal of the project is to develop scaffolds with optimal architecture and multifunctionality, thus introducing co-existence of several functional species. The multifunctional feature of the scaffolds comes from both antibacterial and cellular processes stimulating property.



In vitro limbal stem cells growth

Acknowledgment

This presentation was funded by the Croatian Science Foundation through the project IP-2016-06-6878 Custom Tailored Fibrous Scaffold Prototype for Tissue Cells Culture via Combined Electrospinning.



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Confucius Institute at the University of Zagreb is a university educational center established in May 2012 to promote Chinese language and culture and to strengthen economic ties between the Republic of Croatia and the People's Republic of China. Establishment of the Confucius Institute at the University of Zagreb, Croatia has made an important step in strengthening cultural and educational cooperation with the People's Republic of China, and Zagreb joined the regional group of institutes together with Ljubljana, Vienna and Budapest. Selecting the Shanghai International Business and Economics University as a partner and the incorporation of the Croatian Chamber of Commerce in the Board of directors, the Institute has clearly positioned itself as one of the top five European business institutes together with those in London, Copenhagen, Ljubljana and Athens. Since 2012, Institute is conducting Chinese language courses for all ages, as well as Cultural programs such as Chinese Calligraphy, traditional Chinese painting, Chinese Chess, Weiqi, Taiji and Wushu. Programs are held across Croatia in cooperation with partner institutions like Faculty of Economics and Business (University of Zagreb), Faculty of Economics (University of Rijeka), Faculty of Economics (University of Osijek), Faculty of Kinesiology (University of Zagreb), Faculty of Humanities and Social Sciences (University of Split), Faculty of Tourism and Hospitality Management (University of Rijeka), University of Dubrovnik and University of Zadar.

Mr Krešimir Jurak, Croatian Director

Mrs Feng Min, Chinese Director

Confucius Institute at the University of Zagreb

Savska cesta 25, 10000 Zagreb, Croatia

info@ki.unizg.hr

phone: +385 (0)1 48 43 601

Confucius Institute at the University of Zagreb, Savska cesta 25, 10000 Zagreb, Croatia
www.ki.unizg.hr; info@ki.unizg.hr; phone: +385 (0)1 48 43 601

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Croatian Academic and Research Network – CARNET is a public institution operating within the Ministry of Science and Education in the field of information and communication technology and its application in education. CARNET began operating in 1991 as a project of the then Ministry of Science and Technology and became the first and only provider of Internet services in Croatia. Four years later, the Government of the Republic of Croatia adopted the Decree on the establishment of CARNET institution with the aim of innovating the education system and encouraging the progress of individuals and the society as a whole through ICT.

CARNET network is a private network of the academic, scientific and research community of the Republic of Croatia, as well as the institution within the primary and secondary education system. CARNET services are available to primary and secondary schools, institutions from the science and higher education institutions, as well as to numerous public institutions such as certain ministries, hospitals, etc. More than 2600 institutions, with more than 3800 locations across Croatia, are currently connected to CARNET network. CARNET individual users are students, teachers, professors, scientists and other staff members of CARNET member institutions, and all citizens of the Republic of Croatia in the segment of security on the Internet.

Focus on users is a core motivation for more than 170 CARNET's employees in six cities – Zagreb, Rijeka, Osijek, Split, Pula and Dubrovnik – who, with their knowledge and experience, improve the daily operation of the institution.

Following the latest trends in ICT, infrastructure and education over the years, CARNET has devised a number of projects and developed new services. Currently, CARNET offers more than 70 services, from education and training to multimedia, computer security and user support. Users access all services through the electronic identity in the AAI@EduHr system.

In addition, CARNET provides user support for the systems of the Ministry of Science and Education - e-Matica and National information system for applications and enrollments into secondary schools, and within the e-Citizens system CARNET developed e-Citizens mToken credentials. CARNET's well known service is the e-Class Register – application for the management of the class register in electronic form, which is used by 95 percent of schools in the Republic of Croatia.

With the aim of building a digitally mature society, CARNET has successfully implemented, in collaboration with its partners, the pilot project “e-Schools: Establishing a System for Developing Digitally Mature Schools”, by which 10 percent of primary and secondary schools have increased the level of digital maturity. The introduction of adequate ICT infrastructure and equipment in 151 Croatian schools, the development of digital content, e-Services and tools for teaching and work processes, as well as systematic education, have enabled the regular use of technology in learning and teaching and increasing the digital competence of educational staff in schools. Based on the experience and results gained through the pilot project, CARNET launched the second phase of the programme “e-Schools: Development of the System of Digitally Mature Schools (Phase II)”, worth 1.3 billion kuna. By the end of 2022, all Croatian schools will be digitally transformed.

CARNET also manages the national domain of the Republic of Croatia (.hr), participates in a number of international activities and cooperates with other European academic and research networks, the GÉANT Association organisation and the organisations responsible for managing the internet resources in the world.

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CARNET, Josipa Marohnića 5, 10000 Zagreb, Croatia
<http://www.carnet.hr>; ured@carnet.hr



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Appendix

SYMPOSIUM PROGRAM



Textile Science & Economy 2020.
13th International Scientific-Professional Symposium



VIDEOCONFERENCE

CARNET



CHINESE-CROATIAN FORUM:
**Innovation, Design and Digitalization in the
 Textile and Leather Sector**

September 18, 2020
University of Zagreb Faculty of Textile Technology (FTT)

VIRTUAL ROOM A – Invited Lectures


Time (UTC +2)	Agenda	
08:30 - 09:00	Registration for Invited Participant and System Testing	
09:00 - 10:00	Opening the Symposium and Welcome Speeches: <ol style="list-style-type: none"> 1. Dean of the University of Zagreb Faculty of Textile Technology Professor Gordana Pavlović, PhD. 2. President of the Organizing Committee of TSE 2020; Professor Slavenka Petrak, PhD. 3. President of the Committee for Innovation and Technology Transfer, University of Zagreb Professor Tomislav Josip Mlinarić, PhD. 4. Head of the Office for Management and Improvement of Scientific Research Activities at Ministry of Science and Education Hrvoje Meštrić, 5. Founding Member of BASTE – Balkan Society of Textile Engineers Professor Savvas Vassiliadis, PhD. 6. State Secretary Mario AntoniĆ, Republic of Croatia Ministry of Economy and Sustainable Development 7. Rector of the University of Zagreb Professor Damir Boras, PhD. 	
10:00 – 10:30	Gordana Pavlović, Dean of the FTT - Presentation of the University of Zagreb Faculty of Textile Technology	
Invited Lectures		
10:30 – 11:00	Xungai, WANG	Body Odour and Smell Related Properties of Different Fibres and Fiber Blends
11:00 – 11:30	Henry Yi, LI	Facemasks: Wear or Not Wear - Sciences and Facts
11:30 – 11:50	Krešimir, JURAK	Entering the world's biggest market and working with China, the world's manufacturing superpower of the 21 st century

11:50 – 12:10	Tomislav Josip, MLINARIĆ	Innovation Potential of the University of Zagreb in the function of Economic Development of the Republic of Croatia
12:10 – 12:20	BREAK: Virtual Exhibitions of Students Art Work – 2nd Year of Graduate Studies Textile and Fashion Design, Supervisor: Koraljka Kovač Dugandžić	
12:20 – 12:40	Tomislav, KRIŠTOF	Digital Apocalypse and How to Cope
12:40 – 13:00	Davor, SABOLIĆ	Material Development with Respect to Sustainable Growth
13:00 – 13:20	Neven, MARKOVIĆ	Commercialization of Innovation
13:20 – 13:40	BREAK: Short History of University of Zagreb – promotional video	
13:40 – 14:10	Edit, CSANÁK	131 Days in China: Design & Methods
14:10 – 14:30	Tomislav, PRIBANIĆ	Principles of Active Illumination 3D Reconstruction Systems - Application Examples
14:30 – 14:50	Ghadi, ALI	Innovations and Their Commercialization in Entrepreneurship: Innovation Leads to Entrepreneurship
14:50 – 15:00	BREAK: Calligraphy Virtual Workshop and Guzeng music - Confucius Institute Zagreb	
15:00 – 15:30	Uwe, REISCHL	Changes in Fabric Elasticity in Response to Sterilization with Ozone Gas
15:30 – 15:50	Gordan, SMUĐ	Trends and Challenges in Digitalization of Fashion Industry
15:50 – 16:10	Sead, ARSLANAGIĆ	Recycling of Textile Waste Using The Example Of Feasibility Study For Construction of Plant For Recycling (Tptw -Technological Postindustrial Textile Waste)
16:10 - 16:30	Martinia Ira, GLOGAR	Digital Textile Printing - Innovative Directions for Future Development
16:30 – 16:40	BREAK: PROJECT CHINA – Traditional Chinese Theater and Peking Opera as Inspiration for Theater or Film Costume Design – Costume portfolio of 2nd year graduate students of Costume design, supervisor: Ivana Bakal	
16:40	Closing the Symposium	

VIRTUAL ROOM B

**Presentation of Selected Scientific Projects on University of Zagreb
Faculty of Textile Technology**

Presentation of Croatian Companies from Textile and Leather Sector

Time (UTC +2)	Agenda	
 Selected Scientific Projects on FTE		
10:30 – 10:40	Dubravko, ROGALE	Development and thermal properties of intelligent clothing (IP-2018-01-6363)
10:40 – 10:50	Zenun, SKENDERI	Comfort and antimicrobial properties of textiles and footwear (IP-2016-06-5278)
10:50 – 11:00	Budimir, MIJOVIĆ	Custom Tailored Fibrous Scaffold Prototype for Tissue Cells Culture via Combined Electrospinning (IP-2016-06-6878)

11:10 – 12:10	Presentation of Croatian Companies from Textile and Leather Sector
Čateks d.d.	
Odjeća d.o.o.	
Tekstilpromet d.d.	
LECTRA DEUTSCHLAND GMBH	
VARTEKS d. d.	
Zlatna igla – Siscia d.o.o.	
MOIRA d.o.o.	
GRAFKO-CASPAR d.o.o.	
Miret d.o.o.	
VIVIANI d.o.o.	
GALKO d.o.o.	
12:10 – 13:00	Presentation TTF Alumni - Successful Young Entrepreneurs
ANIMA M, by Mirna Posavčević	
Matija Čop fashion studio, London, UK	
Staša design, by Staša Doblanić Rendel, London, UK	
Yelena H., by Jelena Holec	
Adriana Rajčić Design	
Katarina Mamić Design	
Schapé, Lejla Dizdarević Brković	
Irena Vucinic Jewelry	
DuoD Design, Dijana Zagorac	
13:00 – 13:15	<p>Virtual Exhibition of Students Art Work – 2nd year of undergraduate studies Textile and Fashion Design, Supervisor: Helena Schultheis Edgeler</p> <p>Movie Presentations of Graduate Papers and Fashion Collections – University of Zagreb Faculty of Textile Technology</p>

VIRTUAL ROOM C

Presentation of Doctoral Study Textile Science and Technology, University of Zagreb Faculty of Textile Technology

Presentations of Scientific Research of Ph D Students

Time (UTC +2)	Doctoral Study Textile Science and Technology, University Zagreb Faculty of Textile Technology	
12.30 - 12:40	Movie about Doctoral Study Textile Science and Technology, University of Zagreb, FTT	
12:40 - 12:50	Opening the PhD section - Welcome Speech	
Time (UTC +2)	Ph. D. Students - University of Zagreb Faculty of Textile Technology	
B_Novel Materials: Biomaterials, Nanomaterials And Smart Materials		
12:50 - 13:00	Zorana, KOVACEVIĆ; Sandra, BISCHOF & Mizi, FAN	Nanobiocomposites Reinforced with Spanish Broom (Spartium Junceum L.) Fibres
13.00 – 13:10	Lela, MARTINAGA; Sara, ČAČKO; Stella, HAMILTON; Ana, VRSALOVIĆ PRESEČKI & Iva, REZIĆ	Environmentally Acceptable Synthesis of Nanoparticles for Their Potential Use as Textile Coatings
K_Anthropometric body measurements – modern measurement systems and applications		
13:10 – 13:20	David, BOJANIĆ; Kristijan, BARTOL; Tomislav, PETKOVIĆ & Tomislav, PRIBANIĆ	A Review of Rigid 3D Registration Methods (University of Zagreb Faculty of Electrical Engineering and Computing)
13.20 – 13:30	Maja, MAHNIĆ NAGLIĆ & Slavenka, PETRAK	Development of a Female Body Types Classification Method
13:30 – 13:40	Marija, NAKIĆ & Slavica, BOGOVIĆ	Designing of Functional Garment Item for People with Disabilities
H_Thermophysiological properties and comfort of textiles, clothing and footwear		
13.40 – 13:50	Nikolina, JUKL; Snjezana, FIRŠT ROGALE & Dubravko ROGALE	Thermal Properties of The Protective Vest Tested on a Thermal Manikin in Static Mode
13:50 – 14:00	BREAK: Lacemaking in Croatia – cultural heritage promotional movie	
E_Medical and protective textiles, clothing and footwear		
14.00 – 14:10	Franka, ŽUVELA BOŠNJAK; Sandra, FLINČEC GRGAC & Suzana, MIHANOVIĆ	Application of Microscale Combustion Calorimeter to Characterize Protective Properties of Bovine Leather
G_Analysis and methods of measurement in textiles, clothing and footwear		
14:10 – 14:20	Katia, GRGIĆ & Tanja, PUŠIĆ	Adsorption of Cetylpyridinium Chloride on Standard Polyester Fabric in The Electrokinetic Analyzer
14:20 – 14:30	Rajna, MALINAR & Sandra, FLINČEC GRGAC	Textile Dust Generation from Cotton and Cotton/Polyester Blend Fabrics
14:30 – 14:40	Kristina, ŠIMIĆ; Ivo, SOLJAČIĆ & Tihana, PETROVIĆ LEŠ	Analysis of Metal Threads in The Historical Croatian Textile from 17th to 20th Century
14:40 – 14:50	Mateo Miguel, KODRIĆ KESOVIA & Željko, PENAVA	Applying Image Analysis for Measuring The Density of Historical Textiles
F_Advanced Processes Of Finishing, Care, Dyeing And Printing Of Textiles And Leather		

14:50 – 15:00	Ksenija, VIŠIĆ & Tanja, PUŠIĆ	The Influence Physico-Chemical Properties of Anti-Redeposition Agents on The Zeta Potential of Washed Cotton Fabrics
15:00 – 15:10	BREAK: Movie presentation of University of Lodz	
Time (UTC +2)	Ph. D. Students - Technical University of Lodz, Faculty of Material Technologies and Textile Design	
F_Advanced Processes Of Finishing, Care, Dyeing And Printing Of Textiles And Leather		
15:10 – 15:20	Anna, BEDNAROWICZ & Zbigniew, DRACZYŃSKI	Modification of Cotton Fabric with Cross-Linked and Grafted Gelatine
15:20 – 15:30	Nina, TARZYŃSKA & Zbigniew, DRACZYŃSKI	Impact of The Aging Process on Sodium Alginate Solutions With The Addition of Low Molecular Weight Ionic Compounds
15:30 – 15:40	Dominik, SIKORSKI & Zbigniew, DRACZYŃSKI	Assessment of The Degree of Attachment of Acid Groups to Chitosan Fibers
15:40 – 15:50	Session closing	