BOOK OF ABSTRACTS

Emerging Trends in Medical Plastics

Designs & Materials for Next Generation & Medical Devices & Drug Delivery Systems

October 16, 2023

PREFACE

Dear Speakers, Dear Guests, Ladies and Gentlemen,

I would like to warmly welcome you to the European Medical Polymers Division MiniTec conference, initiated by the Society of Plastic Engineers based in the United States of America. I am very happy that we have the privilege of hosting this event right here in Zlín at the Centre of Polymer Systems of Tomas Bata University.

It is a particularly great honor for me to welcome especially our esteemed keynote speakers and to thank the members of the organizing committee. We greatly appreciate your support and thank you all for your fantastic help.

The theme of our conference is Emerging Trends in Medical Plastics. The program is designed to provide a high-level update on the latest developments in medical polymers. I would like to point out that the common denominator of all the contributions that we will see and hear here on this occasion is the key issue of today, namely sustainability.

I believe that especially students and young scientists will be able to improve their awareness of the latest findings in the field of medical polymers, which they will use in their work, thanks to the contributions presented. They will have the opportunity to meet the world leaders in the field and to establish their first contacts that can grow into future long-term cooperation.

I wish all participants a pleasant and beneficial stay in Zlín.

Professor Petr Sáha
Director
University Institute
Tomas Bata University in Zlin
Czech Republic

Emerging Trends in Medical Plastics

Designs & Materials for Next Generation & Medical Devices & Drug Delivery Systems

October 16, 2023

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Welcome! to all attendees of the
European Medical Polymers Division MiniTec Conference
with a One Pre-day **Seminar Program**
at **Tomas Bata University**, in Zlin, Czech Republic

Dear Friends,

It is with great pride and much pleasure that I welcome you to this special conference event that has been long in the planning and the work of many of our conference programming team! We have assembled an amazing cast of presenters for this program and we know that you will find it both enjoyable and a source of learning, often in areas that go beyond the standard conference fare!

Our planning committee has worked hard to gather experts from across Europe and beyond to present new developments in technology directly related to healthcare and advanced medical treatments. Several new technologies offer improved and unique methods for advanced bone healing and even optimizing the use of resorbable polymers. Novel hydrogel developments can lead to improved patient outcomes with reduced surgical intervention yielding better results.

While the world population is becoming aware of the need to address sustainability in all products used in life, our industry is addressing sustainability from a variety of fronts from materials of choice to new product designs. Our experts come from working in the trenches doing the advanced work that will position our industry to take advantage of leadership in this area. Learn from the experts and help your company and network join the ranks of the informed!

This program will feature presentations on Factory 4.0, innovative drug delivery techniques and even address the latest on sterilization concerns facing the medical device industry. Get the latest on TPU materials as well as how PARA has been used as a metal replacement for improved instruments. And the area of cellulose membranes will be covered explaining how new techniques lead to the latest in tissue regeneration methods.

This conference will bring together great minds in our industry giving you the chance to meet and discuss their work and your ideas as well as your challenges with leaders in the industry!

We would like to take a moment to thank our on-site organizers: Associate Professor Dr. Nabanita Saha, Senior Researcher at TBU and a co-technical program chair of the EMPD of SPE and her very capable associate (and sister) Dr. Nibedita Saha, a Project Manager and a Lecturer at TBU who has also joined the organizing committee helping prepare this conference. Finally, we are grateful for the wonderful help & support of our long-time friend and SPE member, Professor Petr Saha (no relation to the Saha sisters) who is the Director UNI at TBU in Zlin. His help has been amazing and we thank him for all this support.

And we appreciate the work of all the MiniTec programming committee who have spent countless hours working to bring this event to reality. We do this to help our members and others in industry learn from each other to help improve the materials, processing technologies and treatments while developing new medical devices for better healthcare for all!

Len Czuba
EMPD Past-Chair
MPD Emeritus Member
SPE President 2005 – 2006
Distinguished Honored Service Fellow

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Dr. Tomas SAHA [Administration & Fund Raising]

Assoc. Prof. Nabanita SAHA (SPE-EMPD member) [Scientific/Technical communication]
Assist. Prof. Nibedita SAHA [Scientific/Technical communication]
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SPE INSPIRING PLASTICS PROFESSIONALS

Emerging Trends in Medical Plastics

Designs & Materials for Next Generation & Medical Devices & Drug Delivery Systems

European Medical Polymers Division presenting "Day One Seminar" Zlin, Czech Republic

Organized by University Institute, Centre of Polymer Systems (U17)
Tomas Bata University in Zlin, Czech Republic

18th October 2023

Session I – Advanced Processing in Novel Healthcare Medicine

Time	
8:00	Registration
8:30	**KNW Prof. Petr Saha (Director University Institute, TBU in Zlin & SPE Member)** **Welcome / Introduction of Tomas Bata University in Zlin**
9:00	W1 **Prof. Austin Coffey** "Converging Technologies into the Medical Device Arena – A New Era for Medical Polymers"
9:45	W2 **Dr. Ondrej Kucera** "Breaking Symmetry, Building the Future: From Protein Polymers to Bio-Inspired Active Materials"
10:30	**Coffee Break**
10:45	W3 **Prof. Dr. Martijn van Griensven** Additive manufacturing using polycaprolactone in combination with stem cells and morphogens for bone regeneration
11:30	W4 **Dr. Martin Humenik** Specific cells binding on surfaces using DNA-spider silk hybrids
12:30 - 13:30	**Lunch Break** (CPS-U17)

Session II - Medical Devices Delivering Advanced Methods in Healthcare

Time	
13:30	W5 **Prof. Vimal Katiyar** Novel nano-Hydroxyapatite based Bioabsorbable Polymeric Orthopedic Internal Fixation Devices
14:15	W6 **Assoc. Prof. Nabanita Saha** Bacterial Cellulose and Bacterial Cellulose based Hydrogel: Emergent Materials for Next Generation
15:00	**Coffee Break**
15:15	W7 **Prof. Radostina Alexandrova** Cell culture models in biocompatibility assessment of biomaterials – challenges, lessons and opportunities
16:00	**W8 Asst. Prof. Nibedita Saha** Multi-Stakeholder Vision Fosters Footwear Industry's Sustainability- A Management Approach
16:45	**Round Table discussion & Concluding remark**
17:00 - 21:00	**Official Dinner** [Invited speakers/Guests/ Organizers and Participants]

*** Arrangement of Tea/ Coffee/ Water/ Snacks will be remained outside of the Seminar Room**

****18.10.2023, Moderator: Dr. Siobhan Matthews & Conductor: Assistant Prof. Nibedita Saha**

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Designs & Materials for Next Generation & Medical Devices & Drug Delivery Systems

Prof. Austin Coffey
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Biography:

Professor Austin Coffey is Head of Department of Engineering Technology & Principal Investigator within the School of Engineering at Southeast Technological University, Ireland; with over 25 years' experience in academia, commercial management, and technical roles. He is Adjunct Full Professor of Engineering at Thammasat University, Thailand and Founder and former Managing Director of WCMS Technologies Ltd (a SETU spin-out company). Founder and former Managing Director of CCT Plastics Engineering & Solutions Ltd as well as approved Clinical Investigator at University Hospital, Waterford, Ireland. Professor Coffey has a long and successful track record in polymer materials and processes, engineering design, materials development, new product development, material analysis and advanced composite engineering for infrastructural and biomedical applications. He is educated to Ph.D. and MBA level. At a Global level, Austin has been past - President of Divisions of the Society of Plastics Engineers From a research perspective, Professor Coffey is Founder and Principal Investigator within the Convergent Technologies Research Group; an interdisciplinary applied research group in Infrastructural, Energy, Materials, Biomedical and New Technologies where more than 100 Masters and PhD students have graduated.

Abstract (W1):

"Converging Technologies into the Medical Device Arena – A New Era for Medical Polymers"

The theme for this Seminar Talk, "Converging Technologies into the Medical Device Arena – A New Era for Medical Polymers" is to bring the participants up to speed on the newest trends and technical advances in the field of Medical Devices as it relates to Polymeric Materials. The target audience is Public Research Organisations, Medical Device Producers, Moulders of Sub-Assemblies, Plastic & Additive Suppliers, Equipment & Prototype Designers, Regulatory professionals, Sales, Marketing, and Business Development leaders throughout the entire supply chain of the health-Care industry. The conference and seminar have been structured to provide ample opportunity for networking to encourage the sharing of new ideas and concepts throughout the value chain.

The purpose of this unique conference is to strengthen the interactions within the community of engineers, scientists, and business leaders in new technology advancements in the field of medical polymers for a range of medical, ICT and pharmaceutical applications. The current status, challenges and requirements for future developments of medical polymers will be presented by Professor Austin Coffey. The working seminar on "Converging Technologies into the Medical Device Arena – A New Era for Medical Polymers" will offer delegates innovative and stimulating topics with an opportunity for Q&A to delve deeper into possibilities for the future.

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Biography:

Dr. Ondrej Kucera is an electrical engineer turned biophysicist. Ondrej's scientific journey began in 2005 when he started conducting research as an undergraduate at the Czech Technical University in Prague and the Czech Academy of Sciences. Ondrej was lucky to grow professionally under the supervision of excellent scientists in Prague, Trondheim, Vestec and Grenoble while focusing on the noncanonical forces in protein polymers. As a Lecturer and Principal Investigator at the South East Technological University in Ireland, Ondrej is passing on his knowledge and passion to the next generation of scientists and biomedical professionals. Apart from the scientific questions, he is fascinated with the aesthetic beauty of the cytoskeletal protein polymer systems. Outside of his work, Ondrej enjoys skiing, finding solace and adventure on the slopes.

Abstract (W2):

"Breaking Symmetry, Building the Future: From Protein Polymers to Bio-Inspired Active Materials"

Protein polymers that constitute the cytoskeleton are implicated in a plethora of cellular events and processes, including contractility and symmetry breaking. Although they have significant potential for applications in developing active materials, the molecular mechanisms underlying these activities are often unclear or only partially understood. Here, we explore the multifaceted role of anillin—a key protein implicated in cytokinesis and cancer biology—in mediating interactions between two prominent cytoskeletal protein polymers: actin filaments and microtubules. We demonstrate that anillin possesses a dual affinity for these cytoskeletal polymers, facilitating a cross-linking mechanism and an intriguing capacity to generate contractile forces. Remarkably, this contractile activity is executed in an ATP-independent manner and independent of cytoskeletal polymers' innate structural polarity. This behaviour, which practically breaks symmetry in actin, microtubule, or actin-microtubule systems, can be further amplified by coupling to the self-assembly or disassembly of these protein polymers. Overall, our observation suggests a previously unrecognised function of anillin in regulating cytoskeletal dynamics and force generation in these protein polymers. This discovery has potential implications for developing self-assembling active materials and nano-devices.

Prof. Dr. Martijn van Griensven
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Biography:

Prof. Dr. Martijn van Griensven (1974) studied in Leiden (NL) and was trained in Hannover (D). He was appointed as full professor for experimental trauma surgery in 2002 and at that time he was the youngest professor in Germany. In 2005, he became co-director of the LBI for Experimental and Clinical Traumatology in Vienna (A). In 2011, he was appointed as director of Experimental Trauma Surgery at the Technical University of Munich (D). Since September 2019, he is full professor of regenerative medicine and head of the department of Cell Biology-Inspired Tissue Engineering of the MERLN Institute at Maastricht University (NL). Since February 2022, he is vice-director of the MERLN Institute and interim chair of the department of Instructive Biomaterial Engineering. He is also affiliated to the Musculoskeletal Gene Therapy Research Group (Prof. Chris Evans), Mayo Clinic, Rochester, MN, USA. He is a visiting professor at UPCH in Lima (Peru). He is professor at the UNESCO chair for biomaterials, Universidad de la Habana (Cuba). His research areas are related to engineering methods (including gene and transcript therapy) for the musculoskeletal system with a strong pathway from pathogenetic causes to translational medicine. He has published 329 peer reviewed papers, 3 patents, 28 book chapters and he has edited 4 books. His h-factor is 68 (Scholar). He successfully supervised 59 doctoral theses and 25 master theses. He serves currently on the council of TERMIS-EU and is vice president of the section basic research of the German society for orthopaedics and trauma surgery.

Abstract (W3):

Additive manufacturing using polycaprolactone in combination with stem cells and morphogens for bone regeneration.

Bone tissue normally has the ability of healing spontaneously. However, in some cases the healing ability is impaired. Delayed healing is occurring when the bone doesn't unify within nine months. When after nine months the bone is still not unified, the term non-union is used. Regeneration of such defects can be achieved by different methods, depending on the patient's condition. The “diamond concept” can be applied using 1) cells, 2) biomaterials, 3) growth factors, and 4) mechanical stimulation. All factors can be used or just one of the four. As a biomaterial we have used polycaprolactone. This can be matched to the defect based on a CT scan and using additive manufacturing. The microstructure (pore size, structure, interconnectivity) can also be adapted for cells to adhere, proliferate, and differentiate. The cells that are applied should be mesenchymal stem cells. They could proliferate, differentiate, and excrete important cytokines and growth factors. These mesenchymal stem cells can be derived from different tissues, but mainly bone marrow or adipose tissue. Nowadays, several machines exist for automated isolation of these mesenchymal stem cells intraoperatively. The biomaterial can be combined with morphogens for inducing bone formation and act as drug delivery platform. This tissue regeneration concept of applying a biomaterial together with cells and morphogens can lead to an increased success rate of healing of non-union fractures. We have successfully applied these techniques in docking site non-unions and in large defect non-unions of the tibia. Importantly, regenerative medicine uses techniques for personalized medicine including additive manufacturing and drug delivery.

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Biography

I studied chemistry and completed my PhD in organic chemistry at P. J. Safarik University in Kosice, Slovakia. After my postdoc at the Biochemistry Department at the University of Bayreuth, I have held the position of Senior Researcher at the University of Bayreuth, Chair of Biomaterials, since 2009. I lead the research group Hybrid Materials, specializing in the field of macromolecular material technology. In 2022, I completed my habilitation at Tomas Bata University, Faculty of Technology in Zlin, Czech Republic.

Our research focuses on the chemical and genetic modification of structural proteins and enzymes, the modification of nucleic acids, and the preparation of protein-DNA conjugates. We investigate the structural and functional characterization of modified biomacromolecules, develop processing methods for the self-assembly of proteins into nanostructures in solutions and on various surfaces, and work on strategies for protein and DNA immobilization and patterning. Additionally, we implement biochemical triggers based on DNAzymes, aptamers, and enzymes in nano- and microstructured protein coatings. Our research aims to develop functional biocompatible surfaces for cell immobilization, biocatalysis, and bioanalytics.

Abstract (W4)

Specific cells binding on surfaces using DNA-spider silk hybrids.

M. Humenik[1]*, A. Minařík[2], K. Kocourková[2], C. Heinritz[1], Z. Lamberger[1], H. Bargel[1]
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We established DNA-spider silk conjugates using "click" coupling of the recombinant protein eADF4(C16) with short DNA strands to create hybrid materials. Whereas the spider silk moiety enabled self-assembly into nanofibrils controlled by phosphate ions in aqueous buffers, the DNA part enabled DNA specific fibril labeling (*1*) or sequence specific immobilization of DNA-spider silk conjugates (*2*). Recently, we developed surface nucleated self-assembly of the DNA-modified recombinant spider silk proteins into immobilized fibril-based networks, which revealed swelling and softening properties of nanohydrogels suitable as an enzyme depot (*3*). The DNA-functionalization in the highly hydrated, cell repellent networks could be used in a specific cell binding. For this, a mild lipid-DNA incorporation into cell membrane was employed, which showed high labelling efficiency as well as negligible cytotoxicity. Based on the complementarity of the nucleic acids, highly specific DNA-assisted immobilization of the cells on the spider silk nanohydrogels with tuneable cell densities was possible. Designed competitor DNA probes enabled the cell's lift off on demand (*4*). We also employed modification of the nanohydrogels with DNA-aptamers capable of binding to cell markers to immobilize different types of cancer cells specifically (*5*). The principle of surface nucleated fibril self-assembly and nanohydrogel formation was further combined with photolithography. Using a positive-tone resist on an amino-reactive substrate, arbitrarily shaped microwells were patterned, which bottom served to define the binding of spider silk nucleation sites and formation of the fibrillar networks (*6*). After stripping of the sacrificial photoresists, nanohydrogel micro-structured pattern were achieved enabling either the DNA-assisted immobilization of DNA-labelled cells (*4*) or the aptamer-cancer cell marker interactions with high spatial fidelity (*5*).

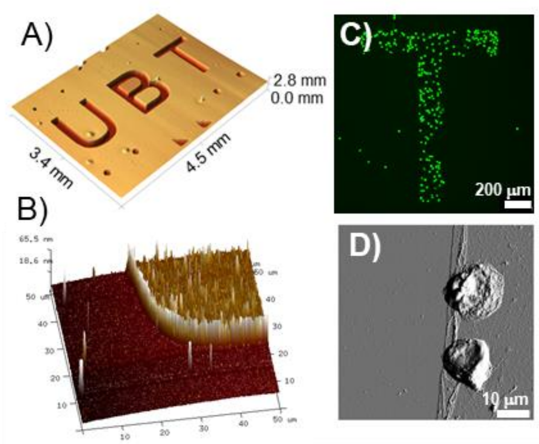

Figure 1. Micropatterning of cells on nanohydrogels. A) Optical profilometry of microwells after development of positive tone photoresist. B) AFM profile a the nanohydrogels assembled in the microwell after the photoresist stripping; C) DNA modified Jurkat cells immobilized on the complementary modified nanohydrogels; D) AFM profile of a boundary between

References

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5. Z. Lamberger, H. Bargel, M. Humenik, Aptamer-modified nanohydrogel microarrays for bioselective cancer cell immobilization. *Adv. Funct. Mater.* **32**, 2207270 (2022).
6. Z. Lamberger, K. Kocourková, A. Minařík, M. Humenik, Dual patterning of self-assembling spider silk protein nanofibrillar networks. *Adv. Mater. Interfaces* **9**, 2201173 (2022).

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Biography

Dr. Vimal Katiyar is currently a Professor in the Department of Chemical Engineering and also working as Dean, Research and Development at Indian Institute Technology Guwahati, India. He is also an Honorary Senior Fellow to Kyoto Institute of Technology, Kyoto, Japan, Visiting Professor at GIFU University, Japan and also honoured as Chair Professor Numaligarh Refinery Limited & Hindustan Gums Co. Limited. He received Ph.D. degree in Chemical Engineering from Indian Institute of Technology Bombay, India. His main area of research includes sustainable polymer development, it's processing, and their structure property relationship, rheological aspects, migration studies, toxicological effects, polymer degradation, polymer based nanomaterials, food packaging, clean and green energy technologies. Currently, he is a coordinator for three Centre of excellence at IIT Guwahati including Centre of Excellence for Sustainable Polymers funded by Department of Chemicals and petrochemicals, Govt. of India and the Joint Centre of Excellence for Biofuels and Biocommodities funded by Department of Biotechnology, Govt. of India and NRL-Centre of Excellence for Sustainable Materials at IIT Guwahati through industry intervention. Prof. Katiyar is dedicated in developing the cost-effective, bio-based and biodegradable plastic products and its related technologies using various feedstock including bio-derived plastics and biopolymers. He is also establishing DSIR funded Common research & Technology development Hub (DSIR-CRTDH) for MSMEs at IIT Guwahati to cater the need of Industries in biodegradable polymers and its technologies. Currently, he is engaged in establishing India's first heat stable biodegradable polymer production pilot plant and biobased process line for . He is also a co-inventor of 29 granted/filed patents. He had published more than 140 peer reviewed research articles in highly reputed journals and more than 250 conference papers and 85 book chapters. Under his able guidance, 23 of his students have got their Ph.D. and placed across the reputed institutions in India and abroad. His research group has received multiple National and International innovation awards in the development of bio-based polymeric products, nano-biomaterials, and related technologies. Prof. Katiyar has been engaged with numerous projects in the area of sustainable biopolymers, agriculture, food processing, and related technologies. He is also a member of NITI Ayog committee on biodegradable plastics and Member of FSSAI Panel on Food Packaging.

Abstract (W5)

Novel *nano*-Hydroxyapatite based Bioabsorbable Polymeric Orthopedic Internal Fixation Devices

Traditional metallic internal fixation devices provide reliable fixation, but after fracture healing, retraction without pain and discomfort is almost not possible. The main limitations associated with metal implants are a frequent need for non-intended secondary surgical removal of hardware (e.g. due to implant migration, discomfort, pain, or stress shielding phenomena). To overcome these problems, bioabsorbable internal fixation devices (IFDs) have been developed and fabricated. The advantages associated with these devices are that the concerned patient need not go for resurgery for removal of implants, as they were in the case of metallic implant devices. The mechanical properties of the bone and developed IFDs are almost in the same range thus avoiding stress shielding phenomenon. Thus the mechanical properties should match with the properties of bone, and elastic modulus value must lie in the limit of bone properties so that stress shielding phenomenon could be avoided.

Bioabsorbable IFDs are the implants used inside in our body to fix the fractured bones. The widely used IFDs are cortical screws, cancellous screws, bone plate, Steinmann pins and U-type bone staples. In this research, bioabsorbable IFDs are based on biocompatible, bioabsorbable polymers as matrix and functional nano powders as a reinforcing phase. Since the natural bone is also consisting of both inorganic and organic components, it combines the strength and stiffness of the inorganic compound (nano Hydroxyapatite (nHAp)) and flexibility using toughend resorbable copolymers. The toughness and resorbability of an organic phase such as pure bioabsorbable polymers (poly lactic acid (PLA)) and its copolymers with poly(caprolactone), this will combine the osteoconductivity and biodegradability of polymers/ceramic composite which is further expected to mimic the natural bone to some extent. Various IFD were fabricated including cortical screws, cancellous screws, bone plates, Steinmann pins and U-type bone staples, as shown in figure 1.

Optimization of injection moulding process parameters such as screw speed, temperature and residence time were set to produce the optimum IFDs. Various experiments were conducted for finding the significant concentration in weight percentage of filler materials and base materials after that parameter (extrusion temperature, injection moulding temperature, cylinder temperature, mould temperature, residence time, holding time, screws speed and air pressure). Once the concentration of filler and base material were optimized, all IFDs were produced through twin screws extruder cum injection moulding process. *In vitro* bioactivity studies were conducted as per the standard protocol in simulated body fluid at 37°C of pH 7.4. *In vitro* hydrolytic degradation studies were conducted on PLA and PLA/nHAp biocomposites. Once the process parameters and involved machinery were optimized the bioabsorbable IFDs were studied one by one using ASTM standards. Various fixtures of metals and wooden materials were fabricated to know the near exact properties and its durability. For every IFDs, separate test arrangement has been done with the help of fabricated fixtures such as for cortical screws, axial pull out strength, flexural strength, torsional test and double shear strength etc. These all have been determined with varying concentrations of filler to base materials. Similarly, a separate arrangement for hydrolytic degradation has been studied to know the degradation time of every type of IFDs. Development, fabrication of moulds, related fixtures, bioactivity

studies, cytotoxicity studies, *In vitro* hydrolytic degradation studies of each IFDs and ultimately conclusion about its application and targeting for various age group people makes this finding impactful, affordable and replacement of existing metallic internal fixation devices.

Figure 1: Various bioabsorbable internal fixation devices developed at IIT Guwahati using in-house developed resorbable matrix and nano-fillers.

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Biography

Dr. Nabanita Saha is basically a Biotechnologist, received BSc and MSc degree in "Life Sciences (Botany)" from Visva Bharati University, Santiniketan, India and awarded PhD in "Microbial Biotechnology" from Indian Institute of Technology, Kharagpur. She received her habilitated 'Associate Professor Degree' on "Technology of Macromolecular Substances" in 2006 from Tomas Bata University in Zlin Czech Republic. Last 22 years she is working at Tomas Bata University in Zlin, Czech Republic on Biomaterials and Bio composites/Bio based Polymeric Materials. She is engaged as Associate Professor (Faculty of Technology)/Senior Researcher (Centre of Polymer Systems & Footwear Research Centre). Her research group mainly focusing their research activity on preparation and characterization of bio-based biomaterials (in the form of gel and hydrogels and production of Bacterial Cellulose) for health care and commodity applications. She is author/co-author of more than 82 papers published in International peer reviewed scientific journals (recorded in Scopus, Web of Science data base). In 2012, her research work nominated for ENI Award-2013 competition on 'Protection of the Environment'. She was associated with e-COST, MP1301-NEW GEN project (2014-2017) as working group (WG) member, CA15216-ENBA project (2016-2020) as MC member, CA17107-CONTEXT project (2019-2022) as WG member. She is/was involved in many, internal/national and international projects running at Centre of Polymer Systems, TBU in Zlin. She is member of Polymer Processing Society (PPS) as well as associated with SPE-European Medical Polymer Division since 2009 as a Board member.

Abstract (W6)

Bacterial Cellulose and Bacterial Cellulose based Hydrogel: Emergent Materials for Next Generation

Bacterial cellulose (BC) is a biopolymer, demonstrated as a potential player in medical field. BC has several applications in the field of biotechnology due to large-scale manufacturing cost is low and have several beneficial material qualities like strength, mold ability and water holding capacity including biocompatibility and biodegradability. The properties BC fibers influenced by several factors: media composition, inoculum size, type of bacteria, pH, temperature and other environmental conditions. Commercial applications of BC include biomedical, wound dressing, tissue engineering, scaffolds, blood-vessel formation, and bone reconstruction also uses as a substitute material for garments or leather.

- NaOH treated BC mat/impurities free BC, itself looks like Gel (hydrogel)
- BC mat/ hydrogel use as a matrix for bio mineralization
- BC itself possesses no antimicrobial activity.
- BC for the preparation of injectable gel

Research performed at Centre of Polymer Systems on Bacterial Cellulose (BC) and BC based hydrogel will be discussed during presentation and demonstrated during laboratory visit.

Prof. Radostina Alexandrova
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Biography:

Professor Radostina Alexandrova graduated with honors in Biochemistry and Microbiology (now Molecular Biology) at the Faculty of Biology of Sofia University "St. Kliment Ohridski in 1991 with a specialization “Virology”. She is a PhD in Virology and Professor in morphology, has specialized in Slovakia, Hungary and Denmark, author/coauthor of more than 180 publications in Bulgarian and international scientific journals and conference proceedings, 5 book chapters, over 100 popular science articles and a book with short stories and fairy tales. R. Alexandrova is a member of the editorial boards of several Bulgarian and international scientific journals, the Union of Scientists in Bulgaria, the Bulgarian Anatomical Society; part-time lecturer at the Faculty of Biology (since 1998) and at the Faculty of Medicine (2011-2014) at Sofia University “St. Kliment Ohridski”; lecturer in PhD school of Bulgarian Academy of Sciences; principal investigator of 8 research projects funded by the National Science fund in Bulgaria, more than 10 bilateral projects between BAS and related organizations in Romania, Belarus, Lithuania, Spain, Greece and Egypt; MC member in 7 COST actions; supervisor of 10 PhD students and 40 MSc students.

Abstract (W7):

Cell culture models in biocompatibility assessment of biomaterials – challenges, lessons and opportunities

The purpose of this study is to summarize our experience in testing the cytocompatibility of a wide range of biomaterials for bone implants and wound dressings. The main advantages and disadvantages of cell cultures used in this field will be discussed, including various types of stem cells.

The main methods and strategies in evaluating the cytocompatibility of biomaterials which provide information on their influence on cell adhesion, survival, and proliferation, cytopathological changes and genotoxicity caused by them (if any) will be described.

The complex approach based on a panel of cell cultures and the performance of short-term (up to 72 hours) and long-term (over 1 week) experiments carried out by methods with different targets (molecules, organelles) and mechanism of action that is suitable for the cytocompatibility assessment of new materials for bone implants and wound dressings of different composition and structure will be presented.

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Biography

Assist. Prof. Nibedita Saha, MBA, PhD.: https://uni.utb.cz/en/contacts/nibedita-saha-ph-d-mba-2/ She is working at TBU in Zlín since September 2012 as a Project Manager dealing with international projects: FP-7, Horizon 2020, ERA Chair project, Twinning Project, Societal challenges Call, COST Open Call, associated with e-COST Action MP 1301 (NEWGEN), ICT COST Action IC 1401 (MemoCis) and in CA 15216 (ENBA) is representing as an MC substitute and in CA 18236 (SHIINE), CA 20137 (VOICES) she is representing as an MC member. She is also associated as Lecturer at Faculty of Management & Economics (FaME). She obtained 3 theses, 38 research publications in the Journal (National, International and Book Chapter) including Web of Science, Scopus, and others. She is actively involved in HRS4R (HR Award Project) and received training on HRS4R as sessors, organized by the European Commission. Beside this she is actively involved in teaching activity, giving lectures on Human Resource Management and Managerial Communications & Business Negotiation.

Abstract (W8)

Multi-Stakeholder Vision Fosters Footwear Industry's Sustainability-A Management Approach

Nibedita Saha[1*], Nabanita Saha[1,2], Tomas Sáha[1], and Petr Sáha[1, 2]
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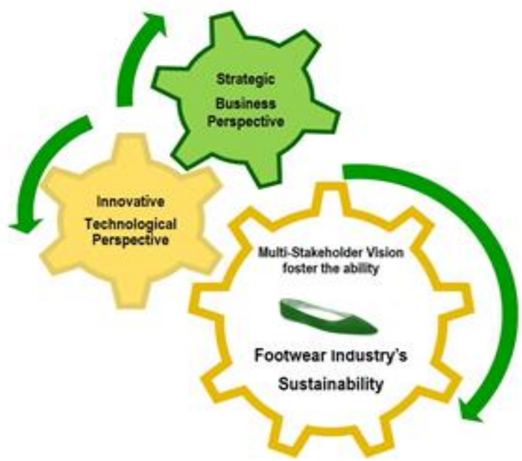
You can walk everywhere, if you have a healthy Footwear,
Footwear companies can foster sustainability, through business agility,
Multi-Stakeholder Vision foster the ability, footwear industry's Sustainability.

In today's highly volatile dynamic world, growing sustainable value creation for any businesses especially for footwear business is a great challenge. Footwear is also considering as a garment used for fashion and adornment as well as to protect the feet from the adverse environment and prevent injuries. One of the major contests for footwear businesses in Europe is how to high-quality, high-added value segments, and niche markets in footwear businesses flourishes from the socioeconomic and global business perspective point.

The present research on the role of MSIs highlight particularly, environment-friendly, sustainable and renewable biomaterial's application in the footwear industry. Though, the phenomenon like *EU multi-stakeholder dialogue* is a unique thought that did not latch numerous researchers' appreciation. But currently, the EU multi-stakeholder innovation platform is gaining its prominence in the EU's socio-economic challenges policy discourse, due to its part in the forthcoming novel program of Horizon Europe.Therefore, this study drives to address the role of multi-stakeholder's engagement in footwear industry, especially relating to human health and present a conceptual model to assess how advances in footwear design and usage will address the healthy living challenge; and the study will also identify priority areas for joint activity.



This study represented the strategy setting of MSIs in footwear industry to meet the societal challenges as well as to strengthen the national and international community programs with multi-stakeholders' collaboration. As, MSIs can raise awareness, enhance prevention and effective management system in medical application. It can raise through business, civil society organizations (CSOs), non-governmental organizations (NGOs). The approach of this study reveals to focus on European footwear market fashions; the way the economy is slowly recovering to increase sustainable value.

Scientific intent:

- MSIs have emerged as a critical force in economic social development
    - It fascinates the attention of numerous *policymakers, academicians, technocrats, clinician, podiatrist, special footwear and orthotics, and researchers* from developing and developed countries.
    - *From Healthcare point of view Multi-stakeholder perspective is a new paradigm shift in science and in its relation to society and policies occurred for health, industry, footwear market and society.*

ACKNOWLEDGMENTS

The first author is thankful to the Director of the University Institute for providing management support system (MSS) and infrastructure facility to carry out this research. Also, the first author dedicated this work to her only beloved son "Kanishka Binayak Saha", and the first & second author dedicated this work to their beloved father "Chittaranjan Saha".

INSPIRING PLASTICS PROFESSIONALS

Emerging Trends in Medical Plastics

Designs & Materials for Next Generation & Medical Devices & Drug Delivery Systems

European Medical Polymers Division's "Day Two MiniTec Conference" Zlin, Czech Republic

Organized by University Institute, Centre of Polymer Systems (U17)

Tomas Bata University in Zlin, Czech Republic

19th October 2023

Session I - Designs & Materials for Next Generation

Time	
8:00 – 9:00	Registration and Poster Session set-up
9:00	**Welcome/Introduction** - Prof. Petr Saha (Director UNI, TBU in Zlin)
9:10	**KNTh1 Prof. Austin Coffey** - Sustainability in new products
9:50	Th1 **Mr. Armand Duijsens** - DSM Leading Toward Sustainable Materials
10:20	**Coffee break / Poster session**
10:30	Th2 **Dr. Yuanyuan Chen** Fabrication of continuous iron wire reinforced Poly-L-lactic acid (PLLA) filaments for producing biodegradable stents via a braiding process
11:00	Th3 **Mr. Adam Aberra Challa** Biomineralized hydroxyapatite/graphene oxide/bacterial cellulose scaffold for bone tissue engineering: A green synthesis
11:30	Th4 **Ms. Monika Kriete** Presentation title: Medical grade TPU – Its versatility and scope in medical field
12:00 – 13:00	**Lunch Break (CPS - U17)**

Session II - Medical Devices & Drug Delivery Systems

Time	
13:00 – 13:10	**Introduction (SPE-EMPD)** – Prof. Austin Coffey
13:10	**KNTh1 Dr. Siobhan Matthews,** Factory4.0: A MedDev Manufacturing Perspective
14:00	Th5 **Mr. Mainak Chaudhuri** *Lactobacillus plantarum*-based Probiotic Bacterial Cellulose: A Novel Biomaterial
14:30	Th6 **Dr. Probal Basu** Biofunctionalized cellulose membrane for guided tissue regeneration
15:00	Th7 **Dr. Federico Baruffi** Ixef® PARA for Single-Use Instruments - Combining metal replacement and sustainability
15:30	**Coffee break / Poster Session**
15:40	Th8 **Poster Presenter's Introduction** - Ms. Anubhuti Saha, IIT-Kanpur, India - Ms. Markéta Kadlečková, TBU-Zlin, Czech Republic - Dr. Oyunchimeg Zandraa, TBU-Zlin, Czech Republic
16:10	Th9 Expert Panel Discussion
16:40	**Speaker Panel**: Sterilization, Sustainability, MDRs, Biomaterials, etc.
16:55	**Concluding remarks** - Nabanita Saha / Austin Coffey / Siobhan Matthews
17:00	**Center for Polymer Systems lab visit / Poster Session for discussion**
18:00	**Dinner (CPS-U17)**

***Posters will remain displayed from 9:00 to 18:00**

****18.10.2023, Moderator: Siobhan Matthews & Conductor: Assistant Prof. Nibedita Saha**

Emerging Trends in Medical Plastics

Designs & Materials for Next Generation & Medical Devices & Drug Delivery Systems

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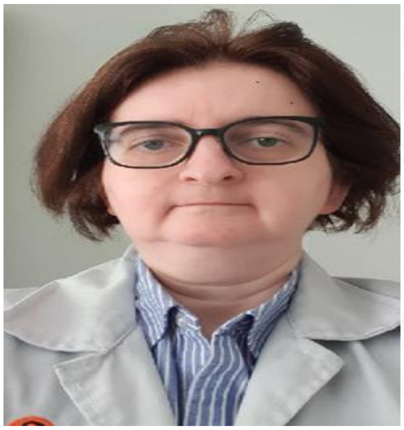
Biography:

Professor Austin Coffey is Head of Department of Engineering Technology & Principal Investigator within the School of Engineering at Southeast Technological University, Ireland; with over 25 years' experience in academia, commercial management, and technical roles. He is Adjunct Full Professor of Engineering at Thammasat University, Thailand and Founder and former Managing Director of WCMS Technologies Ltd (a SETU spin-out company). Founder and former Managing Director of CCT Plastics Engineering & Solutions Ltd as well as approved Clinical Investigator at University Hospital, Waterford, Ireland. Professor Coffey has a long and successful track record in polymer materials and processes, engineering design, materials development, new product development, material analysis and advanced composite engineering for infrastructural and biomedical applications. He is educated to Ph.D. and MBA level. At a Global level, Austin has been past - President of Divisions of the Society of Plastics Engineers From a research perspective, Professor Coffey is Founder and Principal Investigator within the Convergent Technologies Research Group; an interdisciplinary applied research group in Infrastructural, Energy, Materials, Biomedical and New Technologies where more than 100 Masters and PhD students have graduated.

Abstract

KNTh1 - Sustainability in new products

Medical plastics, integral to modern healthcare, face increasing scrutiny in the context of sustainability. The outbreak of COVID-19 clearly showed the growing demand for single use plastics. Hence, completely avoiding plastics can be challenging at this point of time. While these materials have revolutionized patient care, their production, use, and disposal contribute to environmental challenges. This talk explores the multifaceted dimensions of sustainability concerning medical plastics, addressing issues such as material selection, recycling, waste management, and the development of eco-friendly alternatives. It underscores the urgent need for the healthcare industry to adopt more sustainable practices, minimize plastic waste, and embrace innovations that reduce the environmental footprint of medical plastics, ensuring that the benefits they bring to medicine are not outweighed by their long-term ecological impact. Achieving sustainability in medical plastics is not only an ethical imperative but also vital for safeguarding both human health and the planet's well-being in the years to come.



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Biography

Siobhán is a co-founder SCF Processing Ltd., Ireland and its CEO and CTO. She is also a co-founder of Greenfields DST.

Siobhán is a member of various professional societies including The London Materials Society, currently she is the secretary of the LMS Council. She is a former Chair of the LMS. She was the chair of the Younger Members' Committee of The Institute of Materials, Minerals and Mining (IoM3), which represents over 18,000 members. She was also member of the Managing Board of the Institute and a member of the governing body, the Council, of the IoM3. Siobhán was awarded the IoM3's International Award in 2009.

Siobhán is also affiliated to the Society of Plastic Engineers (SPE) where she is secretary and Board Member of the European Medical Polymers Division. Siobhán has a BSc in Polymer Technology from Athlone Institute of Technology (now TUS) in Ireland, an MSc in Polymer Science from Loughborough University, UK, and a PhD in Materials Engineering from Brunel University, UK.

Apart from processing materials using supercritical fluids Siobhan's another claims to fame was that she was the first female rugby referee in Ireland. Back in 1996 she was part of the first ever rugby match to be officiated by an all-women team at the Rosslyn Park National Schools Sevens.

Abstract

Factory 4.0: A medical device perspective

We are now in the fourth industrial revolution. The term Industry 4.0 has been coined to represent the digitisation of manufacturing. The ability for computers to be connected, communicate and share information without the need for human interaction has been the driver behind Industry 4.0. Historically, production lines in the medical plastics industry once established were not changed as the financial cost and regulatory requirements needed to effect change were considered prohibitive.

Sensors and data analysis to speed up production and reduce waste are currently being used to good effect within the medical device sector and Industry 4.0 has gradually gained a foothold within the sector. However, the growing demand for recycling, natural materials, sustainability, personalised medicine, and life cycle analysis as well as industry regulations such as MDR will force greater and faster change. Is a smart factory, Factory 4.0 for medical device manufacture possible? This talk will examine the benefits of Industry 4.0 and explore its application to medical device manufacturing.

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Biography:

Mr. Armand Duijsens received a BSc degree in Mechanical Engineering and in Polymer processing and Rheology. He spent his career in Sekisui Chemical and DSM. Starting in the R&D area, held managerial roles in product development, technical service, process engineering and application development, market development, product management and business development.
He has over 30 years of experience in various application fields. Predominantly in extrusion process design, polymeric foams, membrane films, fibers, wire & cable and tube & hose.
His current role is Business Development Manager Specialties at Envalior, Netherlands.

Abstract (Th-1)

Delivering More Sustainable Materials for Medical Devices

DSM is recognized as a global industry leader in sustainability. Our leadership chairs sustainability panels at Davos. We are recognized as best in class for transparency related to the key metrics used to assess environmental performance. Join the thought leader for more sustainable engineering materials to explore DSM Engineering Materials' unique material solutions that enable safer and more sustainable medical devices. We will present current state of the art options for more sustainable materials and discuss the future roadmap towards circular economy solutions.

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Biography

Dr Yuanyuan Chen is a principal investigator in the Polymer, Recycling, Industrial, Sustainability and Manufacturing (PRISM) at the Technological University of the Shannon: Midlands Midwest (TUS), Ireland. She is working on biodegradable polymer synthesis, modification, and recycling. She has secured approximately €9 million competitive research funding from Science Foundation Ireland (SFI), Irish Research Council (IRC), European Space Agency (ESA), Department of Agriculture, Food and the Marine, Enterprise Ireland (DAFM), and European Commission Horizon Europe. She is currently supervising 5 PhD candidates. Her Research areas: Biodegradable polymers, Waste valorisation for polymer synthesis, Polymer recycling, Additive manufacturing.

Abstract (Th-2)

Fabrication of continuous iron wire reinforced Poly-L-lactic acid (PLLA) filaments for producing biodegradable stents via a braiding process.

Poly-L-lactic acid (PLLA) has a long history in stent implants due to its excellent biodegradability and good biocompatibility. In order to increase the mechanical strength of PLLA and develop stents with thin stent struts, continuous iron wire reinforced Poly-L-lactic acid (CWRF-PLLA) filaments was produced by crosshead extrusion in this study. The mechanical strength of CWRF-PLLA was significantly improved from 2.6 ± 0.03 GPa for the Young's modulus of the PLLA filament to 3.4 ± 0.17 GPa. Stents were braided using CWRF-PLLA filaments. The radial compression force of the stents was nearly doubled due to the continuous wire reinforcement. The filament samples were tested to be nontoxic and blood compatible.

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Biography

Adam Aberra Challa is a doctoral student of Biomaterials and Biocomposites at Tomas Bata University (TBU) in Zlin, Czech Republic. He is currently working on developing biocomposites for bone tissue engineering applications. His research is based on graphene-based biomaterial composites synthesized from natural sources such as agricultural biomass.
Adam studied structural engineering for his master's degree. As a structural engineer, he worked in a design office in his home city, Addis Ababa, Ethiopia where he was involved in building design projects, review of structural designs, and investigation of building materials for quality applications. In addition, before his Ph.D. studies in the Czech Republic, he worked as a lecturer at the Addis Ababa Institute of Technology, Addis Ababa University. Adam is a proud Rotarian and a member of Toastmasters International.

Abstract (Th3)

Biomineralized hydroxyapatite/graphene oxide/bacterial cellulose scaffold for bone tissue engineering: A green synthesis

<u>Adam Aberra Challa</u>, Nabanita Saha, Petr Saha
Centre of Polymer Systems, University Institute, Tomas Bata University in Zlin, Czech Republic

Biomineralization is a process where biominerals such as carbonates, silicates and phosphates are formed through biological actions of micro-organisms. Its main applications include bone tissue engineering. In this study, hydroxyapatite (HA) will be biomineralized from natural sources, i.e. agricultural biomass. The produced HA will be used to provide the calcium phosphate mineral necessary for bone regeneration. To enhance its properties, it will be used as a biocomposite scaffold with graphene oxide, for a better mechanical property, and bacterial cellulose, to compliment the biocompatibility and cell growth. The graphene oxide will also be produced from agricultural residue, whereas the bacterial cellulose is derived from fruit waste media. The production process proves to be environmentally sustainable. The scaffold will be tested for morphology, hydrophilicity, mechanical strength and biocompatibility. The researchers expect that the results will show a biocompatible and mechanically stable scaffold made in a sustainable process.

Keywords: biocomposite, hydroxyapatite, biomass, biomineralization, sustainability

Acknowledgment: This work financially supported by Internal Grant Agency of Tomas Bata University in Zlín, Czech Republic (IGA/CPS/2023/005).)

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Biography

Ms. Monika Kriete, lives in Nuremberg, Germany. She started her job as Technical Marketing Manager for medical polymers for EMEA-region with Lubrizol end of last year. In this position she gives technical service to the medical TPU-customers in EMEA. Furthermore, she is available for TPU workshops to deepen the knowledge about its unique characteristics.
Prior to this role, she worked at Covestro for 5 years as a Process Development Engineer and manufactured semi-finished products made of carbon fiber-reinforced polycarbonate. There, she took care of processing and testing of R&D-products as well as their handover from R&D to mass-production.
She is holding a Master-degree in "Material Science" from TU Berlin and gained more practical experience in the field of polymers and composites during her student-time at Volkswagen AG, different Fraunhofer Institutes and Federal Institute for material testing (BAM).

Abstract (Th4)

Medical grade TPU – Its versatility and scope in medical field

Thermoplastic Polyurethane (TPU) is ideal for use in a variety of medical fields such as cardiology, urology, wound care, oral care, vascular or drug-device combination products. Apart from its unique in-body-softening behavior which increases the patient's comfort for certain applications, it can also be highly customized: Depending on its raw materials, TPU's properties can be adjusted in terms of biostability, strength, flexibility, solubility, hardness and more. This presentation will give an insight into different TPU-chemistries and how to choose the right TPU-chemistry for different requirements. Furthermore, it will include some application studies covering what benefits TPU brought to the respective medical device.

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Biography

Mr. Mainak Chaudhuri, B.Sc. and M.Sc. in Zoology from The University of Burdwan, India. At present, working as a doctoral student at the Centre of Polymer Systems of Tomas Bata University in Zlin, Czech Republic, under the supervision of doc. Nabanita Saha, M.Sc. Ph.D. in the course 'Biomaterials and Biocomposites'. In the meantime, I attended "Training School 2022 Textile Technologies" in July 2022, organized by COSTAction_CONTEXT_CA17107 at Prato, Italy and "Training on Cell Studies" in August 2022, organized by Rudlofs Cimdins Riga Biomaterials Innovation and Development Centre at Riga, Latvia, for INJECT-BIO project "Bioactive injectable hydrogels for soft tissue regeneration after reconstructive maxillofacial surgeries".
Mainak Chaudhuri represented his University in All-India Science Congress with his team during his master's degree. Besides this, his hobby is Wildlife and nature photography, and he is fond of capturing beautiful photographs of nature.

Abstract (Th5)

***Lactobacillus plantarum*-based Probiotic Bacterial Cellulose: A Novel Biomaterial**

Mainak Chaudhuri, Nabanita Saha, Petr Saha
Centre of Polymer Systems, University Institute, Tomas Bata University in Zlin, Czech Republic

Novel antimicrobial polymers have attained high demand in present research for preparing different types of biomaterials for biomedical applications. Despite being a preferred material of interest for preparing different biomaterials viz. hydrogels, scaffolds etc. pure bacterial cellulose (BC), does not have antimicrobial properties itself. Therefore, probiotic bacterial cellulose (PBC) is to be obtained by coculturing antimicrobial property containing probiotic bacteria, *Lactobacillus plantarum* (Lp) and BC-producing bacteria, *Komagataeibacter xylinus* (Kx) in a favorable cultural environment**.** The antimicrobial properties of the novel Biomaterial (PBC) is tested in presence of Gram positive, Gram negative bacterial and fungal cell. The PBC (untreated with NaOH) is resisting the growth of *Staphylococcus aureus* (Sa); a Gram-positive bacteria and liable for causing a wide variety of clinical diseases. The basic properties of the novel Biomaterial (PBC) will be discussed during presentation. The combined properties of BC biopolymer including antimicrobial agent (released by probiotic bacteria,Lp) are expected to make PBC; a novel biopolymer to develop biomaterials for biomedical application.

Keywords: Probiotic Bacterial cellulose, antimicrobial agent, biomaterial, *Staphylococcus aureus*
Acknowledgment: This work is supported by Internal grant Agency of Tomas Bata University in Zlin, Czech Republic (IGA/CPS/2023/005).

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Biography

Dr. Probal Basu is a *Marie Skłodowska–Curie Postdoctoral Fellow* in Institute of Clinical Dentistry, Department of Biomaterials, University of Oslo, Norway. Previously, he was working in the Department of Chemistry and Chemical Engineering, at Chalmers University of Technology, Sweden as WWSC (Knut and Alice Wallenberg Foundation) Postdoctoral Fellow. After completing his Ph.D. from TBU in Zlin in 2020, he was a Junior Researcher at CPS, Zlin. He has 12 publications and conference articles, 9 h index, 74 citations available in Web of Science and Google Scholar. His present research interest involves cellulose-based biomaterials for biomedical and industrial applications.

Abstract (Th6)

Biofunctionalized cellulose membrane for guided tissue regeneration

Probal Basu and Hanna Tiainen
Institute of Clinical Dentistry, Department of Biomaterials,
University of Oslo, Norway.

Cellulose is an exciting biomaterial for guided tissue regeneration (GTR) due to its excellent physicochemical properties (i.e., porosity) and biocompatibility. Most of the reported GTR specific biomaterials/bio-membranes compromise porosity for strength and typically lack antibacterial properties. The present work focuses on the development of microcrystalline cellulose (MCC) based bio-membrane with improved physicochemical and antimicrobial properties for GTR. MCC will be first functionalized with lactic acid (MCC-LA). MCC-LA will be utilized with other polymers such as PEG to prepare a LA functionalized MCC-based bio-membrane. The membrane will be characterized based on its mechanical, chemical, and antimicrobial properties. This bio-membrane will be expected to provide a notable alternative to the reported GTR specific biomaterials due to its high efficiency for tissue regeneration and its antibacterial activity.

Emerging Trends in Medical Plastics

Designs & Materials for Next Generation &
Medical Devices & Drug Delivery Systems

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Biography

Federico Baruffi, is a Technical Development Engineer at Solvay Materials based in Bollate, Italy. Federico holds a master's degree in mechanical engineering from Politecnico di Milano, Italy. He was then awarded a PhD in Manufacturing Engineering by the Technical University of Denmark, where he specialised in micro injection molding for medical devices. He joined Solvay in 2019 and, since then, he supports application development and provides technical support for customers in the Consumer, Healthcare and Construction markets in EMEA.

Abstract (Th7):

Ixef® PARA for Single-Use Instruments - Combining metal replacement and sustainability.

Ixef® polyarylamide (PARA), part of Solvay's portfolio of specialty polymers, represents an ideal material for metal replacement in surgical instruments by combining excellent biocompatibility, resistance to gamma and EtO sterilization, excellent surface quality and exceptional mechanical performances. During the years, it has become the state-of-the-art solution for polymeric single-use surgical instruments by successfully replacing metal in numerous kits.

The presentation focuses on the efforts held by Solvay and some partners to move beyond the current status of single-use surgical instruments by also implementing a sustainable loop. More specifically, a case study based on upcycling and revalorization of end-of-life Ixef® PARA single use instruments will be presented and discussed. The aim is to prove that the medical safety provided by high-performance polymers such as Solvay's Ixef® PARA in single-use surgical instruments, can be reconciled with the need for greater sustainability and resource efficiency.

POSTER

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Biography

Ms. Anubhuti Saha was graduated (B.Tech in Electrical and Electronics) from Sikkim Manipal Institute of Technology, Majitar, India and (M.Tech in Instrumentation and Control Engineering), from Sant Longowal Institute of Engineering and Technology, Panjab, India. Presently, pursuing PhD in the Department of Design, Indian Institute of Technology, Kanpur, India (Final year student).
Research achievement: she acquired 7 publications (marked in Web of Science data base with *h*- index 2) Her research activity in doctoral study includes Design and Development of Low-Cost Point of Care Diagnostic Platforms for Coagulation Disorders.

Abstract:

Design and Materials: Development of Cost-Effective Point of Care Prothrombin Time (PoC-PT) Diagnostic Platform

Anubhuti Saha and *Shantanu Bhattacharyya*
Department of Design, Indian Institute of Technology,
Kanpur, Uttar Pradesh, India,

Prothrombin Time (PT) with associated international normalized ratio (INR) is a standardized coagulation test performed to evaluate several thromboembolic and hemorrhagic disorders. Patients with cardiovascular disorders (CVD) are among the main candidates in requirement of routine PT monitoring along with life-long oral anticoagulation. The respective anti-coagulation therapy requires an efficient routine PT monitoring due to the narrow therapeutic window shared by anticoagulation drugs to alleviate thrombotic or hemorrhagic risks. Thus, the availability of a rapid low-cost assay has the capability to reduce the gap in healthcare in low resource and time limited settings. The existing/commercial Point of Care Prothrombin Time (PoC-PT) diagnostics presently available in the market are generally built using acoustic, optics, electro-mechanical, or electrochemical transduction methodologies. These devices are generally developed

using plastics/polymer such as PLA and ABS to fashion and implement the desired technology. Advances in additive manufacturing and 3D printing have provided an immense thrust to engineer complex but efficient micro-structures to device miniature devices especially diagnostic assays implementing microfluidic phenomenon. As diagnostic assays are mainly engineered to test blood or plasma, the developing technology is centered around modulating and studying the microfluidic behavior of the analyte. This has led to implementation of paper or nitrocellulose like substrates as a choice for PoC diagnostic assays in combination with plastic technology. Additionally, the efficient functionality of these point of care diagnostic systems mainly relies on its easy to handle and smart design. Thus, design material plays a vital role in engineering and development of a user-friendly efficient design. These PoC platforms often require a reader or processor unit in addition to that of the chip for implementing digital or smart detection. The designing of polymer material also contributes to the efficient functioning of the respective processor unit. Thus, the present work discusses the scope of plastics and paper to build a smart but low-cost diagnostic platform for PT-INR detection to provide a rapid detection suitable for PoC-PT.

Emerging Trends in Medical Plastics

Designs & Materials for Next Generation & Medical Devices & Drug Delivery Systems

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Biography

Markéta Kadlečková is a junior researcher at Tomas Bata University in Zlín - Centre for Polymer Systems. In 2022, she completed her PhD studies in Technology of Macromolecular Substances and her main topic was 3D printing of polymer systems for biological applications. She is currently involved in several projects focused on basic research mainly in the field of tissue substitute's creation using advanced 3D printing methods and electrospinning.

Abstract

Preparation of silk/Polycaprolactone Porous Scaffolds

Karolína Kocourková [a,b], Markéta Kadlečková [a,b], Filip Mikulka [a,b], Martin Humenik[c], Antonín Minařík [ab]*

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The conformational transition of the secondary structure of silk fibroin due to shear stress complicates its processability using 3D printing techniques. Therefore, mixtures of polycaprolactone (PCL) with fibroin in various solvents were prepared. From these mixtures, 3D objects were created by electrospinning and extrusion 3D printing. In case of PCL solution, the effect of used solvent and processing temperature on the formation of porous structure was observed. The arrangement of macromolecules in the printouts from fibroin with PCL solution was analyzed. Using atomic force microscopy (AFM), we observed formation of polycaprolactone spherulites which were disrupted by the incorporated fibroin in the form of nano to micro particulate structures. The organization of the lamellae of the PCL spherulites and topography of the printed structures was rearranged by phase separation process caused by poor solvent in the printing dope.

Keywords
polycaprolactone, silk, protein, 3D printing, electrospinning, scaffold, atomic force microscopy

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Abstract

Vegan Leather: A Biobased Material for Healthy Footwear

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According to the International Hyperhidrosis Society, up to 3% of the world's population suffers from extreme sweating. People having hyperhydrosis and diabetes are also suffer from extreme sweating and skin injuries, occur more on wet skin surface. The wet surface of the skin is a pleasant environment for the growth of bacteria and unpleasant odors. One of the causes of sweating is unsuitable 'shoe sole' material. Hence, insole material should be with antibacterial properties. Many work have been published on antibacterial leather materials, where used silver nanoparticals and leaf extracts or comparing between chromium and vegetable tanned leathers. TBU researchers focuses their research investigation for the preparation of 'Vegan Leather'. This poster paper will describe about the preparation of biobased artificial leather having antimicrobial properties for its application an healthy insole material.

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Abstract

Collagen-GO-PAC-Based Composite Footwear Materials Formulation for Foot Odor Inhibition and Wound Healing Acceleration

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The presence of bacteria within shoes combined with perspiration leads to the generation of volatile organic compounds (VOCs) and unpleasant odors. Additionally, while walking our feet can be subjected to physical and microbial threats, leading to potential injuries. These challenges can be effectively tackled by implementing internal moisture, odor management, incorporating healing and antimicrobial properties within the shoe environment. Powder activated carbon (PAC), hydrolysate collagen, and synthesized graphene oxide (GO) are respectively renowned for their remarkable odor adsorption capabilities, wound-healing attributes, and antimicrobial properties. Composite material was developed through a fiber formation via electrospinning method by the viscous homogeneous collagen hydrolysate-GO-PAC solution. These materials collectively offer a practical solution to address these issues, especially when seamlessly integrated into shoe components such as linings and insoles.

Keywords: Volatile Organic Compounds (VOCs); Antimicrobial; Electrospinning; Collagen hydrolysate.

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