UK-Poland Bioinspired Materials Conference

23rd-24th November 2020

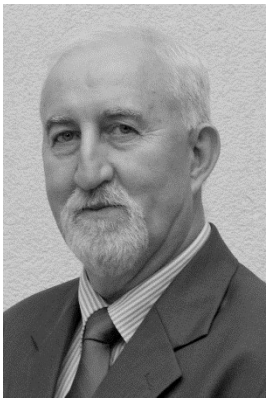
Conference addressed to UK and Polish Early Career Researchers (postdocs and PhD students)

CONFERENCE PROGRAMME AND BOOK OF ABSTRACTS

ONLINE CONFERENCE VIA MICROSOFT TEAMS

IN MEMORY OF
PROFESSOR JAN CHŁOPEK

Professor Jan Chłopek
1952 - 2020



Professor Jan Chłopek passed away on Saturday, November 14, 2020. He was Head of the Department of Biomaterials and Composites, former Dean of the Faculty of Materials Science and Ceramics at AGH University of Science and Technology, former President of the Polish Society for Biomaterials, an academic lecturer, a scientist, but above all a wonderful human being, a leader and an extraordinary mentor of students and younger scientists.

For almost 50 years, Professor Jan Chłopek was associated with the Faculty of Materials Science and Ceramics at the AGH University of Science and Technology – first as a student and then as a faculty member. He graduated in materials science in 1976, received his PhD degree in technical sciences in 1983, habilitation in 1998, and finally became a full professor in 2005.

He was an outstanding scientist working on biomaterials engineering and composite technology. He was the author of over 350 publications, including 7 books/book chapters and 25 patents/patent applications. He was a supervisor of 9 PhD dissertations and over 200 Bachelor and Master students' theses.

Prof. Jan Chłopek was Dean of the Faculty of Materials Science and Ceramics (2005-2012), Deputy Dean for International Cooperation (2002-2005), Head of the Department of Biomaterials and Composites (2012-2020). He was a founder member of the Polish Society for Biomaterials, where he served as Vice-President (1999-2006, 2010-2013) and President (2014-2016). From 2007, he was Editor-in-Chief of the „Engineering of Biomaterials" journal. He was Chairman of the „Biomaterials in Medicine and Veterinary Medicine" conferences, which has been organized annually since 1991. Having gained international recognition as a biomaterial scientist, Professor Chłopek chaired organizing committees of such important scientific meetings as the 27th European Conference on Biomaterials (ESB 2015) and International Conference on Biomedical Polymers and Polymeric Biomaterials (ISBPPB 2018). Prof. Jan Chłopek managed a nationwide team which developed teaching standards for "Biomedical Engineering" in Poland. He was a co-founder of the Multidisciplinary School of Biomedical Engineering at AGH. He received many awards and distinctions for his scientific and teaching activities. As an accomplished figure in the field of biomaterials science and engineering, Professor Chłopek received the accolade of „Fellow, Biomaterials Science and Engineering" (FBSE) from the International Union of Societies for Biomaterials Science and Engineering (IUSBSE).

The sudden death of Professor Chłopek has left us all in deep grief. He will be remembered as a scientist, mentor, husband, father, grandfather, football fan, player, and coach. We will always cherish his kindness, sense of humor, positive attitude, and faith in people.

CONFERENCE ORGANISERS

LANCASTER UNIVERSITY, UK:

Dr. Timothy E.L. Douglas

Laurine Martocq

NEWCASTLE UNIVERSITY, UK:

Dr. Marloes Peeters

AGH UNIVERSITY OF SCIENCE AND TECHNOLOGY, POLAND:

Prof. Elżbieta Pamuła

Dr. Patrycja Domalik-Pyzik

MSc Katarzyna Trała

Partners:

Endorsed by:

Special Issue "Bioinspired Materials for Medical and Biotechnological Applications"

Journal of *Functional Biomaterials*

Dear Colleagues,

Nature is a practically inexhaustible source of inspiration for the design of synthetic materials. Hence, "bio-inspired materials" is a practically limitless field. In this Special Issue, we will focus on applications in medicine and biotechnology, where materials interact with biological systems, tissues, cells, and microorganisms to invoke the required response in a specific application. For example, we usually do not need microorganism growth in medicine, but we often need it in biotechnology. Characteristics of bio-inspired materials which are relevant for their performance may include, but are not limited to, topographical, chemical, mechanical, and electrical properties. Due to the wide scope of bio-inspired materials, contributions relating to biomaterials, tissue engineering, and biomimetics are also welcome.

Dr. John G. Hardy
Prof. Dr. Elzbieta Pamula
Dr. Timothy E.L. Douglas
Dr. Marloes Peeters
Guest Editors

Special issue website:

https://www.mdpi.com/journal/jfb/special_issues/bioinsp_mater_med_biotech

Table of contents

FINAL PROGRAM

KEYNOTE	UK	POLISH

Mon 23/11	UK TIME	POLISH TIME			
Session 1	10.00	11.00	***Opening***	Prof. Elżbieta Pamuła	Welcome AGH University of Science and Technology, Krakow, Poland
				Mr. James Hughes	Minister-Counsellor for Economic Affairs, British Embassy in Warsaw
				Prof. Jerzy Lis	Rector, AGH University of Science and Technology, Krakow, Poland
				Prof. Ian Postlethwaite	Head of Engineering School, Newcastle University, UK
				Prof. Rob Short	Head of Interdepartmental Materials Science Institute, Lancaster University, UK
				Dr. Timothy Douglas	Introduction Lancaster University, UK
	10.30	11.30	**Keynote 1**	**Tomasz Ciach**	Biomimetic coatings for medical devices and implants
	11.00	12.00		Aleksandra Benko	Physicochemical and electrochemical determinants of the CNTs biocompatibility, antibacterial and anti-cancer properties
	11.15	12.15		Marcin Kotlarz	Bioprinting of natural cell-laden hydrogel coatings to enhance osseointegration of metal implants
	11.30-12.00	12.30-13.00	Break		
Session 2	12.00	13.00	**Keynote 2**	**Vitaliy Khutoryanskiy**	Poly(2-oxazolines) as emerging materials for drug delivery
	12.30	13.30	**Keynote 3**	**Radosław Wach**	Radiation engineering of biobased hydrogels towards biodegradable medical devices
	13.00	14.00		Carmen Piras	Supramolecular hybrid microgels for biological applications
	13.15	14.15		Vladyslav Vivcharenko	Superabsorbent foam-like chitosan/agarose based biomaterial for external wound dressing application
	13.30-13.45	14.30-14.45	Break		

Session 3	13.45	14.45	**Keynote 4**	**Wojciech Święszkowski**	Biofabrication of functional and biomimetic 3D tissue-like constructs
	14.15	15.15		Ewa Sroczyk	Biocompatibility of polyimide (PI) electrospun membrane
	14.30	15.30		Laurine Martocq	Development of amine-rich coatings for antimicrobial applications
	14.45	15.45		Ewelina Cichoń	Whey protein isolate (WPI) as a prosperous additive to α-TCP based bone cements
	15.00-15.15	16.00-16.15	Break		
Session 4	15.15	16.15	**Keynote 5**	**John Hardy**	Electroactive biomaterials for drug delivery, tissue engineering and regenerative medicine
	15.45	16.45		Katarzyna Reczyńska	Stimuli-sensitive fatty acid-based microparticles for the treatment of lung cancer
	16.00	17.00		Mark Sullivan	Hybrid Aptamer-Molecularly Imprinted Polymer (aptaMIP) Nanoparticles from Protein Recognition – a Trypsin Model
	16.15	17.15		Aldona Mzyk	Nanodiamond Magnetometry for free radicals detection in sperm cells
	16.30	17.30		Malwina Niedźwiedź	Fatty Acid-Based Injectable Biomaterials For Soft Tissue Engineering
	16.45	17.45	**CLOSE**		
	17.00-18.00	18.00-19.00	**Poster session**		

Tue 24/11	UK TIME	POLISH TIME	

Session 5	9.30	10.30	**Keynote 6**	**Lidija Siller**	Bioinspired processes and materials for CO2 mitigation
	10.00	11.00		Mateusz Kawka	Bifunctional constructs for in vitro transgenic roots immobilization and in situ product extraction
	10.15	11.15		Rabia S Khan	Vibrational spectroscopic analysis of diabetes and its correlation with oral cancer using saliva samples
	10.30	11.30		Weronika Prus-Walendziak	Microcapsules with herbal preparations for dermatological applications
	10.45-11.00	11.45-12.00	Break		
Session 6	11.00	12.00	**Keynote 7**	**Katarina Novakovic**	Smart hydrogels for personalised hands free drug delivery
	11.30	12.30		Grzegorz Kalisz	Application of ATR-FTIR spectroscopic imaging in assessment of collagen maturity and mineralization in mesenchymal stem cells cultured on the hydroxyapatite-based bone scaffold
	11.45	12.45		Paulina Kazimierczak	Osteoconductive and osteoinductive properties of highly macroporous hydroxyapatite-based bone scaffold
	12.00	13.00		Patrick Suemo	Electrochemistry of silver nanoparticles in a layer-by-layer of biopolymers
	12.15-12.45	13.15-13.45	Break		
Session 7	12.45	13.45	**Keynote 8**	**Urszula Stachewicz**	Biomimetic geometries and surface properties of electrospun polymer fibers for tissue engineering and skin care applications
	13.15	14.15		Andrew Reid	Manipulating the chemistry and nanotopography of cultured diatoms for bone regenerative technologies
	13.30	14.30		Michał Dziadek	Multifunctional biomaterials loaded with polyphenolic compounds

	13.45	14.45		Davide Facchetti	Study of the interface of O/W emulsions stabilized by beta-lactoglobulin fibrils at pH 2 by site directed spin labelling and electron paramagnetic resonance
	14.00-14.15	15.00-15.15	Break		
Session 8	14.15	15.15	**Keynote 9**	**Antonios Kelarakis**	Carbon dots and their emerging applications
	14.45	15.45		Michał Wojasiński	Lecithin-based modification of hydroxyapatite nanoparticles – bioinspired coating
	15.00	16.00		Zhan Yuin Ong	Bioinspired synthesis of monodisperse and multifunctional porous silica nanoparticles for drug delivery
	15.15	16.15		Agnieszka Drozdz	The advanced spectroscopic methods in the study of the iron oxide nanoparticles influence on living organisms
	15.30-15.45	16.30-16.45	Break		
Session 9	15.45	16.45	**Keynote 10**	**Agata Zykwinska**	Bacterial polysaccharides to mimic extracellular matrix of connective tissue
	16.15	17.15		Sam Swingler	Bacterial cellulose: Natures Band-Aid
	16.30	17.30		Magdalena Głąb	Physicochemical and biological analysis of hydroxyapatite for bone tissue regeneration
	16.45	17.45		Dagmara Słota	Protein-based composite hydrogels for bone tissue regeneration
	17.00	18.00	***CLOSING Remarks***		

KEYNOTE SPEAKERS

TOMASZ CIACH

Warsaw University of Technology, Poland

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Biomimetic coatings for medical devices and implants

Tomasz Ciach PhD, Prof.
Warsaw University of Technology
Faculty of Chemical and Process Engineering
Warynskiego str. 1, 00-645 Warsaw, POLAND
www.biomedlab.ichip.pw.edu.pl
Head of Biotechnology and Bioprocess Division
Head of Biomedical Engineering Laboratory

Education:

Chemical Engineering at Warsaw University of Technology,
Biology at Warsaw University,
Doctorate at the Faculty of Chemical Engineering, Warsaw University of Technology.

Scientific interest:

Applied research on the border of Chemical Engineering and Medicine including:
- Drug delivery systems: various types of drug delivery devices, implants or injectable systems designed to deliver the drug in the proper place and rate.
- Nanotechnology – nanoparticles for targeted drug delivery, cancer treatment and caner diagnostics, nanocoatings for medical applications.
- Medical devices and implants: bone, cartilage, vascular prosthesis, cell encapsulation.
- Advanced coatings for medical devices and implants regulating proteins and cell attachment and decreasing platelet activation.

Technologies on the EU medical market:

- drug eluting coatings for coronary stents, Balton.
- biocompatible low friction coatings for urological catheters, Galmed.
- hydroxyapatite nanoparticles for bone implants, Biovico (human trials).

Founder of five university spinoff companies.

JOHN HARDY

Lancaster University, United Kingdom

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Electroactive biomaterials for drug delivery, tissue engineering and regenerative medicine

John Hardy was awarded his MSci and PhD in Chemistry in 2002 and 2007 from the University of Bristol and University of York, respectively. From 2006 to 2015 he undertook postdoctoral research in Chemical Engineering at the University of Strasbourg in France, in Bioengineering at the University of Bayreuth in Germany, in Biomedical Engineering at the University of Texas at Austin, the University of Florida in the USA, and in Pharmacy at Queen's University Belfast in Northern Ireland. He is currently a 50th Anniversary Senior Lecturer in the Department of Chemistry and Materials Science Institute at Lancaster University.

ANTONIOS KELARAKIS

University of Central Lancashire, United Kingdom

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Carbon dots and their emerging applications

Antonios has established a long track record in ground-breaking research and product development and his publications cover a broad area of topics related to nanomaterials, nanocomposites, nanosensors, colloids, polymers, smart coatings, aerogels, biomaterials, energy materials and forensic nanotools. Antonios' research is interdisciplinary in nature (it combines elements from material science, nanotechnology, chemistry, biology, pharmacy and medicine) and emphasizes on the development of a new generation of energy-efficient materials and the establishment of green chemical approaches for a sustainable future. Currently Antonios is leading a high-profile research group that has hosted more than 20 postgraduate students within the last 5 years and numerous undergraduate students, Erasmus exchange students and international visitors.

Prior to joining the University of Central Lancashire Antonios has gained extensive experience in both academic research and commercial development with appointments in world-leading institutions in Europe (Universities of Manchester and Sheffield in U.K., University of Athens in Greece, University of Karlsruhe in Germany) and U.S.A. (Cornell University and SUNY at Stony Brook). For more than two decades Antonios is working closely with major industries in USA, Europe, Middle East and India. To that end, Antonios has participated in projects funded by Intel Corporation, Dow Company, Kimberly Clark, Coca Cola, Astra Zeneca, Aramco, while his research has also been sponsored by the U.S. Department of Energy, National Science Foundation of U.S.A., New York State Energy Research and Development Authority, Hellenic National Scholarship Institution, Research England, Marie Sklodowska-Curie Research and Training Network, the European Commission (5th and 6th Framework Programs and Horizon 2020) and the Newton fund.

VITALIY KHUTORYANSKIY

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Poly(2-oxazolines) as emerging materials for drug delivery

Prof. Vitaliy Khutoryanskiy has been Professor of Formulation Science since 2014, having previously been Associate Professor (Reader) in Pharmaceutical Materials (2010-2014) and Lecturer in Pharmaceutics (2005-2010) at Reading School of Pharmacy. Prof Khutoryanskiy has researched broadly in the area of new biomaterials for pharmaceutical and biomedical applications, with a particular emphasis on drug delivery, mucoadhesive materials, hydrogels, and stimuli-responsive polymers. He was the recipient of the 2012 McBain Medal from the Society of Chemical Industry (SCI) and Royal Society of Chemistry (RSC) for his imaginative use of colloid, polymer and interface science in the development of novel biomedical materials, 2020 Polymers Best Paper Award (MDPI) and 2020 Supervisor of the Year Award (FindAUniversity). He has published 158 original research articles and 23 reviews, accruing over 8300 citations with an h-index of 45 (Google Scholar). Prof Khutoryanskiy has supervised 10 postdoctoral research assistants and 29 PhD students to successful completion.

KATARINA NOVAKOVIC

Newcastle University, United Kingdom

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Smart hydrogels for personalised hands free drug delivery

Dr Katarina Novakovic, Senior Lecturer at the School of Engineering, Newcastle University, UK, is a leading expert in Oscillatory Carbonylation Reactions (OCRs) with a core interest in their applications to intelligent materials for novel healthcare technologies and other interdisciplinary applications. Katarina graduated from the University of Belgrade, Serbia (1997) with a degree in Chemical Engineering, specialising in Organic Chemical Technology and Polymer Engineering. Following this, she worked in the pharmaceutical industry (1997-2000) at Solid Forms Plant, Hemofarm. Katarina obtained her PhD (2000-2004) from the School of Chemical Engineering and Advanced Materials, Newcastle University, where she gained expertise in the area of mathematical modelling and simulation of polymerisation processes in a Spinning Disc Reactor. Subsequently, Katarina continued working at Newcastle University and began to study the oxidative carbonylation reaction and achieved reproducible oscillations in both pH and heat output. Katarina's efforts in this area resulted in a five year EPSRC Career Acceleration Fellowship awarded in 2009 (CAF2009). Building on the outcomes from CAF2009, in 2012 Katarina was awarded further funding via the EPSRC Developing Leaders award. At that time Katarina entered the area of stimuli responsive hydrogels, her research group pursues as injectable and implantable forms. EPSRC support enabled Katarina to establish new directions in the area of intelligent polymeric materials and discover the world's first oscillatory chemical reaction employing a polymeric substrate. These findings accelerated to further developments and EPSRC Healthcare Technologies Impact Fellowship (2016) where Novakovic group achieved a proof-of-principle rhythmic material envisioned for application in hands-free drug delivery and mechanoresponsive tissue regeneration.

LIDIJA SILLER

Newcastle University, United Kingdom

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Bioinspired processes and materials for CO_2 mitigation

Prof Lidija Siller has obtained BSc in Physics (Zagreb, Croatia) and PhD in Physics (Cambridge University, UK). She was holder of four fellowships (EC Fellowship in Condensed Matter Physics (Italy), Royal Society Dorothy Hodgkin Fellowship (UK), EPSRC Fellowship (UK) and North Western University (USA)). She is Professor in Nanoscale Science and Head of the Advanced Materials and Electrochemical engineering Group in the School of Engineering at Newcastle University, UK. LŠ has published + 90 papers in peer-reviewed international journals and is a co-author of 7 patents out of which 3 have been licenced. LŠ has experience in working with industry in commercialisation of research outcomes. She is co-founder of a spinout company, Dragonfly Insulation Ltd. She has research interests in gold nitride, aerogels, electronic and optical properties of nanomaterials, nanotoxicology, water purification, carbon capture and mineralisation, bioinspired materials and processes.

URSZULA STACHEWICZ

AGH University of Science and Technology, Poland

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Biomimetic geometries and surface properties of electrospun polymer fibers for tissue engineering and skin care applications

Urszula Stachewicz is an associate professor at AGH University of Science and Technology in Krakow, Poland. She graduated from Delft University of Technology with PhD in electrohydrodynamic of liquids to use electrospray as an on-demand deposition method, with research performed at Philips Research Laboratories in Eindhoven, the Netherlands. She conducted the postdoctoral research at Queen Mary, University of London (UK) and work at spin-out company Nanoforce Technology Ltd. in polymer science and electrospun fibers. In 2018 she was a Visiting Fellow at the University of Cambridge at Department of Materials Science and Metallurgy, UK. Her research activity is focused on surface properties of electrospun fibers for biomedical and water and energy harvesting, and in situ mechanical testing of synthetic and naturally structured materials. She developed advanced 3D tomography protocols using focus ion beam and scanning electron microscopy (FIB-SEM) for nanofibrous biomaterials and membranes. In 2020 she has been awarded with the ERC starting grant. More information can be found at http://orcid.org/0000-0001-5102-8685.

WOJCIECH ŚWIĘSZKOWSKI

Warsaw University of Technology, Poland

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Biofabrication of functional and biomimetic 3D tissue-like constructs

Wojciech Swieszkowski, Ph.D. is a Professor in the Materials Design Division, Faculty of Materials Science and Engineering (MSE), Warsaw University of Technology (WUT), Poland. He is the Director of the MSE Materials Design Division and a Faculty Coordinator in the Erasmus Program. He has earned a PhD in Biomechanics and a Habilitation in Materials Science and Engineering at WUT. He was a Postdoctoral Researcher for 4-years at the Delft University of Technology (Delft, The Netherlands). He has been a Visiting Professor at several universities, including Harvard University, NIMS Japan, Università Politecnica delle Marche (Ancona, Italy), and TU Wien (Vienna, Austria).

He is an expert in the field of biofabrication and bioprinting, biomaterials for implants and tissue engineering, computational modeling, and the characterization of materials. He leads the BioMaterials Group (10 post doctorate and 10 PhD students, www.bio.materials.pl) at WUT. He has been the leader and project manager of 12 international and 17 national projects with total funding > 10M EURO. He has authored more than 170 publications, 16 book chapters, and 9 patents, with over 4200 citations, and h index =34 (Google Scholar). Some of his work products have been licensed to medical device companies. For example, a radial head endoprosthesis, produced in Poland, has been used to treat patients. One of his bone scaffold technologies has been used to treat dogs.

He has received several awards including: 1st Prize from the Prime Minister of Poland (2001) and Prizes from the Rector of WUT for scientific achievement (2011, 2012, 2013, 2014, 2017), the ICE Publishing Award 2017, the Mieczyslaw Wolfke's Prize of Warsaw University of Technology for scientific achievements (2017), the Kajal Mallick Memorial Prize, and the best paper prize in the journal Bioinspired, Biomimetic and Nanobiomaterials (BBN). That award-winning BBN paper was titled: "Fracture Safety of double-porous hydroxyapatite biomaterials".

He has been the doctoral advisor for 10 students who have earned the PhD and is the supervisor of 8 PhD doctoral students whose work is currently in progress. He has a supervised 40 BSc and MSc theses.

He has been invited for keynote lectures at several conferences, including: SELECTBIO: Tissue Engineering, Biofabrication & 3D-Bioprinting in Life Sciences (Boston, MA) 2016; TERMIS-AP (Taipei, Taiwan) 2016; ECI Conference on Biofabrication for Hierarchical in Vitro Tissue Models

(Hernstein, Austria) 2017; Biofabrication 2017, (Beijing, China); Biofabrication 2018 (Wurzburg, Germany), ESB2019 (Dresden, Germany).

He is a member of Tissue Engineering & Regenerative Medicine International Society-European Chapter (TERMIS-EU), the International Society of Biofabrication (ISBF) and Polish Society for Biomaterials. He is also a member of Editorial Board of the Journals: “Biofabrication”, “Journal of Medical and Biological Engineering”, and “Bio-Design and Manufacturing”. He was a Chair of EUROMAT 2015 in Warsaw, Poland. He has been a member of the Scientific Advisory Committee and organized sessions of several TERMIS conferences. Moreover, he was chairman of the 1st TERMIS EU Workshop on "3D Printing in Musculoskeletal Tissue Engineering” in Warsaw, Poland in March, 2018 and he is a chairman of TERMIS-EU 2022 in Poland.

RADOSŁAW WACH

Łódź University of Technology, Poland

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Radiation engineering of biobased hydrogels towards biodegradable medical devices

Radoslaw A. Wach, Ph.D., Eng. – assistant professor at the Institute of Applied Radiation Chemistry, Faculty of Chemistry, Lodz University of Technology

Eng. & M.Sc. in polymer technology (Lodz University of Technology, Poland), Ph.D. in chemical-biological engineering (Gunma University, Japan), industry experience at Chemical Works 'Organika' Lodz; post-docs at the University of Tokyo and Japan Atomic Energy Agency;

Expertize in basic and applied research of radiation-induced reactions and processes, synthetic and natural biodegradable polymers, sterilization of polymeric biomaterials and medical devices;

Manager or principal investigator of biomaterials-related R&D projects co-funded by European Union: Protec, Custom IMD (6FP); BIP-UPy (FP7); Optogenerapy (H2020) –leading biocompatibility & sterilization tasks; beneficiary of International Reintegration Grant (Marie Curie FP7); technical coordinator of BIP-UPy project (FP7)

Member of the Technical Committee for Sterilization of Polish Committee for Standardization (PKN); Expert of Polish Centre for Testing and Certification (PCBC)

Co-founder and member of the board of BioMatGel Co. Ltd.TBC

AGATA ZYKWINSKA

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Bacterial polysaccharides to mimic extracellular matrix of connective tissue

Agata Zykwinska is a physico-chemist of biopolymers at Ifremer, National Institute of Ocean Science in France. After graduating in Chemical Engineering from the Silesian University of Technology in 2002, Agata moved to France to undertake her PhD thesis at National Institute of Agricultural Research (INRA), defended in 2006. During her thesis, she worked on the elucidation of interactions between plant cell wall polysaccharides, namely pectin and cellulose. After a few postdoctoral fellowships, she joined Ifremer Atlantic Center in Nantes in 2013 to explore the potential of exopolysaccharides produced by marine bacteria as glycosaminoglycan-mimetics for biomedical applications, in particular in tissue engineering. She is involved in the elucidation of the relationship between the structure of the exopolysaccharides and their functional (biological, mechanical) properties.

ORAL PRESENTATIONS

ALEKSANDRA BENKO

Aleksandra Benko[1, 2*], David Medina-Cruz[2], Joanna Duch[3], Tadeusz Popiela[1], Sebastian Wilk[1], Marta Bińczak[1], Marek Nocuń[1], Elżbieta Menaszek[4], Luke D. Geoffrion[5], Grégory Guisbiers[5], Andrzej Kotarba[3], and Thomas J. Webster[2]

[1]AGH University of Science and Technology, Faculty of Materials Science and Ceramics, A. Mickiewicz 30 Ave. 30-059 Krakow, Poland
[2] Department of Chemical Engineering, Northeastern University, 360 Huntington Ave., Boston, MA, United States of America
[3] Faculty of Chemistry, Jagiellonian University, Gronostajowa 2, 30-387, Krakow, Poland
[4] Department of Cytobiology, Collegium Medicum, Jagiellonian University, 9 Medyczna St., 30-068 Krakow, Poland
[5] Department of Physics and Astronomy, University of Arkansas at Little Rock, 2801 South University Avenue, Little Rock, AR 72204, United States of America

Physicochemical and electrochemical determinants of the CNTs biocompatibility, antibacterial and anti-cancer properties

Carbon nanotubes (CNTs) are regarded as interesting candidates for the fabrication of a new generation of conductive and biologically-inspired tissue engineering scaffolds that, by combining multiple biomimetic cues and ability for electrical stimulation, could induce a positive reaction of cells, while providing excellent antibacterial and anticancer properties. In this study, 4 types of CNTs-based scaffolds (differing in morphology and chemical composition) were fabricated and their extensive evaluation allowed for identification of determinants of specific reactions of cells.

While all of the obtained materials were found to be cytocompatible in contact with mice and human cells, their antibacterial and anticancer properties were strictly related to their work function value and type and amount of functional groups present on their surface. Specifically, a ~50% depletion in the number of Gram-positive bacteria was observed on materials with lower work function, while Gram-negative bacteria were more sensitive toward carbon coordination number and presence of nitrogen atoms (cell depletion of up to 48% on amidized carbon nanotubes). After 1-day culture, >80% reduction in the melanoma cells number was observed. Both the antibacterial and anti-cancer properties correlated with with enhanced production of reactive oxygen species (ROS).

Due to the growing concerns over implant-related infections as well as growing rates of antibiotic-resistant bacteria and chemotherapeutic-resistant cancer cells, the present in vitro results of decreasing bacteria and cancer cell functions without negatively influencing mammalian cells nor using drugs demonstrates that the present all-carbon nanotube layers should pave the way for a wide range of biomedical applications.

Acknowledgements: This study has been supported by the National Science Center, Poland, under grant no. UMO-2017/24/C/ST8/00400. The authors would like to thank Sivasubramanian Somu of the George

J, Kostas Nanoscale Technology and Manufacturing Research Center, Northeastern University, for his valuable insights and instructions for performing the 4-point probe characterization. The authors would also like to thank Michal Dziadek of the AGH, University of Science and Technology for his help with statistical analysis.

EWELINA CICHOŃ

Ewelina Cichoń[a], Timothy Douglas[b, c], Joanna Czechowska[a], Anna Ślósarczyk[a], Aneta Zima[a]

[a] Faculty of Materials Science and Ceramics, AGH University of Science and Technology, Mickiewicza Av. 30, 30-059, Krakow, Poland
[b] Engineering Department, Lancaster University, Lancaster, UK
[c] Materials Science Institute (MSI), Lancaster University, Lancaster, UK

Whey protein isolate (WPI) as a prosperous additive to α-TCP based bone cements

Calcium phosphate cements (CPCs) are easily formable, chemically-bonded bone substitute materials. Their main drawback is the lack of macroporosity (>50 μm), preventing cell infiltration, neovascularisation and connection with the host tissue. To date, self-setting and porous CPCs have been developed using foaming agents such as surfactants, albumin, soybean and sucrose. Whey protein isolate (WPI) is widely used in the food industry as an emulsifying, thickening, gelling, water binding and foaming agent. Its foaming ability in CPCs can lead to the formation of pores.

In this study, a novel CPC with the whey protein isolate addition was obtained and developed. The solid phase of this material was highly reactive α-TCP powder obtained by a wet synthesis method. As the liquid phase, a foamed 2 wt.% solution of Na2HPO4 with the addition of WPI (80 g/L) was used. The liquid to powder ratio was 0.7 g/g. SEM observations confirmed the presence of numerous, mainly closed micro- and macropores within the investigated foamed cement. WPI addition led to the increase of the compressive strength. The open porosity decrease if compared with the control cement without the additive was noticed. This can be explained by the coating of the α-TCP grains and the closure of the pores by WPI.

Developed material with the addition of whey protein isolate can be a prosperous alternative to commonly used CPCs due to the presence of pores and beneficial mechanical properties. Moreover, WPI biodegradability can lead to a further increase in the porosity and consequently faster bone regeneration.

Acknowledgements: This study was supported by the National Science Centre, Poland (Project No. (017/27/N/ST8/00913). E.C. acknowledges financial support from the National Science Centre, Poland under Doctoral Scholarship No. 2019/32/T/ST5/00207. Research funded by the Faculty of Materials Science and Ceramics AGH UST - University of Science and Technology, Krakow, Poland, Project No. 16.16.160.557 (2020).

AGNIESZKA DROZDZ

Agnieszka Drozdz[1], Joanna Chwiej[1], Katarzyna Matusiak[1], Zuzanna Setkowicz[2], Aldona Kubala-Kukuś[3], Ilona Stabrawa[3], Christophe Sandt[4], Ferenc Borondics[4], Daniel Horak[5], Michal Babic[5]

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[3]Institute of Physics, Jan Kochanowski University and Holy Cross Cancer Center, Kielce, Poland
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The advanced spectroscopic methods in the study of the iron oxide nanoparticles influence on living organisms

Presented dissertation concerns verification of the usefulness of modern spectroscopic methods, namely total reflection X-ray fluorescence spectroscopy (TXRF) and Fourier transform infrared microspectroscopy (FTIR), for assessing of the iron oxides nanoparticles (IONP) influence on living organisms.In the experiment magnetite polyethylene-glycol-coated (PEG-IONP) and maghemite D-mannitol-coated nanoparticles (M-IONP) were used. Male Wistar rats were intravenously injected with low doses of the tested IONP. Elemental analysis, conducted with TXRF spectroscopy, revealed significant changes in Fe, Cu, Ca and Zn contents within examined organs for both of tested IONP types. The analysed nanoparticles differed in the hydrodynamic diameter, hence (by evaluation of the changes in Fe concentration) their different biodistribution as well as pharmacokinetics were observed. Furthermore the biological response to intravenous administration of nanoparticles, examined by analysis of changes in Cu, Ca and Zn contents, was different for each type of IONP. Applying the FTIR microspectroscopy enabled detection of long-term anomalies in accumulation and structure of the main biomolecules in liver and kidneys of animals exposed to the low dose of M-IONP.
Results obtained in frame of the dissertation are valuable complement to the current state of knowledge about the IONP impact on living organisms and prove the great possibilities of modern spectroscopic methods in the field of nanotoxicology.

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Multifunctional biomaterials loaded with polyphenolic compounds

Biomaterials with new levels of biofunctionality and tunable properties, that can meet complex requirements of bone tissue engineering, should be designed and developed. For this purpose, numerous active substances are used to modulate the response of the human body's environment. In this work, polymeric and bioactive glass (BG)-modified composite films were successfully loaded with polyphenols (PPh) extracted from sage. It was hypothesized that PPh, alone and in combination with BGs particles, would affect physicochemical and biological properties of the films. Furthermore, sol-gel-derived BG particles would serve as an agent for control the release of the polyphenolic compounds, and other important properties related to the presence of PPh. On the one hand, the results showed that PPh can be considered as plasticizers for PCL, on the other hand, they can act as coupling agent in composite materials, improving their mechanical performance. The presence of PPh in materials improved their hydrophilicity and apatite-forming ability, and also provided antioxidant activity. What is important is that the aforementioned properties and kinetics of PPh release can be modulated by the use of various concentrations of PPh, and by the modification of PCL matrix with BG particles, capable of binding PPh. The films exhibited cytocompatibility, significantly increased alkaline phosphatase activity and the expression of osteocalcin and osteopontin in osteoblasts, while they reduced intracellular reactive oxygen species production in macrophages. Furthermore, materials loaded with PPh showed antibiofilm properties against Gram-positive and Gram-negative bacteria.

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Study of the interface of O/W emulsions stabilized by beta-lactoglobulin fibrils at pH 2 by site directed spin labelling and electron paramagnetic resonance

The use of fibrillated proteins as an emulsifier in food preparations is an excellent way to improve the technological capabilities of ingredients. O/W emulsions stabilized by β-lg fibrils were analysed by side directed spin labelling and EPR spectroscopy at pH 2. The samples were prepared with native β-lg, fibrillated β-lg and both “amyloid” and “non-amyloid” fractions of fibrillated β-lg in water emulsion of MCT oil. The concentrations of emulsifier used were mainly 0.2 wt. % and 1 wt. %. In addition, the spectra were simulated to obtain information about the structure at the interface. The results showed that there were no differences in the protein conformation in the fibrillated β-lg samples between the aqueous phase and the interface. In particular, the rotational correlation time does not change in any of the protein populations, maintaining a value of 6.68 ± 0.40 ns. On the contrary, for the native protein, a decrease in the rotation correlation time in the interface was shown compared to the aqueous phase, synonymous with an interface denaturation. In addition, the better emulsifying capacity of unreacted peptides compared to all other physical protein organizations was highlighted. Eventually, the effectiveness of the freeze drying method in concentrating the peptides derived from the fibrillation process was evaluated.

MAGDALENA GŁĄB

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Physicochemical and biological analysis of hydroxyapatite for bone tissue regeneration

In recent years, the problem of an aging society has been mentioned very often. Appropriate forecasts indicate that the aging process will be very accelerated in the coming years. As a consequence, the number of people with serious health problems will increase. It is assumed that the skeletal system diseases will have a significant role. Therefore, research on the development of new solutions in bone tissue engineering is important.

A material of particular importance in bone tissue engineering is hydroxyapatite (HAp) - a material corresponding to the chemical composition of an inorganic part of bone. It is characterized by biocompatibility and osteoinduction. This study presents hydroxyapatite obtained in the wet precipitation method. Calcium phosphates obtained as a result of the synthesis were subjected to analyzes determining their physicochemical properties, including the degree of crystallinity and surface structure. The chemical structure of the powders was determined by FT-IR analysis (Fourier Transform Infrared Spectroscopy). In addition, biological studies were carried out to determine the cytotoxic properties. The stability of the suspension of hydroxyapatite in distilled water was also checked. The conducted analyzes provided information on the possibility of using HAp to obtain composite materials intended for bone tissue regeneration.

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Application of ATR-FTIR spectroscopic imaging in assessment of collagen maturity and mineralization in mesenchymal stem cells cultured on the hydroxyapatite-based bone scaffold

Bone tissue engineering products such as implants are rapidly developing field of regenerative medicine. It aims for very high bioactivity, surgical handiness and biocompatibility of implantable biomaterial. That can be achieved with mixing compounds of different properties as a scaffold and subsequently seeding mesenchymal cells for accelerated regeneration. The aim of this work was to use the macro ATR FTIR spectroscopic imaging for analysis of the ceramic-based biomaterial (chitosan/β-1,3-glucan/hydroxyapatite) with culture of mesenchymal cells derived from adipose tissue (ADSCs) and bone marrow (BMDSCs) on the surface. Infrared spectroscopy allows the acquisition of information on both the organic and inorganic parts of the tested composite. This innovative spectroscopic approach proved to be very suitable for studying the formation of new bone tissue and ECM components, sample staining and demineralization are not required and consequently the approach is rapid and cost-effective. The novelty of this study focuses on the innovatory use of ATR-FTIR imaging to evaluate the molecular structure and maturity of collagen as well as mineral matrix formation and crystallization in the context of bone regenerative medicine. Results of ADSCs and BMDSCs activity have been evaluated in terms of collagen production and mineralization and also collagen maturation by use of FTIR with macro ATR accessory. Chitosan/β-1,3-glucan/hydroxyapatite biomaterial with mesenchymal stem cells is promising for biomedical application as a highly biocompatible bone implant. In addition, ATR FTIR spectroscopic imaging is an excellent technique to determine both the organic and mineral content of biological samples and ceramic sample respectively simultaneously during one measurement.

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MATEUSZ KAWKA

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Bifunctional constructs for *in vitro* transgenic roots immobilization and *in situ* product extraction

In vitro cultured plant biomass is recognized as suitable source of pharmaceutically relevant bioactive compounds, according to unique biosynthetic abilities exhibiting by plant cells and/or organs. Nowadays, bioengineering of plant biomass culture systems (e.g. biomass immobilization, target metabolite extraction) leads to higher yields of secondary metabolites extracellularly secreted from cells/organs of endemic plant species. One group of high-value bioproducts detected in many plant species is naphthoquinones (NQs), i.e. lipophilic secondary metabolites originated from bicyclic naphthalene. Aim of the study was to examine silica aerogels (SA) and polyurethane foam (PUF) as bifunctional materials, which simultaneously support *in situ* immobilization of biomass and *in situ* adsorption of NQs, in cultures of *Rindera graeca* (*Boraginaceae* family) transgenic (i.e. hairy) roots.

Hairy roots were simultaneously cultured for 28-days in DCR medium in three independent culture systems: (i) non-immobilized biomass (as reference), as well as biomass immobilized on porous solid constructs made of (ii) SA and (iii) PUF. For every system, the concentration of NQs was quantitatively monitored in extracts obtained independently from: hairy roots, porous constructs (if applied) and culture media, according to HPLC UV-VIS/DAD methodology.

SA and PUF exhibited biocompatibility toward *R. graeca* hairy roots. SA constructs significantly promoted the proliferation of hairy roots, which resulted in 4.33x higher fresh mass of roots compared to the reference system. Furthermore, SA-supported cultures resulted in altered phytochemical characteristic of extracts. The highest level of NQs productivity, i.e. 3.774 mg $g_{dry\ mass}^{-1}$, was noted for *R. graeca* roots on PUF at 3.34x decrease in biomass production.

PAULINA KAZIMIERCZAK

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Osteoconductive and osteoinductive properties of highly macroporous hydroxyapatite-based bone scaffold

Highly macroporous biomaterials with three-dimensional structure are commonly used in regenerative medicine and bone tissue engineering. Their primary role is to provide sufficient space for migration and proliferation of cells as well as to enable new bone tissue ingrowth and implant vascularization. Moreover, scaffolds for bone tissue engineering should possess osteoconductive and osteoinductive properties. The aim of this study was to produce a macroporous biomaterial composed of chitosan-agarose matrix and nanohydroxyapatite with osteoconductive and osteoinductive ability. In this study, we demonstrated that fabricated biomaterial is non-toxic against osteoblasts [1-2] and supports cells adhesion, spreading and proliferation on its surface [3]. Moreover, developed bone scaffold fovour protein adsorption with the highest affinity toward fibronectin [3]. Importantly, chitosan/agarose/nanohydroxyapatite biomaterial has osteoinductive properties since it induces osteogenic differentiation in mesenchymal stem cells [3]. Thus, produced novel biomaterial is characterized by osteoconductive and osteoinductive ability and may be used as a bone scaffold in regenerative medicine and bone tissue engineering to enhance bone fracture healing.

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Vibrational spectroscopic analysis of diabetes and its correlation with oral cancer using saliva samples

Diabetes is a public health issue, with its different types and glucose intolerance it has huge global impact on health. Whereas, oral cancer is the 8th most frequent cancer worldwide that involves, gums, lips, tongue, hard and soft palate and soft tissues of oral mucosa. Diabetes and cancer diagnosed in same individual is more usual than expected. There are risk factors which are common to both diseases. The direct impact of diabetes on oral health such as mucosal fibrosis (thickening of the mucosa), ulceration, gum disease, tooth decay, infection and alterations to oral micro-flora may contribute directly to the development of oral cancer. Saliva being a versatile unique biofluid is the most convenient way of all the availabilities because it can be collected noninvasively, it is cost effective, with minimal risk of infections and no issues of shipping and storage. Vibrational spectroscopic techniques, which rely on the interaction of light with the matter, as well as histopathology might be able to be used for the detection and development of biomarkers for diseases.

The aim of this study is to see the association between diabetes and oral cancer incidence and prognosis through oral cancer biopsy analysis through histopathology and vibrational spectroscopy. For this prospective cohort study, the saliva samples and biopsies was obtained from the diseased and healthy cohorts. Spectral data from Fourier transform infrared spectroscopy (FTIR) by accumulating scans was processed and analysed in Origin Pro which showed significant spectral peak differences between healthy and diabetic group and gave us the insight for our study.

MARCIN KOTLARZ

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Bioprinting of natural cell-laden hydrogel coatings to enhance osseointegration of metal implants

Upon implantation of a metal implant, a cascade of events occurs at the bone-metal interface. The implant surface serves as a powerful signalling cue for cells. Its characteristics have an important role in promoting the early osseointegration by encouraging bone deposition and stabilising bone-implant interface. In this work, we show the application of a bioprinting technique called Reactive Jet Impingement[1] (ReJI) to directly deposit cell-laden hydrogels onto metallic implants, intending to enhance osseointegration through providing a cell-laden layer on the surface of the implant.

Tri-component hydrogels consisting of collagen, alginate and fibrin[2] loaded with 4 x 10^7 cells/ml of human TERT immortalised bone marrow stromal cells were deposited onto Ti6Al4V ELI titanium alloy surfaces with varying surface morphology and surface roughness. The cell-laden hydrogel/metal constructs were evaluated using immunofluorescence, Alizarin Red and SEM.

High cell viability was observed at day 1 indicating that the bioprinting process did not affect the viability. Cellular morphology and organisation were influenced by surface characteristics. All the Ti6Al4V ELI surfaces studied supported cell attachment and migration. Direct cell-metal interactions were visible from day 1. SEM observations and Alizarin Red indicated cell mineralisation in the areas were the hydrogels were deposited.

The ReJI system allowed for direct bioprinting onto substrates with various surface features and roughness. High cell densities encouraged quick cell-biomaterial interactions at the interface leading to the formation of a layer of functional bone-like tissue on the titanium alloy surfaces.

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Development of amine-rich coatings for antimicrobial applications

The World Health Organization estimates that out of 100 hospitalised patients, 7 in developed and 10 in developing countries will acquire at least one healthcare-associated infection (HCAI). HCAIs are infections acquired during a stay in hospitals and represent one of the main leading cause of death. It is estimated that by 2050, every year, 10 million of people will die because of HCAIs due to the antimicrobial resistance problem. Moreover, these infections lead to a financial loss of about €7 billion in Europe. Thus, there is a growing need to develop new strategies to avoid the increase of HCAIs.
Amine (NH_2) groups are known to promote cell adhesion, proliferation, and osteogenic differentiation. For the implantation of medical device, this advantage is really important as it will determine the tissue integration of the device. Another advantage is that they can be used for biomolecules immobilization, such as antibacterial agents.
In this project, different techniques to obtain NH_2 groups will be tested, such as protein or plasma coatings. Then, all the coatings will be physicochemically characterised and microbiological tests will be performed to compare their efficiency. The general strategy of this project including each coating technique and their preliminary results will be presented.

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Nanodiamond Magnetometry for free radicals detection in sperm cells

The free radical theory of infertility is derived from the more general free radical theory of ageing. It states that free radicals are the reason why sperms become dysfunctional. Additionally, free radicals or oxidative stress are expected to be linked to various pathogenic conditions which impact male fertility. Some free radicals are also needed to maintain crucial functions in sperms including sperm capacitation, the acrosome reaction, and sperm-oocyte fusion. However, despite their undeniable importance we know relatively little about where free radicals are generated exactly, which ones play a role or if we can alter their generation. Unfortunately, free radicals are short lived and reactive and thus very difficult to detect with the state of the art methods. As a result, detecting radicals is despite the enormous potential not used as clinical marker. Nanodiamond magnetometry potentially offers a complementary solution. It allows to measure nanoscale magnetic resonance signals with unprecedented sensitivity using the fluorescent nanodiamond (FND) probes. This is possible due to presence of nitrogen-vacancy centers (NVs) in a crystalline structure of FNDs. Since free radicals have a free electron spin, they cause a magnetic noise which can be measured and read out as an optical signal. In this study we have shown for the first time that fluorescent nanodiamonds can be used as probes for detection of free radicals in single sperm cells.

MALWINA NIEDŹWIEDŹ

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Fatty Acid-Based Injectable Biomaterials For Soft Tissue Engineering

Soft tissue loss or injury often requires reconstructive surgery [1], where natural autologous grafts are most frequently applied. On the other hand, rapid development of tissue engineering providing natural or synthetic materials for cell/tissue support and regeneration has emerged, and here collagen [2], fibrin [3], hyaluronic acid [4] and fatty acid-based derivatives [5,6] are the materials of choice. Their physical and chemical properties can easily be adjusted and selected in a way to overcome the complications and provide truly biocompatible and biomimetic materials.

A great promise for reconstructive surgery are injectable materials which can be easily delivered to target tissue using minimally invasive surgical protocols. Therefore, in our work we have developed an injectable and photocurable non-toxic fatty acid-based telechelic macromonomers for soft tissue engineering applications. The obtained materials were characterized by FT-IR, 1H-NMR and GPC. The in vitro cytocompatibility revealed non-toxic effect of the extracts on L-929 mouse fibroblasts. The photopolymerization of difunctional precursors has allowed to produce flexible and elastomeric materials with mechanical strength matching that of soft tissue.

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Bioinspired synthesis of monodisperse and multifunctional porous silica nanoparticles for drug delivery

Porous silica nanoparticles (PSiNPs) are highly attractive for drug delivery due to their ease of synthesis, excellent biocompatibility, large surface areas, and tuneable surface properties. Sub-100 nm PSiNPs are of interest for drug delivery applications as the size range is optimal for preventing premature clearance, promoting tumour accumulation via the enhanced permeation and retention effect, and increasing cellular uptake. However, conventional methods used to prepare sub-100 nm PSiNPs typically results in poor particle uniformity and reproducibility. Furthermore, multiple synthetic steps are required to impart additional functionalities such as cancer targeting and stimuli-responsive properties, which add to the time and cost of synthesis. Here, we report a facile, bioinspired one-pot method for the synthesis of cancer targeting and pH-responsive PSiNPs in the sub-100 nm range. With the judicious choice of oppositely charged polymer/amino acid pairs and the use of alcohols, monodisperse polyelectrolyte complexes (PECs) could be utilised as soft templates for silane hydrolysis and condensation. Highly uniform PSiNPs with tuneable diameters between 42 – 178 nm and disordered pore structures (1.1 – 2.7 nm) were obtained. Importantly, the retention of the PEC constituents within the PSiNPs enabled a high doxorubicin hydrochloride (Dox) loading (22 % w/w) and resulted in 4-fold increase in drug release under weakly acidic conditions. The surface presentation of the amino acids conferred targeting of patient-derived glioblastoma cells, which effectively led to lower IC50 values for the functionalised Dox-loaded PSiNPs. This work brings forward new insights for the development of monodisperse PSiNPs with highly desirable built-in functionalities for biomedical applications.

CARMEN CRISTINA PIRAS

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Supramolecular hybrid microgels for biological applications

Hydrogels with spatio-temporally controlled properties are appealing platforms for biological and pharmaceutical applications. We herein report multicomponent hybrid gel beads formed by a low molecular weight gelator (LMWG) based on the dibenzylidene sorbitol (DBS) framework (namely 1,3:2:4-di(4-acylhydrazide)-benzylidene sorbitol (DBS-$CONHNH_2$)) and the biopolymer alginate, in which the spatial arrangement of the two networks could be directed.[1] DBS-$CONHNH_2$ is a thermally triggered LMWG that self-assembles in response to a heat-cool cycle. Alginate forms hydrogels when cross-linked with multivalent cations (*e.g.* Ca^{2+}). Since the two gelators have orthogonal methods of preparation, a specific spatial arrangement of the two networks within the hybrid gel beads could be imposed by temporally controlling the gelation process, forming (1) core-shell structured gels or (2) interpenetrated networks. Interpenetrated gel beads were obtained by an emulsion method that could be adapted to give spherical gel particles of controllable sizes with diameters in the mm or μm range (respectively milli- and micro- beads). The prepared microbeads have reproducible diameters around 800 nm and are stable in water at room temperature for months. We applied these innovative gel microbeads for the release of the bioactive molecule heparin. The hybrid microgel beads could successfully retain and release heparin in cell culture medium in the presence of human mesenchymal stem cells, impacting cell growth. Such formulations may be a sophisticated versatile platform for applications in tissue engineering and regenerative medicine.

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Microcapsules with herbal preparations for dermatological applications

Viola tricolor is a common European wildflower, commonly occurring in Poland. This herbal plant contains numerous biologically active compounds such as flavonoids, carotenoids, anthocyanidins, coumarins, saponins and tannins. *Viola tricolor* has been recognized in Polish traditional folk medicine and herbalism for its beneficial effects on the skin, including regenerating, soothing, antioxidant and anti-inflammatory properties. Today, this raw material is somewhat forgotten due to the "pursuit" of new, exotic plant materials.

The main goal of the research was to optimize the preparation method, size and composition of the microcapsules.

The herb of *Viola tricolor* was prepared by different methods of processing plant materials, namely as an extract, decoction and infusion. Afterwards, the herbal preparations were enclosed in microcapsule shells that increase the efficiency of the penetration of the substance into the deeper skin layers. Microcapsules composed of natural polymers were prepared by the extrusion method. The size distribution, morphology, loading capacity and *in vitro* release profile of polyphenols were determined. Developed microcapsules may find an application in dermatological products intended to combat the side effects induced by anticancer therapy, which are evident as drastic deterioration of the skin.

KATARZYNA RECZYŃSKA

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Stimuli-sensitive fatty acid-based microparticles for the treatment of lung cancer

Lung cancer is one of the most lethal types of cancer. Since it is believed that conventional methods of treatment reached their maximal therapeutic efficiency, there is an urgent need for novel and more effective treatment options. Thus, the aim of the study was to develop a stimuli-sensitive, inhalable anticancer drug delivery system based on fatty acid microparticles loaded with magnetic nanoparticles (NPs) and paclitaxel (PAX). The microparticles were manufactured from lauric acid (LAU) and an eutectic mixture of myristic and palmitic acids (mass ratio: 58/42, MYR/PAL) using optimized oil-in-water emulsification method. It was possible to obtain homogenous batch of microparticles with average particle size ranging from 2.0 μm to 3.2 μm measured by dynamic light scattering method. PAX loading efficacy was determined using high performance liquid chromatography and was 4.9 ± 0.1% and 5.9 ± 0.4 % for LAU-based and MYR/PAL-based microparticles, respectively. Drug loaded microparticles effectively suppressed the growth of malignant lung epithelial cells (A549), which was confirmed by metabolic activity tests, live/dead staining and clonogenic assay. In simulated hyperthermia conditions, the decrease in cell viability was more pronounced for LAU-based MPs due to more appropriate melting temperature of the MPs and facilitated PAX release.

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ANDREW REID

Mr Andrew Reid (QUB), Dr Pamela Walsh (QUB), Professor Fraser Buchanan (QUB), Professor Matt Julius (St Cloud State University, USA)

Manipulating the chemistry and nanotopography of cultured diatoms for bone regenerative technologies

Diatoms are a class (*Bacillariophyceae*) of eukaryotic microalgae. They are unique in that their cell walls (frustules) are composed of biogenic silica and have very intricate structures. Their frustules are highly porous, nanopatterned and have a large surface area (~10 - 300m^2g^{-1}) and are identically replicated between generations. Additionally, it has been shown that diatoms have the ability to incorporate material other than silica into their frustule, allowing for doped frustules for added functionality.

The ability to modify the diatom frustule *in vivo* opens the possibility for new functionalised biomaterials which can be tailored for the desired application. It may offer a novel approach to highly porous silica nanomaterials with multiple key benefits and may lead to the development of a new implantable material for bone regeneration.

We plan to chemically modify the frustule of *Cyclotella meneghiniana* with Magnesium^{2+} and Strontium^{2+} ions (which are beneficial for bone growth), then optimise the growth for the maximum uptake of each ion. We will then characterise the doped diatoms with a vast array of analytical techniques, including SEM, EDSX, AFM, ICP & TGA, to determine the extent & location of the ion incorporation. Finally, we will study the dissolution of ions from the doped frustules, and the rate of their decomposition. It is well documented within the literature that an "*in-vivo* feeding" approach has been successful in incorporating various metals, such as Calcium, Germanium, Iron and Titanium into the frustules of diatoms, which is good supporting evidence for the viability of our research.

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Smart hydrogels for personalised hands free drug delivery

The investigations of biological-nanomaterial properties (mechanical, thermal, electrical, optical and catalytic) have always been a challenge. Thus modelling using mono and multilayers of nanomaterials are often used to mimic the structures found in the nature. The combination of nanoparticles and biomolecules is of great interest in the field of electroanalysis. Since nanoparticles display a large surface area, good molecular biocompatibility and often good conductivity, they are widely used to immobilise biomolecules. With this motivation in mind we have used layer by layer method to investigate the electrochemistry of silver nanoparticle (AgNPs) layer in poly-L-lysine (PLL) assembled layer. The effect of bovine serum albumin (BSA) in the AgNP/PLL layers and in buffer solutions on the Ag/AgCl electrochemistry of AgNPs has been studied.

The stripping of silver nanoparticles covering a monolayer of poly-L-lysine (PLL) formed at pH 4.00 gave highest AgNP amount on the PLL surface if compared with PLL adsorbed on gold from solution with pH 7.01 and 9.01. In this study we for the first time show that PLL/AgNP layers terminated with PLL allow Ag^+ ion interaction with BSA in solution. The effect was not possible to detect if BSA was surface confined by including it into layer-by-layer structures. This result might be important for developing electrochemically controlled, antimicrobial, Ag ion delivery formulations.

DAGMARA SŁOTA

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Protein-based composite hydrogels for bone tissue regeneration

Whey protein isolate (WPI) is one of the by-products of the dairy industry. However, it is characterized by an impressive biological value and in the culture medium, it supports the proliferation of Saosa-2 cells resembling human osteoblasts. At elevated temperature, the WPI solution undergoes the process of gelation, creating a three-dimensional network. Hydrogels obtained in this way can be used in tissue engineering, due to their biocompatibility, but most of all structural similarity to the extracellular matrix. Moreover, their unique structure facilitates modification through the introduction of active substances. However, hydrogel itself does not show sufficient mechanical strength to be used for bone tissue regeneration, although the suspension of ceramics in the WPI matrix increases the strength of the biomaterial.

The ceramic phase in the presented studies was hydroxyapatite (HAp). This material was chosen because of its impressive bioactivity, biocompatibility, osteoinduction as well as osteoconduction. The aim of this work was the synthesis of hydrogels based on a 40% solution of whey protein isolate, which was subjected to gelation at elevated temperature. The obtained WPI/HAp hydrogels were evaluated by physicochemical as well as microbiological analysis.

Acknowledgements: The “Multifunctional biologically active composites for applications in regenerative bone system medicine” project is carried out within the TEAM-NET program of the Foundation for Polish Science financed by the European Union under the European Regional Development Fund.

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Biocompatibility of polyimide (PI) electrospun membrane

Polyimide (PI) as a very rigid polymer is mostly used for aerospace industry, microelectronics and other industrial applications. Despite that, the PI films are considered as a biocompatible material. In our research we performed biocompatibility tests of PI films and electrospun fibers. The electrospinning is a process that produces very thin fibers which collected create a porous membrane. Such membranes from polymer fibers are characterized with high surface area to volume or mass ratio. The porosity of such membranes is very high, reaching 96%. The spaces between fibers may be filled up with a potential drug. The bandages with a drug may be applied externally to the skin, the drug may then release in a controlled way and heal the skin. Therefore, the electrospun membranes are an excellent material for biomedical application.

To confirm the biocompatibility of PI we performed cell culture on the PI samples up to 7 days. The obtained results after 1st, 3rd and 7th day of incubation were verified using scanning electron microscopy (SEM), confocal laser scanning microscopy (CLSM) and the MTS cells viability assay. All these results confirmed both PI films and PI fibers biocompatibility.

Acknowledgements: This study was conducted within Nanofiber-based sponges for atopic skin treatment project, carried out within the First TEAM program of the Foundation for Polish Science co-financed by the European Union under the European Regional Development Fund, project no POIR.04.04.00-00- 4571/17-00

MARK SULLIVAN

Mark V. Sullivan - De Montfort University, Micheal P. Moazami - UMass Medical School, Oliver Clay – De Montfort University, Jonathan K. Watts – UMass Medical School, Nicholas W. Turner – De Montfort University

Hybrid Aptamer-Molecularly Imprinted Polymer (aptaMIP) Nanoparticles from Protein Recognition – a Trypsin Model

Molecular recognition is a highly important feature of analytical science and usually comes from a biological element, such as enzymes, antibodies and DNA. While aptamers (short strands of DNA), offer excellent recognitions properties, their performance and environmental stability is low and this can compromise their uses, with environmental degradation being a particular problem. Artificial recognition material alternatives have been used to combat these derogatory issues, with molecular imprinted polymers (MIP) at the forefront of this technology. While MIPs offer the robustness and ability to work in extreme environmental conditions, not seen with aptamers, they often lack the same recognition specificity of biological elements. By slightly adapting the chemical structure of the aptamer DNA we have incorporated an aptamer for use as the recognition part of a MIP, thus creating an aptamer-MIP hybrid. Here we have developed novel aptamer-MIP hybrid nanoparticles (aptaMIPs) for the detection of the target protein trypsin. The aptaMIP nanoparticles offer superior binding affinity over a conventional MIP nanoparticles (nanoMIPs), with K_D values of 6.8×10^{-9} M and 10.3×10^{-9} M for the aptaMIP and nanoMIP, respectively. When applied to a sensor platform (Surface Plasmon Resonance), the limit of detection based on the aptaMIP nanoparticles was fivefold lower (2nM) compared to the nanoMIP (10 nM). The introduction of the aptamer as a “macro-monomer” has beneficial effects and offers potential to improve this class of polymers significantly.

SAM SWINGLER

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Bacterial cellulose: Natures Band-Aid

One of the most abundant polymeric materials that can be found in nature is cellulose, being found in all plant life, and produced by several microbial organisms. (Park *et al*., 2019). Moreover, the production of cellulose can also be obtained by fungi, seaweed and some bacterial species- most notably, *Komagateibacter xylinus* (Bernardelli de Mattos *et al.,* 2020).

Biomedical devices made from bacterial cellulose exhibit key characteristics such as; maintaining moist wound environments, allowing sufficient gaseous exchange, absorption of blood and exudate, low tissue adherence and thermal insulation. The need for all these conditions to be met in order to produce a superior biomaterial, the design and manufacture of the bacterial cellulose needs to have a sufficiently interactive surface to allow for cell contact (Gupta *et al.,* 2020; (Swingler *et al.,* 2019).

The relationship between somatic cells and the bacterial cellulose plays a critical role in the performance of *in vivo* biomaterials which have been developed for implants, drug delivery systems, wound healing, scaffolds and tissue/organ regeneration (Anton-Sales *et al.,* 2019).

Bioengineered materials such as bacterial cellulose which increase cellular adhesion, promotes proliferation, migration and the eventual differentiation of cells, thereby, increasing the rate of re-epithelialisation leading to faster healing wounds, stands at the foreground of regenerative medicine (Sajjad *et al.,* 2019).

Bacterial cellulose demonstrates characteristics that are congruent in combining macromolecular and surface properties, which are crucial for *in vivo* and *in vitro* biomedical applications. Subsequently, bacterial cellulose has been shown to be a prominent novel biomaterial for biomedical exploitation (Hickey and Pelling, 2019).

VLADYSLAV VIVCHARENKO

Vladyslav Vivcharenko, Paulina Kazimierczak, Michał Wójcik, Agata Przekora

Department of Biochemistry and Biotechnology, Medical University of Lublin, Poland

Superabsorbent foam-like chitosan/agarose based biomaterial for external wound dressing application

Biomaterial engineering as a progressive field of science changes the approach to the wound management by introducing alternative possibilities for skin injuries healing by the use of bioactive wound dressing. The aim of this study was to develop a new, superabsorbent, biocompatible external wound bandage based on agarose and chitosan for potential applications in exuding wound management. In conducted study, a foam-like biomaterial with characteristics of promising wound dressing was produced. Biomaterial based on two polysaccharides was non-toxic to the cells and did not promote their adhesion to its surface, which means that it will deprive the patient of painful removal after the regeneration process. Due to the fact that foam-like chitosan/agarose biomaterial had high absorption properties, its external use will ensure adequate humidity at the wound bed and enable the removal of heavy exudates. Its degradation properties in conditions imitating the chronic wound environment were also confirmed. All mentioned features mean that the material produced using agarose and chitosan can be potentially used for repairing of continuity or skin tissue injuries characterized by high exudate.

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MICHAL WOJASIŃSKI

Michał Wojasiński, Joanna Latocha, Paweł Sobieszuk, Tomasz Ciach

Lecithin-based modification of hydroxyapatite nanoparticles – bioinspired coating

Lecithin – zwitterionic surfactant, a mixture of phosphatidylcholines ubiquitous in cellular membranes of mammals, can be applied to control hydroxyapatite nanoparticles (nHAp) precipitation. Thanks to its properties, lecithin prevents crystals growth and allows the formation of amorphous nHAp, additionally modifying the resulting particles' surface properties. We investigated lecithin's influence on nHAp particles' properties in semi-batch and continuous precipitation. We assessed the influence of lecithin concentration, precipitation temperature, and pH on particles' morphological properties precipitated in the semi-batch process. While for the product of a continuous process, we evaluated the influence of lecithin concentration and aging conditions. All hydroxyapatite nanoparticles modified with lecithin (nHAp-LE) powders underwent the cytotoxicity evaluation using MTT assay and various particles' concentrations in culturing media. Size and morphology of semi-batch precipitate depend mostly on lecithin concentration and temperature, while pH affects the composition of resulting nHAp-LE. Semi-batch precipitated nHAp-LE became spherical for the highest lecithin concentration, and the size of the spheres was in the range from about 80 to 100 nm. On the contrary, in a continuous process, lecithin concentration affects the only size of nHAp-LE particles, regardless of the aging conditions. The morphology of continuously precipitated nHAp-LE remains spherical for all tested precipitation and aging conditions. The size of continuously precipitated nHAp particles was in the range from about 10 to about 20 nm. Only continuously precipitated nHAp-LE particles showed non-cytotoxic properties according to MTT test results. Nevertheless, the presented results show that lecithin-based bioinspired precipitation processes give modified hydroxyapatite nanoparticles with defined properties.

POSTER PRESENTATIONS

SHERIHAN GALAL ABDELHAMID

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Poster 1: Hydroxychloroquine Delivery Using Gelatin-Based Systems For Combating COVID-19: Bio/chemoinformatics Case Study

Background: Hydroxychloroquine(HCQ) is undergoing several clinical trials for evaluating its efficacy and safety as an antiviral. Yet, there is still a great debate about their efficacy in combating COVID-19. We hereby, hypothesize the success of the intranasal and the pulmonary routes through a gelatin matrix to overcome a lot of its pharmacodynamic and pharmacokinetic challenges and to increase their local concentrations at the sites of initial viral entry while minimizing the side effects.

Methods: Molecular dynamic simulation of a gelatin matrix was performed. Molecular docking of HCQ on this simulated carrier and on mucin as well as various receptors including Angiotensin-converting enzyme 2 (ACE-2), heparin sulphate proteoglycan and Phosphatidylinositol binding clathrin assembly protein (PICALM), which are expressed in the lung and intranasal tissues and represent initial sites of attachment of the viral particles to the surface of respiratory cells was accomplished.

Results: Molecular docking on the gelatin-simulated matrix proposed high loading and a sustained release profile. Moreover, strong binding to all the investigated receptors was obtained.

Conclusions: The presented data provide insight into the rational for an intranasal or pulmonary HCQ formulation aiming for a sustained prophylaxis effect and/or a treatment strategy against COVID-19 pandemic viral infection.

ADRIANNA BARASIŃSKA

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Poster 2: Assessment of changes in the properties of medical devices manufactured from poly(lactic acid) (PLA) as a result of degradation processes

Degradation of polymeric materials is an extremely dynamic process during which the physico-chemical, mechanical and biological properties are changing. The condition of use the biodegradable implant in the human body is to maintain its excellent biocompatibility and adapt the appropriate time and kinetics of the disintegration mechanism to the progressive process of healing and regeneration of tissues. Currently, due to the high biocompatibility and non-toxicity of degradation products, poly(lactic acid), which belongs to biodegradable aliphatic polyesters, is very often used in clinical applications. In an in vivo environment, it undergoes hydrolytic degradation. The aim of the research was to assess the impact of degradation processes on the properties of poly(lactic acid), from which biodegradable elements of intramedullary nails are made. The implants were incubated in conditions reflecting the natural environment of the body for following periods of time: 2, 14, 30, 60, 90 and 180 days. After subsequent periods of degradation were carried out analyzes of changes in physical properties of implants, changes in the chemical structure of polylactide, changes in mechanical properties and the evaluation of the biological evaluation by in vitro cytotoxicity tests. The results of the tests presented that during the degradation process of poly(L-lactide) increases the crystallinity of the polymer, which results in an increase in hardness and improvement of strength properties. Obtained results also proved the occurrence of a repetitive process of heterogeneous mass erosion during the six-month incubation period. Biological tests have not shown the cytotoxic effect of poly(L-lactide) on human osteoblast cells.

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MICHAL BARTMAŃSKI

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Poster 3: Chitosan/nanosilver composites coatings produced by electrophoretic deposition methods on anodized titanium alloy

The bacterial infection is one of the reasons of loosening the implants. To ensure bactericidal properties of implants surface, the silver or nanosilver particles are often used. The currently applied modification method is based on the decoration of calcium phosphate coatings with the silver/nanosilver element. However, such a modification does not provide an antibacterial effect throughout the life of the implant, but only in the initial phase after implantation. The titanium surface treatment proposed in the research, thanks to the use of a polymer matrix sensitive to pH change and a presence of dispersed silver nanoparticles, is able to provide "intelligent" protection only in the event of inflammation. The poster presents the results for chitosan coatings deposited by electrophoretic method on the oxidized titanium alloy Ti13Zr13Nb. To ensure antibacterial properties, silver nanoparticles were applied and an appropriate dispersant was used to avoid their agglomeration. The microstructural studies show a positive effect of the dispersant on the distribution of silver nanoparticles in the coating and on surface topography. The effects of variable electrophoretic deposition parameters (current, voltage and the presence or the absence of dispersant) on nanomechanical properties (hardness, Young's modulus, and adhesion) determined by nanoindentation and nano-scratch techniques are demonstrated.

PATRYK BEZKOSTY

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Poster 4: Nanocomposite coatings on metallic substrates from SiOC-SiO_2 system

The refinement of surfaces with thin layers attracted increasingly interest in the field of biomaterials. Currently, not only tissue substrates that have a positive effect on cell adhesion or proliferation are sought. In some applications, such as medical devices and blood-contacting materials, the repellent surfaces are even desired. Blood is more challenging liquid to repel in comparison with water due to its high adhesion tendency to foreign surfaces by activating internal hemostatic mechanisms. However, in the vast majority of cases water-repellent materials are also repellent for blood. Generally, the repellency results from the topographical roughness at the nano- and microscale and it is also combined with low surface energy. Therefore, the aim of this work was to obtain superhydrophobic nanocomposite coatings on stainless steel and titanium, which are usually used in blood-contacting implants. The first component of the designed coatings was a synthetic amorphous silica with nanometric particle sizes, whereas the second one were polysiloxanes obtained by a sol-gel synthesis. Dip-coating and electrophoretic deposition methods were used for the coating preparation. After receiving the materials, their structural and microstructural characteristics were carried out. Then, the surface topography and wettability were determined and also the preliminary assessment of sample cytocompatibility were characterized.

JACK CAMPBELL

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Poster 5: Self-shrinking biopolymer microgels as drug delivery vehicles: fabrication and encapsulation

The title of this poster is "Self-shrinking biopolymer microgels as drug delivery vehicles: fabrication and encapsulation" and will focus on the formulation of layer-by-layer assembled biopolymer-based microgels templated upon biocompatible vaterite CaCO3 crystals. Such systems are able to host large amounts of fragile bioactive molecules (e.g. enzymes, proteins, nucleic acids, etc.), as well as provide on demand sustained release. Of key interest, these tailor-made microgels are able to undergo shrinkage (i.e. closure of multilayer voids) at physiological conditions; this property is explained via the charge compensation phenomena taking place within the polymer multilayer network. Such fine control over this microgel shrinkage has been achieved via the variation of charge density and chain length of the biopolymers constituting the multilayers, as well as the charge of the biomolecule to be encapsulated – providing simple approaches for such carriers to reach the nanoscale. Herein, we explore the kinetics of microgel shrinkage, their stability, as well as the encapsulation dynamics of such gel systems fabricated from polyanionic biopolymers including hyaluronic acid, chondroitin sulphate, dextran sulphate, and heparin sulphate, paired with polycations poly-L-lysine, protamine, dextran amine and collagen. Moreover, such shrinkage can be manipulated to mechanically entrap biomacromolecules of interest via the closure of the multilayer pores surrounding the vaterite-co-synthesised cargo within hyaluronic acid/poly-L-lysine multilayers. The loading of silver nanoparticles into such microgels is also discussed. Altogether, the findings of this work will pave the way for new routes within the field of advanced drug delivery, utilizing biopolymer microgels as cages for biocompatible encapsulation.

KAMILA CHĘCIŃSKA

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Poster 6: Polyphenols influence long-term degradation of composites modified with bioactive glass

Bone tissue regeneration is one of the most significant aspects of medicine. Bone tissue engineering (BTE) in particular, as an alternative to autogenous, allogeneic and xenogeneic transplants, plays an important role in the search for methods of bone tissue regeneration. Degradation process of biomaterials is crucial for the successful tissue regeneration. The aim of this work was to assess how polyphenols (PPh) extracted from sage (Salvia officinalis L.) affect long-term degradation behaviour of the polymeric and composite materials based on two bioresorbable polymers (poly(L-lactide-co-glycolide) (PLGA) and poly(ε-caprolactone) (PCL)) and sol-gel-derived bioactive glass (BG) particles.

Materials were prepared in form of films were prepared using the solvent-casting method. Films were enriched with two concentrations of PPh (1 and 4.5 wt.%). BG particles (d50 – 2 μm) with the composition of (mol%) 40SiO2–54CaO–6P2O5 were used as a modifying phase (30 wt.%). Materials were incubated in phosphate-buffered saline (PBS) for 1, 2, 3 and 6 months and they were analysed in terms of mechanical properties, degree of crystallinity, thermal properties, microstructure, chemical composition, and weight changes. Furthermore, the concentration of the ions in incubation media and also pH changes were assessed.

The results have indicated that polyphenolic compounds significantly affect degradation process of both polymeric and composite materials, however, it differed depending on the polymer used.

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KATARZYNA CZARNECKA

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Poster 7: Structure and properties of solution blow spun polycaprolactone nanofibers and their dependence on process parameters

Solution blow spinning is a submicron fiber production method gaining significant interest in recent years as a viable and efficient alternative to the commonly used electrospinning. Due to the relative novelty of the method, not many studies are available to date on process parameters selection and the relationship between process parameters and fiber morphology. The purpose of this study was to determine the influence of polymer solution rheological parameters and concentration, as well as collector rotational speed on fiber morphology, diameter distribution, and alignment. The established spinnability window and the dependencies between process parameters and material properties can serve as a basis for further design of fibrous composites and tissue engineering scaffolds for tissues with varying native extracellular matrix morphologies. Poly-ε-caprolactone was selected as a biodegradable and biocompatible polymer with appropriate mechanical and biochemical properties and trifluoroethanol was used as a solvent for a model polymer-solvent system in this study. The polymer concentration and the rotational speed of the cylindrical collector were chosen as the parameters with the greatest influence on fiber diameter and alignment. Average polymer macromolecular conformation in the solution was determined through viscometry, using the Huggins and Mark-Houwink equations. The morphology of the samples was determined using scanning electron microscopy with qualitative and quantitative digital image analysis. Fiber diameters were in the submicron range and were characterized with varying degrees of orientation, expressed as an average full-width half-maximum value of the fitted Pearson VII distribution. The relationships between process parameters and morphology of fibrous samples, as well as solution viscosity and polymer macromolecular conformation are discussed, including the further application of this study in the design of rapidly produced tissue engineering scaffolds with controlled morphology.

DOMINIKA CZERWIŃSKA-GŁÓWKA

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Poster 8: Electroactive polymer surfaces for biomedical applications

Neurodegenerative diseases are associated with progressive damage to neural cells, which leads to disturbances in signal transmission pathway. Due to the possibility of using electrical stimulation to support and regenerate damaged tissues, neuroelectrodes are widely used. The material for their implementation should meet a number of requirements, as the key element for the proper growth of cells is their adhesion to the surface. Not only the chemical composition of the substrate, but also its physicochemical features have an impact on cell behavior. Only cells attached to the surface undertake DNA synthesis and proliferate, while loss of contact causes growth inhibition and in many cases apoptotic death.

In this study we prepared polymer matrices based on poly(3,4-ethylenedioxypyrrole) (PEDOP) with immobilized antibiotic (tetracycline) through electrochemical polymerisation. Physicochemical properties were analysed by the use of electrochemical (cyclic voltammetry, chronoamperometry) and spectroscopic (UV-Vis, IR) methods. Morphology of polymer films was assessed by SEM microscopy, profilometer and goniometer. Obtained layers were evaluated with the use of a model rat neuroblastoma B35 cell line. The cytotoxicity of the tested matrices were assessed (MTT test) based on the metabolic activity of the cells. Cytometer were used to assess cell cycles and apoptosis.

The proposed research is aimed to provide a solution to challenges associated with implantable neural electrodes through the development of a conducting polymer coating possessing high conductivity and biocompatibility towards neural tissue.

ADRIAN DOMIŃSKI

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Poster 9: pH-responsive shell-sheddable micelles based on poly(ethylene glycol)-hydrazone-poly[R,S]-3-hydroxybutyrate copolymer for tumor-targeted drug delivery

Nanoparticles consisting of amphiphilic copolymers with tunable physicochemical properties can be used to encapsulate fragile pharmaceutics improving solubility, stability, pharmacokinetic properties, reducing immune surveillance, or achieve tumor-targeting ability. To maximize drug targeting to tumor tissues, nanocarriers with prolonged circulation time are required. The strategy to prolong the circulation of drug carriers in the bloodstream is to coat the surface of nanoparticles with a hydrophilic polymer - polyethylene glycol (PEG). The PEGylation resulting in amphiphilic copolymer enables to self-assembly of such copolymers into micelles featuring an outer hydrophilic shell and hydrophobic copolymer as the core. The hydrophilic shell of the nanocarrier sterically hinders its recognition by the immune systems and removal by the reticuloendothelial system. The PEG shell also inhibits interactions of nanocarriers with the target cancer cells, including endocytosis, or direct membrane penetration, due to the steric effect and water-cushion effect. In contrast, nanoparticles with shell-shedding mechanisms are faster internalized and avoid the lysosomes trap problem.
The aim of the present work was to obtain biodegradable micelles with the pH-triggered sheddable PEG shell for the intracellular release of anti-cancer agents. Nanocarriers were made of a diblock copolymer consisting of hydrazone linked PEG and poly([R,S]-3-hydroxybutyrate blocks. In aqueous solutions, the amphiphilic copolymer is self-assembled into pH-responsive micelles. The acid-triggered hydrolysis of hydrazone bond causes shedding the shell of micelles, resulting in the nanoparticles decomposition and drug release. MTT assay showed that the blank micelles were non-toxic to different cell lines, while drug-loaded micelles, showed increased ability to inhibit the proliferation of cancer cells.

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MICHAEL EUGENE DOYLE

Michael Eugene Doyle

Newcastle University

Poster 10: Developing Synthetic Bone: A Presentation of Research, Methods, and Preliminary Experiments

This presentation will highlight important trends and research in the field of bone scaffolds, knowledge gaps in the literature, as well as promising strategies to fill in such gaps. I will also provide an overview of the in vitro and in silico work I am conducting on this topic.

With an ageing world population and ~20% of adults in Europe being affected by bone disorders (1), the efficacy of bone repair therapies is becoming increasingly important. Conventional scaffolds can have significant drawbacks such as: revision surgeries, implant migration, and stress shielding; all of which cause damage at the implant site. Optimal bone scaffolds should mimic the properties of their destination sites in all ways (i.e. mechanically, degradation rate, porosity etc.), yet a true bone analogue is still to be developed.

The main composition of bone is a collagenous matrix which has been mineralised by hydroxyapatite (65%-70% by weight). While surface mineralisation is easily achieved, interfibrillar mineralisation is intricately controlled by cells. I will explain the rationale for an experiment in which this process may be encouraged by means of seeding hydroxyapatite crystallites onto the end termini of collagen fibrils prior to crosslinking.

Following on from in vitro experiments I will highlight some ways in which in silico models are permitting further advancements in the design of bone scaffolds, such as simulating structural template components in the matrix; as well as providing insight into some of the unobservable processes that occur within bone.

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ANNA DRABCZYK

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Poster 11: Magnetic nanoparticles with functionalized surface as tools useful for targeted delivery of chemotherapeutics

The main task of the research was to obtain magnetic nanoparticles coated with selected substances which may be applied for targeted delivery of cytostatics, i.e. drugs used during the treatment of cancer via chemotherapy. The main attention during the syntheses performed was paid to the development of the methodology of preparation of particles with nanometric sizes which was problematic due to the tendency of magnetic nanoparticles to form agglomerates. It was meaningful to apply the adequate stabilizing agent limiting the mentioned agglomeration as well as making the agglomerates formed more prone to the sonication (process of the disintegration of nanoparticle agglomerates via ultrasounds) and the adequate reaction medium. Synthesis of magnetic nanoparticles coated with nanogold involved two steps. Firstly, Massart synthesis was conducted, i.e. co-precipitation of iron ions in alkaline environment. The process proceeded at elevated temperature and under an inert gas atmosphere. Next step involved the formation of nanogold layer on magnetic nanoparticles. For this purpose, an arabic gum was used as a stabilizing agent, tetrachloroauric (III) acid acted as a source of gold ions and hydroxylamine hydrochloride was applied as a reducing agent. Such structures will be in the next part of the research subjected to the reaction aimed at the formation of additional, polymer coating which will act as a linker between nanogold-coated magnetic nanoparticles and a selected chemotherapeutic. The developed materials are considered as carriers for delivery of cytostatics directly to cancer cells.

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Poster 12: Structural and nanomechanical properties of CA/P contained micro-arc oxidation coating on Ti13Zr13Nb alloy

The calcium-phosphate doped oxide layers were directly deposited on the selective laser melted Ti13Zr13Nb alloy by micro-arc oxidation (MAO) technique under various applied voltages (200, 300, 400V) in an electrolytic solution containing calcium glycerophosphate (GP) and calcium acetate (CA). The microstructure, topography, elemental distribution and phase composition of the MAO coatings were investigated using scanning electron microscope (SEM), laser scanning microscope (LSM), energy-dispersive X-ray spectrometry (EDS) and X-ray diffractometer (XRD), respectively. The early stage bioactivity was evaluated in Hank's solution during immersion test, while nanomechanical properties, and adhesion between the oxide coatings and substrate were measured using nanoindentation and nanoscratch test, respectively.

Macro-porous, Ca- and P-containing titania-based films were successfully formed on the Ti13Zr13Nb alloy substrates. The phase, Ca and P content, morphology, roughness and thickness of the films were strongly dependent on the applied voltage. Due to the good ratio of structural and nanomechanical properties of the coatings, the optimal conditions of MAO process were found at 300V, which resulted in the predictable structure, high Ca/P ratio, the highest demonstrated early-stage bioactivity, better nanomechanical properties, elastic modulus and hardness close to the values characteristic for bones, as compared to specimens treated at lower voltage (200V) and uncoated substrate, as well as higher critical load of adhesion and total delamination.

EWA DZIERZKOWSKA

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Poster 13: The comparison of melt-blown and electrospun fibrous scaffolds for tissue engineering

Fibrous scaffolds get a lot of attention in tissue engineering applications thanks for their ability to mimic extracellular matrix. In this study we compared fibrous scaffolds prepared from polylactide acid using two different fabrication methods i.e.; electrospinning (ES) and melt-blowing (MB). Scaffolds differed in morphology and fiber diameters (NOVA NANO SEM 200). Fibers obtained by the melt-blowing method are submicron (3-30 um), while those obtained by the electrospinning method have smaller diameter (0.5-2 um). The differences in the diameter of the fibers translated into different roughness of the scaffold surface (melt-blown scaffold Ra = 60-160 um, while electrospun scaffold Ra = 3,5 um) and, consequently, into the pore size and porosity (porosity of melt-blown scaffold c.a. 90% while porosity of the electrospun c.a. 80%). The porosity was determined by the mercury porosimetry method (Poremaster 60, Quantachrome) and surface roughness was evaluated using laser measuring microscope (Olympus OLS 400). The technique of the fibers forming also translated into changes in phase transition temperatures of the materials (DSC1 Mettler Toledo). Furthermore, keratinocyte (HaCaT) and macrophage (RAW 264.7) cell viability on scaffolds were evaluated. Higher viability of both cell types was observed on the melt-blown fibrous scaffold. This study showed that the most promising scaffold mimicking ECM was the melt-blown fibrous scaffold with the largest fibers, higher surface roughness, higher porosity and crystallinity than the electrospun scaffold.

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Poster 14: Enhanced cell adhesion and viability via surface functionalization by self-assembly of calcium carbonate micro- and nano-particles production simultaneously with their self-assembly

Porous $CaCO_3$ particles have beneficial properties such as biocompatibility and a high drug loading capability.[1] The colloidal assembly of such particles can be used as sensors, catalysts, and drug delivery systems[2,3] But controlling a required particle distribution during self-assembly is still a challenge.[3] One technique for making thin non-volatile surface coatings on solid substrates is the spin-coating, also referred to as spin-casting.[4] We design new materials via the fabrication and distribution of $CaCO_3$ particles by the spin casting process. The deposition of $CaCl_2$ and Na_2CO_3 solutions for $CaCO_3$ particles production and their deposition has been done using two different washing procedures during spin casting and dipping in water afterward. The size of the particles increased with increasing the salt's concentration and varied in the range from 26 nm to 2.8 µm. The first process is the only feasible technique to produce and deposit $CaCO_3$ nanoparticles (26.4±3.6 nm). The second method is more suitable for producing micron and sub-micron $CaCO_3$ particles (0.7±0.1 µm to 2.8±0.6 µm) to avoid centrifugal force and the gravity effect. During the synthesis, nano and submicron particles self-assembly on wafer surfaces takes place following the pure salts crystallization pattern but the arrangement of the heaviest microparticles is different due to the influence of the gravity. MC3T3-E1 cells were seeded on the coated substrate. Performing viability test and microscopy analysis show that functionalizing the surface with $CaCO_3$ particles can enhance cell proliferation and adhesion on the surface. Such an industrially friendly coating design could be used in various fields of nano medicine and beyond.

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ALEXEY ERMAKOV

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Poster 15: Platforms for Encapsulation, Storage, And Controlled Release of Reactive Oxygen Species

Microencapsulation and targeted delivery of reactive oxygen species (ROS) open a venue for new non-toxic and biodegradable systems. Here, we employ polymeric carriers either as a container to encapsulate ROS with the possibility of a controlled release or as an agent to produce ROS under the action of NIR light directly to the site of interest. We show ordered arrays of microcontainers made of polylactic acid functionalised with carbon dots to encapsulate ROS and release it in response to NIR laser treatment with a high spatial resolution. Suspensions of polyelectrolyte microcontainers were employed to encapsulate zinc phthalocyanine PTD agent which produces singlet oxygen in response to NIR laser treatment. Both systems were tested in vitro and demonstrated a high level of biocompatibility with low cytotoxicity. The developed systems promise prospective delivery routes in many areas such as wound healing by time and site-specific release.

AGATA FLIS

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Poster 16: Poly(hexamethylene citrate)s and poly(octamethylene citrate)s as potential substrates for blood vessel tissue engineering – degradation studies

Poly(diol citrates) (PDCs) are innovative biodegradable elastomers with potential application as substitutes of small blood vessels or as surface modifiers of the commercial Dacron® and ePTFE vascular prostheses. The advantages of PDCs are non-toxic monomers, simple synthesis, controllable mechanical properties and degradability. Additionally, PDCs structure can be modified to provide it with various properties, e.g. anti-oxidant or fluorescent.

The aim of this study was to assess degradation of two types of PDCs: poly(hexamethylene citrate) and poly(octamethylene citrate) (cPHC and cPOC, respectively) modified with panthenol or glutathione at concentrations of 0%, 0.4% or 0.8%. Prior to degradation test, the samples were crosslinked for 4 days at 80ºC. Round specimens 8 mm in diameter were incubated in ultra-pure water at 37ºC for 3 months. Weight measurements of the samples were taken before and after degradation. The weight loss and water absorption capacity of the polymers were evaluated. Additionally, the pH of supernatants was inspected to detect possible degradation products of the polymers.

The results showed proceeding degradation process due to hydrolysis of crosslinked polymer chains. The continuous weight loss was observed and it did not depend on the presence of a modifier, but rather on the type of used diol. Weight loss of cPHC samples (up to 25% of mass) indicated faster degradation in comparison to cPOC (approximately 10% of mass). cPHC samples decomposed before the end of experiment. pH value of incubation fluid decreased sharply during the first day of contact with all samples and was affected by the release of unreacted monomers from the materials.

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Poster 17: Bioactive coatings based on modified black glasses

In the work, a way to improve the properties of metallic implants is proposed by the use of protective coatings based on modified silicon oxycarbide (Si*M*OC, the so-called black glass). The emphasis is on corrosion resistance, biocompatibility, and bioactivity. The materials were modified primarily with phosphorus ions but also with aluminum and boron - ions whose task is primarily to support the permanent incorporation of phosphorus ions into the glass network. The materials are based on pre-ceramic polymers in the form of suitably modified ladder-like silsesquioxanes obtained with the sol-gel method. The coatings were deposited using the dip-coating technique and subsequently underwent high-temperature treatment in a protective atmosphere of inert gas (Ar). Based on the structural and microstructural analyzes of the materials and the functional properties of the coatings testing, it was proved that for the first time materials from Si*P*OC, Si*PAl*OC, and Si*PB*OC systems of the beneficial properties from the point of the proposed application were obtained. Moreover, it has been shown that Si*PB*OC-based materials have the best protective and surface properties and are the most attractive material for bone implant coatings.

BARBARA GIEROBA

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Poster 18: Spectroscopic and microscopic assessment of the molecular structure of hybrid chitosan/1,3-β-D-glucan polymeric matrices cross-linked at 70 °C and 80 °C

Chitosan- and 1,3-β-D-glucan (curdlan)-based polysaccharide matrices are widely used in biomedicine, including tissue engineering, as a base for various biomaterials production, including bone scaffolds. Three different spectroscopic approaches were applied to detect the structural changes in hybrid chitosan/1,3-β-D-glucan polymeric matrices cross-linked at two various temperatures: 70 °C and 80 °C. Vibrational spectroscopies: Attenuated Total Reflection Fourier transform infrared (ATR FT-IR) and Raman spectroscopies are complementary techniques which enabled insightful characterization of molecular organization of designed biomaterial, whereas X-ray photoelectron spectroscopy (XPS) allowed to obtain its surface properties. Atomic force microscopy (AFM) enabled the surface topography characterization and grain-like structures visualization. Second order derivative and deconvolution of FT-IR spectra allowed the determination of various secondary structures located in amide bands. Stronger interactions and more dense package were detected at higher studied gellation temperature (80 °C), where also the α-helices content decreases and deprotonation occurs, which suggest different chain folding in this cross-linking temperature compared with 70 °C. The physicochemical properties and the morphology of the surface also varied. Temperature-dependent differences in chemical interactions between 1,3-β-D-glucan units and N-glucosamine in chitosan resulting in surface polarity changes were found. The presence of different active groups on the surface may promote specific protein adsorption, affecting cell recruitment, proliferation and differentiation on the biomaterials. Within this study it was demonstrated that spectroscopic methods could be applied as an efficient and non-destructive tools to study the molecular composition, and develop the manufacturing process of biocomposites designed for potential biomedical applications to achieve optimal physical/biochemical characteristics.

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Poster 19: Modulation of textural and structural properties of mesoporous bioactive glasses

Over the last few years, mesoporous bioactive glasses (MBGs) have gained much attention because of their excellent bioactive and osteostimulative properties as well as the possibility of use them as local drug-delivery systems in tissue engineering. The incorporation of active substances inside the mesopores ensures controlled and sustained delivery of active agents against bone diseases such as osteoporosis, tumors, or infections. Furthermore, MBGs can be dopped with therapeutic inorganic ions, which are able to promote osteogenesis, angiogenesis and antibacterial effects through the local release. All of these features depend on textural properties of MBGs – i.a. ordered arrangement of mesopores, pore size, pore volume, and surface area. The aim of this work was to assess how different structure-directing agents and sources of CaO affect textural and structural properties of MBGs. The MBGs with the composition of (mol%) $80SiO_2$–$16CaO$–$4P_2O_5$ were prepared using sol-gel method coupled with evaporation-induced self-assembly (EISA) process. Two different structure-directing agents (Pluronic P123 and Pluronic F127) and three various sources of CaO (calcium nitrate, calcium acetate, and calcium chloride) were used. The MBGs were evaluated in term of structural (WAXS, FTIR) and textural (TEM, SAXS, BET) properties. The results have indicated that both structure-directing agents and sources of CaO significantly influence aforementioned properties. This gives the possibility to obtain MBGs differing in bioactivity and biological activity as well as release kinetics of therapeutic agents/ions.

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Poster 20: Integration of Lignocellulose Catalysis and Anaerobic Digestion

Catalytic conversion of biomass towards high value chemicals in second generation biorefineries, is a crucial aspect of the drive towards a low carbon economy. Catalytic conversion of actual biomass can produce residual solid waste that account for up to 50 wt.% of the starting biomass. The carbonaceous solid residues have high levels of surface oxygenated groups that can potentially be used as low-cost sorbents. The absorption of inhibitors during anaerobic digestion with carbonaceous solids has been widely investigated to improve methane yields of animal and human wastes. In this study, we show that solid residue from the sulphuric acid catalyzed production of levulinic acid using Miscanthus x giganetus can be used to improve anaerobic digestion. The addition of 6 g/L of acid catalyzed solid residue improved the anaerobic digestion of ammonia inhibited chicken manure by +14%. The effects of the acid-catalysis parameters was also investigated with consideration to material properties and effects on anaerobic digestion. The co-digestion of biorefinery waste solids and manures could be a promising solution for improving biogas production from animal manures, sustainable waste management method and possible form of carbon sequestration.

PIOTR JABŁOŃSKI

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Poster 21: Impact of pretreatment of nitinol surface using acid-based environments for biomedical application

Nitinol alloy is an excellent example of a material with potential for biomedical applications. It represents special mechanical properties such as shape memory effect (SME) and pseudoelasticity. However, the NiTi alloy application is limited by corrosion resistance and complex oxidation process during which allergenic Ni^{+} ions are released. The functional coatings (*e.g.* biopolymer-based) on the nitinol surface can limit ion diffusion.

Although, due to the different physicochemical nature of metals and polymers, the permanent bonding of these materials requires additional processing. These include, for example, mechanical treatments, pickling in chemical environments or ion processes. Etching in chemical environments could have a triple beneficial impact on nitinol surface. Firstly, changes in topography and surface development are beneficial for coating deposition, secondly activation of the surface by creating free chemical bonds has a good impact on a durable connection between the polymer and metal substrate. Additionally, the chemical environment could change the chemical composition of the surface, leading to binding a free nickel.

In our research, nitinol substrates were etched in four different chemical environments: 1) NH_3 - 5 H_2O_2 – 5 H_2O, 2) 7 H_2SO_4 – 3 H_2O_2, 3) HCl – 3 HNO_3 - 10 H_2O, 4) 7 NH_3 – 3 H_2O_2 - 7 H_2O in time of 15, 30 and 60 minutes. After samples modification their chemical composition were tested using the XPS method. Additionally, morphology and topography were determined using SEM and AFM microscopy, respectively. Moreover, wettability and surface free energy of the modified nitinol surface were measured and analyzed. The obtained results determined the best conditions for the durable adhesion of polymer coating to the alloy substrate.

MICHAL JEDREK

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Poster 22: Application of DRIFT spectroscopy to assess the structural changes at cell-scaffold interface

Various microstructural and physico-chemical properties of biomaterials, such as surface chemistry, surface roughness, topography, mechanical features and interfacial free energy (hydrophobic/hydrophilic balance) are crucial for cell adhesion, proliferation and differentiation.
The Diffuse reflectance infrared Fourier transform spectroscopy (DRIFT) was applied to characterise three-compound ceramic composite biomaterial consisting of chitosan, β-1,3-D-glucan (curdlan) and hydroxyapatite developed as a bone tissue engineering product (TEP).
The structural characteristics and physico-chemical properties of biomaterials were determined not only by DRFIT spectroscopy but also with the use of X-ray photoelectron spectroscopy (XPS) and scanning electron microscopy (SEM). These techniques allowed to assess the changes of the hydroxyapatite caused by stem cells (ADSC – Adipose tisuue-Derived Stem Cells and BMDSC - Bone Marrow-Derived Stem Cells) cultured directly on the ceramic-based biomaterial.
Conducted experiments showed that this ceramic-based composite possesses a large biomedical potential as a novel biomaterial for the regeneration of bone tissue. The obtained results are interesting and promising in terms of spectroscopic methods suitability for qualitative assessment of material-cell interactions.

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Poster 23: Surface modification of polymer fibers based on aminolysis and gelatin immobilization as a method of improvement of cell-scaffold interaction

Surface modification is used in tissue engineering to improve cell-scaffold interaction without altering the bulk properties of the material. Various techniques are used to change surface properties, such as wettability, surface energy, topography, surface elasticity, or to introduce charged groups or bioactive motives that are important from the perspective of the biological application.[1,2,3]

In this study, we modified the surface of electrospun fibers made of poly(caprolactone) (PCL), poly(L-lactide-co-caprolactone) (PLCL) 70:30 or poly(L-lactide) PLLA. Firstly, we introduced amine groups on the surface of fibers using ethylenediamine aminolysis in a wide range of conditions. It was shown that PCL fibers require much more aggressive conditions than PLCL and PLLA. Our results confirmed that the presence of NH2 groups is beneficial for cell response, most likely due to their positive charge. On the other hand, aminolysis caused a decrease in the average molecular weight of polymers, which influences the mechanical properties of nonwovens. Hence, it is crucial to choose conditions of reaction, which enable maintaining mechanical strength.

In the second part, we immobilized gelatin on the surface of aminolyzed fibers using glutaraldehyde cross-linking. Chemical modification was compared to the physical adsorption of gelatin. It was shown that physisorption provides a lower concentration of gelatin and stability of the layer. However, complete hydrophilicity and improvement of cell morphology were observed in the case of all gelatin-covered samples.

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Poster 24: Collagen and diamond as a materials for wound dressings

Even if wounds seem easy to repair for clinicians, but for scientists replicate chronic wounds, are still open challenge in skin tissue engineering. They are one from major health challenge to improve patient's quality of life.

Skin wound dressings are commonly used to stimulate and enhance skin tissue repair. Behind process of skin healing hides a sequence of events, specific timing, and high level of organization and coordination among the involved cell type.

Collagen is the most abundant extracellular matrix animal protein in mammals. The importance of it in wound healing has been appreciated for the simple reason- collagenous composed scar tissue. However, since wound healing and regeneration are complex process in which collagen may affect healing not only at its final stage, but also in the very early stages of healing (ie. adhesion of circulating blood platelets to collagen).

To improve properites of pure collagen wound dressings we decise to modyfied them by usiubf nanocarbon struktures. Nanodiamonds, due to their mechanical and chemical properties and their current popularity in many biomedical applications, were chosed for our research. Possibility of their modification reveal an almost unlimited application. We can not only control the activity of the reaction surface of it, but as well to obtain bacteriostatic activity against pathogens.

In our research viscosity of nanodiamond- Sancoll ® tropocollagen solutions was measured to find the best proportion between ingredients. Difference between Storage And Loss Modulus confirm behavior(like polymers) of collagen molecules and existence crosslinks connection between collagen molecules.

LUKASZ KANIUK

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Poster 25: Cellular response and stability of PHBV fibers and films over time

The biodegradability and physicochemical properties of materials are key parameters in selecting biomaterials for various tissue engineering applications. The stability of materials, especially biodegradable ones, is an important parameter that determines their future practical use. Poly (3-hydroxybutyrate-co-3-hydroxyvalerate) (PHBV) is widely used in medicine due to its non-toxicity and good biocompatibility. Additionally, it can minimize inflammatory reactions in tissues as its degradation products are components of human blood.

In our study, the physicochemical properties of electrospun PHVB fibers and spin-coated films aged for 1, 4 and 8 weeks were analyzed using Fourier Transform Infrared (FTIR) spectroscopy, X-ray photoelectron spectroscopy (XPS) or water contact angle. The morphology of the samples was determined by scanning electron microscopy (SEM). In addition, a cellular response was obtained using mouse NIH 3T3 fibroblasts. The MTS colorimetric cell viability assay enabled the assessment of cell proliferation. In addition, the morphology of fibroblasts was examined by laser confocal (CLSM) and SEM. These studies showed that the activity, adhesion and proliferation of fibroblasts are independent of the aging of PHBV fibers and membranes. Fibroblasts showed good activity and proliferation, cells attach to surrounding fibers and their migration follows in the direction of the fibers. The obtained results confirm the stability of both PHBV films and fibers.

NINA KANTOR-MALUJDY

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Poster 26: Spin coating elastomeric poly(butylene succinate) copolyester thin films for cell adhesion studies

Tissue engineering utilizes polymeric scaffolds to aid in the regeneration or replacement of damaged tissues or organs. In this context, to be able to observe and quantify the interactions between cells and new elastomeric poly(butylene succinate-co-dilinolene succinate) (PBS-DLS) copolyesters, we aimed to prepare thin films on transparent substrates (glass microscopy #1 coverslips, 130-160 µm thick) via spin coating. Based on the literature, we initially used dichloromethane (DCM) to prepare copolymer solutions, but the obtained films were of poor quality, with marked dewetting and poor surface coverage (~80%) and film uniformity, likely due to evaporative cooling. As a result studies were carried out using different solvents with lower volatility than DCM, including tetrahydrofuran (THF), dioxane, and blends. Obtained thin films were characterized by visual assessment, Keyence laser scanning microscopy (LSM), and Krüss drop shape analyzer. For the case of PBS-DLS 5050 (50% weight ratio of PBS hard segments), the use of THF or dioxane resulted in a marked improvement in thin film quality, while PBS-DLS 7030 required a 1:1 blend of DCM:THF or dioxane. The obtained thin films were homogenous (100% coverage), 100-150 nm thick, and with roughness (R_q) in the range of 12-17 nm (<5 nm higher than bare substrate). Interestingly, spin-coated thin films exhibited markedly reduced water contact angles (by 30-45°) compared to hot-pressed foils. Finally, initial cell culture experiments indicate the suitability of the obtained substrates for use in a wider spectrum of studies examining cell adhesion, morphology, and growth.

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KAMIL KLESZCZ

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Poster 27: Functional chitosan layers with bioactive metal nanoparticles on titanium alloy in bioengineering applications

Surface engineering of metallic implants is important, although a complex problem, as interactions on the implant-body interface play a crucial role in the success of the arthroplasty operation. Choosing an appropriate surface treatment method can substantially increase biocompatibility, performance and longevity of the implant. Moreover, layers and modifications introducing antibacterial properties are gaining popularity due to their role in preventing bacteria associated implant failure.

In order to achieve antifouling surface, limit alloy-related ion release and introduce deliberate topography, a two-step modification of Ti6Al7Nb biomedical alloy is proposed. Noble metal ions in combination with chitosan layers were chosen as antibacterial agents due to their well-described properties and safety. Chemical etching in alkaline solution, followed by usage of oxygen-rich plasma was used to activate surface for subsequent deposition of chitosan layers enriched with gold or silver nanoparticles. Performed plasma chemical treatment was proven to influence roughness parameters and allow the growth of a protective titanium oxide layers. Obtained chitosan-based layers exhibited favorable surface topography, hydrophilic properties and beneficial antibacterial ion release kinetics, persisting up to 96h. All tested modifications of Ti6Al7Nb alloy were proven to induce corrosion resistance and high biocompatibility *in vitro*, confirming effectiveness of chosen treatments.

ELŻBIETA KOPCZYŃSKA

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Poster 28: The influence of graphene oxide presence in food films on the adhesion of food-borne pathogens

The main functions of packaging for fatty products should be adequate protection of food against the ingress of microorganisms and protection against external factors such as humidity, light, temperature and oxygen. These factors influence the emergence of unfavorable chemical and biological processes and consequently lead to a reduction in the safety of stored products. Today, no ideal food packaging has been invented that does not contain harmful chemicals that can enter food while fully protecting food.

The aim of the study was to check whether the presence of graphene oxide in food films used for packaging fatty products affects the adhesion of food-borne pathogens and extends the shelf life of food. Four bacterial strains were used in the study: *Escherichia coli* ATCC 25922, *Pseudomonas aeruginosa* NCTC 12903 / ATCC 27853, *Streptococcus mutans* ATCC 35668, *Staphylococcus aureus* ATCC25923 and four types of food films for fatty products: mustard, ice-cream, coffee, ketchup. Adhesion of pathogens to the polymer surfaces of food graphene films was studied by means of a fluorescence microscope (MOTIC B1410E). The evaluation of the adhesion of three bacterial strains to four types of food films with graphene oxide showed statistically significant differences in the action limiting adhesion and viability. Addition of graphene oxide to food packaging creates a protective barrier against bacteria, which increases the shelf life of food. In addition, lowering the adhesion of food film allows to prolong the freshness of fatty products.

FILIP KOPER

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Poster 29: Development and characterization of novel citric acid-based biomaterials for tissue engineering

Poly(diol citrate) (PDC) materials are novel, potentially biodegradable and non-cytotoxic substrates for tissue engineering. Herein, we present the development and full characterization of PDC biomaterials (cPHC and cPOC) based on 2 different diols (1,6-hexanediol and 1,8-octanediol) and various molar ratios (1:1, 2:3).

Prepolymers were obtained under mild conditions in polycondensation reaction between citric acid and diol followed by multi-step purification, resulting in prepolymer solutions, which then were used in crosslinking process. A vast number of analyses was performed to confirm the structure and morphology of obtained materials, as well as to determine their mechanical and biological properties, including NMR, LC – MS/MS, GPC, acid number, tensile strength, hardness measurements and cell proliferation studies on extracts from the materials.

Profound NMR analyses confirmed chemical structure of materials and allowed to determine their properties. NMR, MS and GPC results combined with tensile strength and hardness measurements indicated dependence of final material properties upon prepolymer synthesis protocol as well as diol used and substrates molar ratio. Results shown influence of preferred linear oligomers structure and crosslinking time to hardness and tensile strength of obtained materials. Acid number analyses and cell proliferation studies indicated impact of acidity on cell viability and allowed to assume that the materials obtained in a 2:3 ratio are a preferable medium for cell culture.

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Poster 30: Interaction of nanodiamond powders on the structure of food films

We meet the challenges, so the aim of the research is to gain control over the surface of food packaging. The key idea is to extend the shelf life of short-term food products and to monitor bacteriostatic properties. One of the risks to humans is that foodborne pathogens can enter the human body together with food, causing disease.

Staphylococcus aureus, Escherichia coli, Streptococcus mutan and *Pseudomonas aeruginosa* were selected from among the strains of bacteria to be tested and a barrier in the form of admixture of diamond powders on the surface of the film was created. The laminates differed from each other by the number of layers. We distinguish such types as: monoplex, duplex, triplex, quadroplex. Due to the development of nano-particles of nano-diamond, a staining method was used to check the modified subsidiaries and then a fluorescence microscope was used to investigate the effects. Tests were also performed on Petri dishes to check the visible braking zone. The structure of the nanomaterials analysed by using SEM (Scanning Electron Microscope). Due to the significant development of the packaging industry, research on food film modifications is underway.

ZUZANNA JOANNA KRYSIAK

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Poster 31: Oil wetting behavior controlled by PVB fibers roughness as a perspective use in atopic skin bandages

Atopic dermatitis (AD) is a skin disease affecting people all over the world. There are a lot of methods of AD treatment including non-invasive one as textile – based therapy. Via electrospinning we are able to produce fiber patches based on highly porous mats applicable for skin treatment. To electrospin mats we use polyvinyl butyral-co-vinyl alcohol-co-vinyl acetate (PVB) which have been already well characterized, however, have not been investigated as an oil carriers. In this study, we confirmed the lack of cytotoxicity of electrospun PVB nano and microfibers. The morphology, roughness, porosity and mechanical properties of the membranes were characterized. Finally, borage, black cumin seed and evening primrose oil wetting experiments were performed with their spreading tests.
Importantly, the oils spreading area was affected by the fiber diameter. Wetting area was greater for nanofibers than microfibers for each oil, regardless its viscosity. Our study showed possibility of using electrospun fibers as an oil carriers, which can be useful in the atopic skin treatment patches.

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SONIA KUDŁACIK-KRAMARCZYK

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Poster 32: Transdermal systems containing *Aloe vera* juice for anticancer therapy

In the research, synthesis and investigations on chitosan-based hydrogel polymers modified with *Aloe vera* juice have been presented. Hydrogels have been obtained by photopolymerization. Next, they have been subjected to the numerous analyses aimed at determining their behavior in simulated physiological liquids, swelling ability, mechanical properties or the ability of the release of the active substance from the hydrogel matrix. As a result of the studies, it was stated that obtained hydrogels show biocompatibility with tested liquids, good swelling ability and the relative flexibility. Furthermore, it was reported that the tested chitosan-based hydrogels may release the active substance present in hydrogel matrix but the intensity of this process depended on the type of the environment tested. In the next part of the research, the developed materials will be modified with albumin-based spheres incorporated with selected cytostatic, i.e. drug used during one of the methods of cancer treatment – chemotherapy. Final materials seem to be innovative due to the fact that they combine two meaningful solutions, i.e. the hydrogel wound dressing modified with *Aloe vera* juice (which according to the literature references supports the wound healing process) and the drug carrier (i.e. albumin-based spheres with anticancer drug). Moreover, such a hydrogel dressing may support the cancer treatment due to its modification with anticancer drug and, at the same time have a soothing effect on the burn wound healing caused by the radiotherapy due to the presence of *Aloe vera* juice in hydrogel matrix.

ANNA KUROWSKA

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Poster 33: Methods of periodontal tissues regeneration

Gingival recession consists in the lowering of the cement-enamel junction (CEJ), which leads to exposing the root of a tooth. At present, gingival recessions belong to the most frequent problems signaled by patients coming to dentists surgeries. This review depicts the present state of the current methods of treating gingival recessions used in dentistry. The paper also discusses the effects and causes of the recession**,** as well as advantages and disadvantages of the methods used. This review allows the dentists to compare the methods used and may be helpful in the design of new biomaterials for the treatment of periodontal tissues.The currently applied solutions in the field of periodontal tissues treatment still pose challenges for medical dentistry and materials engineering. Due to the large scale of the problem of gingival recessions and a number of constraints associated with the currently used treatment methods, it seems to be justified to look for new materials exhibiting properties that would meet the requirements of periodontologists and ensure the proper reconstruction of the lost elements of the periodontium (cementum, periodontal ligament, alveolar bone proper) as well as the proper restoration of their attachments.

ROKSANA KURPANIK

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Poster 34: Polymeric shish-kebab fibers mimicking corneal stroma membrane

Interactions between the cell and extracellular matrix are crucial role for replacement of corneal stromal membrane or possibility of its regeneration with corneal cells (keratinocytes, epithelium and endothelium). In the scaffold-based approach, the focus is on the development of a substrate that mimics the microenvironment providing support for the cell population - keratinocytes. It is governed by the fibrous microstructure of the material as well as by morphology of the fibers (shape and size). In this study, PCL nanofibers were obtained by electrospinning method using two-solvent system (DCM:DMF, CL:EtOH). Then the fibers were modified by directional crystallization in PCL solution at different concentrations (0.5-1 w/w). This procedure enabled obtaining the morphology of fibers referred to as shish-kebab, which mimics the D–banding pattern of natural collagen fibrils present in the corneal stromal membrane. The microstructure of samples and fiber size distribution before and after modification were observed using scanning electron microscopy (NOVA NANOSEM, FEI). The influence of the obtained fiber morphology on the physicochemical properties of the membrane (wettability, surface energy) was also investigated (DSA, Kruss 25). The results showed the presence of submicron and nanometric fibers with lamellae parts, characteristic for the shish kebab morphology, which formation was strongly dependent on the fiber size. The obtained fibers exhibited a hydrophobic character, irrespective of their modification.

ALEKSANDRA KUŹMIŃSKA

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Poster 35: Surface modification of the vascular prostheses with acrylic acid

Heart disease remains a significant cause of death. Materials and techniques are sought for the manufacture of small diameter vascular prostheses. Such scaffolds are usually made of polymers, of which polyurethane is the most widely used. In order to minimize the negative response of the organism, modifications of its surface are carried out.

The work aimed to produce cylindrical polyurethane scaffolds using the phase inversion technique. The materials' surface was modified with acrylic acid using a free radical reaction to introduce carboxyl groups and then short peptide sequence REDV. The morphology of the obtained structures was analyzed using a scanning electron microscope. The occurrence of the reaction was assessed by surface wettability analysis, FTIR, and colorimetrical analysis. The number of carboxyl groups introduced onto the surface was also evaluated. Moreover, the cytotoxicity of the obtained structures was examined.

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Poster 36: The influence of a chain extender on selected properties of the polyurethane-based biomaterials

Polyurethanes (PUs) are synthetic polymers containing repeated urethane groups in the structure [1]. The properties of PUs can be easily tailored to the application by changing the chemical composition or the synthesis process. Some polyurethanes exhibit biocompatibility, which makes them good material for biomedical applications [2].

The synthesis of PUs can be performed via a one- or two-step polymerization process. The latter allows better control over the properties of a final product. During the first step, the reaction between a polyol and an excess of isocyanate occurs resulting in the formation of so-called prepolymer terminated with -NCO groups. These groups can further react with -OH groups from the chain extender during the second step [2]. By the introduction of a chain extender, the properties of polyurethanes can be changed significantly.

The most used chain extenders in elastomeric systems are diols containing two hydroxyl groups [1]. Also, natural compounds, such as polysaccharides can be employed. Due to the presence of more than two hydroxyl groups, they can act as a crosslinker.

In this work, polyurethanes manufactured in the two-step bulk polyaddition process were presented. The influence of various chain extenders on the microstructure, mechanical properties, and bioactivity of the material was investigated. The obtained materials may be considered as novel bone-mimic scaffolds.

[1] M. Szycher, Szycher's Handbook of Polyurethanes, (2013).
[2] Q. Chen et al., Prog. Polym. Sci. 38 (2013) 584– 671.

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ANNA LASKA-LEŚNIEWICZ

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Poster 37: Hydroxyapatite as a filler in acrylic bone cements

Hydroxyapatite (HAp) has drawn scientific attention over last few decades. It is widely used in orthopaedics and stomatology, mainly as fillings of bone defects and cavities after some surgeries or accidents, implant coatings and scaffolds in tissue engineering applications. Moreover, HAp seems to be a noteworthy filler in poly(methyl methacrylate)-based bone cements as they still need to be improved.

This research aimed to examine the effects of modification of acrylic bone cements using micro-size hydroxyapatite powder on their physio-chemical and thermal properties. HAp powder was synthesized in wet precipitation method and subsequently processed in order to obtain grain size below 50 μm. The carefully prepared filler was mixed with powder matrix of bone cement in % weight from 3 up to 15. Ready composite bone cements were assessed by a scanning electron microscope (SEM), FT-IR Spectrophotometer, differential scanning calorimeter (DSC) and thermogravimetry instrument (TGA). Additionally, wettability was check and surface free energy was calculated. As toxic residual methyl methacrylate can cause harmful effect on human body, its release was also investigated in 3-month long studies.

Acrylic bone cements with hydroxyapatite showed some improvements comparing to initial source biomaterial. There are also slight correlations between amount of HAp filler and selected properties of composite bone cements.

DOROTA LASKOWSKA

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Poster 38: Application of additive manufacturing to develop personalized medical implants

According to the definition proposed by American Society for Testing of Materials (ASTM) additive manufacturing (AM) is "process of joining materials to make parts from 3D model data, usually layer upon layer, in contrast to subtractive manufacturing and formative manufacturing methodologies". In literature AM is also referred to as 3D Printing, Solid Freedom Fabrication (SFF), Layered Manufacturing (LM) or Rapid Prototyping (RP).

In the initial stage of development, AM was used as a tool to support mass production- the manufactured elements served for a general presentation of the shape of the product, which were made by traditional methods. This allowed for reduced the time and costs of the prototyping process. Currently, 3D printing methods have found application in many areas of life, including automotive, aerospace, architecture and even in medicine bringing many innovative and revolutionary solutions.

There are many additive printing techniques. In most projects, the choice of technique is a compromise between costs and properties (e.g. physical, chemical or mechanical) that the object is to have. Moreover, AM techniques differ in the type (e.g. metal, ceramic, polymer) and form (e.g. powder, sheet, wire, liquid) of the construction material (feedstock) and the process of its solidification.

The purpose of presentation is to review of the additive manufactured methods from metal powders and its potential of medical application, in particular in the design and manufacture of personalized medical implants.

RACHEL LEE

Rachel Lee, Dr Marloes Peeters, Professor Mark Geoghegan

Newcastle University

Poster 39: Materials for Bioelectronics Applications

Bioelectronics concerns the use of electronic devices in biological systems. With particular importance on interfacing electronic signals and biological tissue, providing information about the intercellular communication which occurs in a living organism. Within the human body, response to a stimulus passes a chemical signal through the neural system, such signals can be mimicked using bioelectrical devices in the form of biological scaffolds and transistors. A means of determining these stimuli is needed, which can be achieved using electrochemical transistors. The resultant transistor will need to have mechanical properties that match those of the tissue to which they are in contact, for example the spinal cord. In this project (which has only just started) PEDOT will be used as the active layer, but the polymer itself does not display the right mechanical properties and neither is it biodegradable. Therefore, to effectively function in a transistor it requires doping. All of these problems can be addressed by using a biodegradable anionic hydrogel scaffold, by using materials such as chondroitin sulfate or hyaluronic acid. The aim of the project is to offer a biocompatible OECT, replacing the doping agent, to improve the biocompatibility of PEDOT and offering compatibility with the spinal cord.

ADRIANNA LIS

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Poster 40: Thermoelectric self-powering health sensor

Self-powering sensors are devices with enormous potential in the application for monitoring of the state of health. Human body heat can be a source of energy that can eliminate the need for batteries. The subject of the work is the development of a miniature, self-powered, low-cost biomedical sensor for continuous monitoring of a person's health. The simplest version would be equipped with a temperature sensor, an electronic measurement and communication module and a thermoelectric microgenerator feeding it. Such a system of sensors would allow continuous monitoring of the human health state, for example in epidemic conditions.

It is planned to use composite polymer materials of poly(3,4-ethylenedioxythiophene) polystyrene sulfonate (PEDOT:PSS) and tungsten carbide for the construction of thermoelectric modules. Conductive polymers are ideal materials because of their properties such as flexibility and non-toxicity. The test samples were made by synthesizing PEDOT:PSS with different WC volume content. The obtained samples were examined in terms of their thermal conductivity, electrical conductivity, Seebeck coefficient and visual tests of the microstructure with SEM. The composites maintained low thermal conductivity of the polymer, regardless of the WC volume fraction. Their electrical conductivity increased with an increase of volume fraction of tungsten carbide for samples with a content ranging from 25 to 75%. The SEM results show that WC domains are evenly distributed in the polymer matrix and surrounded by the polymer.

The performed tests confirmed that the examined composites are promising components to be used as elastic thermoelectric materials for the construction of self-powering health sensors.

IWONA ŁOPIANIAK

Iwona Łopianiak, Ilona Kulesz, Michał Wojasiński, Beata Butruk-Raszeja

Poster 41: Polyurethane fibrous materials produced by solution blow spinning method for biomedical application

Polyurethanes can be used as a base material to produce implants and medical devices for contact with blood, as well as scaffolds for three-dimensional cell culture. In this work, polyurethane fibrous materials for biomedical applications were produced by the solution blow spinning (SBS) method. Change in SBS process parameters allows obtaining materials with desired properties. Solutions of polyurethanes ChronoFlex® (AdvanSource Biomaterials) C75A and C75D Shore hardness in 1,1,1,3,3,3-hexafluoro-2-propanol were used in this work.

The work aimed to investigate the effect of the change in concentration of polyurethane solution (2-9% w/w), compressed gas pressure (1-2 bar), polymer solution flow rate (10-30 ml/h), and collector speed rate (200-25000 rpm) on the morphology and mechanical properties of fibrous materials.

Results have shown that the fiber diameter (300-2500 nm) and the material pore size (3-40 µm) strongly depend on the polymer solution concentration, while the collector speed rate affects the arrangement of the fibers in the produced material. Changing the process parameters: compressed gas pressure and polymer solution flow rate allows to minimize the number of defects (stains, spindles, nodules) within the structure of the produced materials. Additionally, the materials mechanical properties are significantly influenced by the hardness of the base polymer and fiber arrangement.

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CHRISTINA LOUKOPOULOU

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Poster 42: Modelling enthesis development in vitro to produce anatomically and clinically relevant bone-tendon constructs for flexor tendon repair

'Jersey finger' is a common hand injury, where the tendons of the *flexor digitorum profundus (FDP)* muscle is injured through digital hyperextension and subsequently avulses from the distal phalanx in the hand. This is due to the accumulation of mechanical force around the tissue transition from tendon to bone. While surgical intervention remains the gold standard for treating a tendon avulsion, this type of repair does not fully reinstate the enthesis, the graduated interface of the tendon-bone insertion. The resulting enthesis loses its highly ordered microanatomy and its initial mechanical strength, thus being susceptible to further impairment. Interfacial tissue engineering is directed at the generation of the microanatomy of the enthesis by creating an *in vitro* bone-tendon construct to evaluate repair techniques. Previous published literature has successfully demonstrated that mechanical stimulation of bone-tendon tissue-engineered constructs can aid in the development of the artificial enthesis highly ordered anatomy *in vitro*. Our research will focus on redesigning and developing an anatomically and clinically relevant 3D *in vitro* tendon-bone model based on pertinent previous work recommending an innovative co-culture system grounded on anatomical morphometrics, while also evaluating the impact of mechanical loading on the engineered constructs.

As a result, we propose that these tissue-engineered constructs will adopt anatomical and mechanical properties similar to those of the native tissue interface, when mechanically stimulated by a custom-made bioreactor. Therefore, these constructs may ultimately show potential for being utilised as a surgical implant for repair at the *flexor digitorum profundus* insertion site.

ŁUKASZ LUŚTYK

Łukasz Luśtyk, Dr Krzysztof Pietryga, Dr. Katarzyna Reczyńska, Prof. Elżbieta Pamuła

Poster 43: Hydrogel materials for bone tissue engineering fabricated using indirect 3D printing

The aim of this research was to fabricate hydrogel scaffolds for bone tissue engineering using indirect 3D printing technique by casting in printed moulds and then dissolving them. The development of the scaffolds was based on CAD models which differ in degree of space filling. The designed models were used for FDM printing of the form based on polylactide and water soluble polymer PVA. The microstructure and dimensions of the forms were assessed, as well as the compliance of the printed forms with the assumed model. The results of assessment of print quality showed that printing with PVA was more problematic than polylactide due to worse compatibility with model. Fabricated PVA moulds were filled with a hydrogel mixture (5% gellan gum, 0.5% gelatin). After gelation of the hydrogel solution, PVA forms were dissolved in water. The micro- and macroscopic analysis of obtained hydrogel scaffolds was carried out to measure the lengths of individual scaffolds' elements and the accuracy of the form imprint. The research showed the possibility of successful fabrication of hydrogel scaffolds using indirect 3D printing method in a wide range of pore sizes. The quality of the obtained hydrogel scaffolding was similar to the quality of the printed forms. However, the process of infiltrating PVA forms with a hydrogel mixture was more challenging for PVA forms with smaller pores. Despite these drawbacks, the scaffolds have been appraised as being suitable for bone tissue engineering applications. Further research will require assessment of e.g. the mechanical properties of the hydrogel.

JAKUB MARCHEWKA

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Poster 44: Conductive CNT/PLA scaffolds prepared by 3D printing for the modification using electrophoretic deposition

Biocompatibility of a biomaterial is one of the crucial properties in regard to its applications in a living body. It could be defined as the ability of a material to be in contact with a tissue without the generation of adverse results, i.e. toxic effect or immunological response. For the preparation of the scaffolds a vast range of biomaterials is used. These porous structures are applied in tissue engineering to support the regeneration of damaged tissue. Therefore their properties should be carefully considered and adjusted in relation to this application. Polylactide-based scaffolds may be produced using fused deposition modeling 3D printing which gives the possibility to receive a highly defined microstructure based on a predesigned 3D virtual model. The appropriate properties of polylactide scaffold may be obtained by subsequent modification of its surface. The aim of this work was to develop composite carbon nanotubes – polylactide scaffolds which could be later modified by the preparation of hydroxyapatite coatings using electrophoretic deposition. Introduction of carbon nanotubes into polymer matrix has assured two significant effects, i.e. the improvement of mechanical properties of the final scaffolds and, with an appropriate amount, the generation of electrical conductivity necessary for the preparation of the coating using electrophoretic deposition. Additional hydroxyapatite coatings of polylactide-based scaffolds should enhance their biocompatibility as well as improve their osteoinductivity, osteoconductivity and osseointegration which is highly desired for the application in bone tissue engineering.

JAKE MCCLEMENTS

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Poster 45: Thermal Detection of Cardiac Biomarkers Heart-Fatty Acid Binding Protein and ST2 Using a Molecularly Imprinted Nanoparticle-Based Multiplex Sensor Platform

Molecularly imprinted polymer nanoparticles (nanoMIPs) were produced for the cardiac biomarkers heart-fatty acid binding protein and ST2 by solid-phase synthesis, and were utilised as synthetic antibodies in a multiplexed sensing platform. Analysis by surface plasmon resonance demonstrated that the affinity of the nanoMIPs is similar to that of commercially available antibodies. The particles were coated onto the surface of thermocouples and inserted into 3D-printed flow cells of different multiplexed designs. We demonstrate that it is possible to selectively detect both cardiac biomarkers within the physiologically relevant range. Furthermore, the developed sensor platform is the first example of a multiplex format of this thermal analysis technique which enables simultaneous measurements of two different compounds with minimal cross selectivity. The format where three thermocouples are positioned in parallel exhibits the highest sensitivity, which is explained by modelling the heat flow distribution within the flow cell. This design is used in further experiments and proof-of-application of the sensor platform is provided by measuring spiked fetal bovine serum samples. The prepared array format sensor provides an interesting alternative to traditional immunoassays due to its high selectivity, short measurement time, and low cost. The use of nanoMIPs enables a multimarker strategy, which has the potential to contribute to sustainable healthcare by improving the reliability of cardiac biomarker testing.

BARTOSZ MIELAN

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Poster 46: Modification of PLGA/HAp microspheres with mineral and organic layers to enhance cell adhesion

Degradable polymeric microspheres (MS) can be used as substrates for cell cultures in tissue engineering and regeneration. MS main advantage are: I) much higher relative surface area as compared to typical 2D cell culture wells and II) assuring better access to the nutrients from the cell culture medium. However, on typical degradable polymers, such as poly(L-lactide-*co*-glycolide) (PLGA) cell adhesion is rather poor.

Therefore, the aim of this study was to produce MS for culture of osteoblasts, thus PLGA was enriched with hydroxyapatite (HAp) microparticles in bulk. Moreover the surface of MS was modified with collagen, poly(L-lysine) (PLL) and calcium phosphate layer obtained by biomimetic approach.

MS were produced by oil-in-water emulsification method, dried, cleaned and sieved to obtain fraction of MS (323 ± 57) μm in diameter. Subsequently the mineral layer was produced by MS incubation in simulated body fluid (SBF) and then additionally MS were coated with type I collagen or poly-*L*-lysine. To verify usefulness of our approach MC3T3 cells were cultured on 1 mg of MS in 96-well anti-adhesive plates (15000 cells/ well) for 1, 3 and 7 days. Samples with cells were examined with scanning electron microscopy with electron dispersion X-Ray spectroscopy (SEM/EDX), Raman spectroscopy, live/dead staining, Alamar Blue assay and confocal microscopy after phalloidin/DAPI staining for cytoskeleton and nuclei.

The SEM/EDX results show calcium phosphate deposits on MS after SBF incubation. Such MS better supported cell adhesion and proliferation than non-modified MS. Additional coatings with PLL and especially collagen improved cell adhesion even more significantly. Interestingly, we also observed self-assembly of MS and formation of three-dimensional cells-microspheres-extracellular matrix constructs. This last finding might be especially promising for modular bone tissue engineering.

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SOFIA MUNICOY

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Poster 47: Hierarchichal structured collagen biomaterial with controlled antimicrobial activity

The development of advanced biocidal systems stands as a global challenge, focused on the increasing demand of new antimicrobial biomaterials. This is the first time that three well-known materials are strategically combined to develop a novel biomaterial with prolonged bactericidal activity that avoids explosive release and toxic effects, by the incorporation of silver nanoparticles in lipid vesicles and their subsequent incorporation in collagen gels. These assemblies show enhanced mechanical properties and sustained inhibitory effect on the growth of Gram-positive and Gram-negative bacteria, while remaining highly biocompatible for mammalian cells. In fact, the hybrid biocomposite prevents bacterial colonization for at least 72 hours, allowing at the same time eukaryotic cell proliferation. As a result, this novel new bactericidal biomaterial provides a new alternative to improve current treatments of bacterial infections with many implications in significant applications, such as wound therapy and tissue regeneration.

KLAUDIA ORDON

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Poster 48: Polyurethane-based biomaterials: influence of starch crosslinkers on thermal and mechanical properties

Polyurethanes (PUR) often show resistance to biodegradation that makes them unsuitable for tissue engineering applications. Use of biodegradable polyols and natural polymers, like polysaccharides, gain attention to made PURs eco-friendly and biodegradable. Natural polymers are non-immunogenic and biocompatible due to their resemblance to living tissues. Starch is one of the most abundant natural polymers with main characteristics of renewability, biodegradability, and low cost [1,2].
Starch modified polyurethanes were synthesized by step-growth polymerization reaction between prepolymer and 1,3-propanediol/starch as chain extender/crosslinker. Polyurethane prepolymer was obtain in the reaction of 1,6-hexamethylene diisocyanate with poly(ε-caprolactone) diol. The prepolymer was further reacted with a different weight ratio of chain extender/crosslinker to obtain final polyurethane-based systems. The structure of obtained samples were confirmed by Fourier transformed infrared (FTIR). Thermogravimetric analysis showed that with an increase of starch content in the crosslinking system the thermal stability of the synthesized materials increases. The influence of starch on the mechanical properties of the PUR was investigated using universal testing Machine (ZWICK). Based on DSC analysis, it was found that after the introduction of starch, the glass transition temperature of soft segments increased. TOPEMDSC results indicated that with an increase of the temperature modulation frequency, the glass transition temperature increased.

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PATRYCJA OSAK

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Poster 49: Long-term assessment of the in vitro corrosion resistance of biomimetic coatings of amorphous calcium phosphate electrodeposited from an acetate bath

Commercial titanium Grade 4 (CpTi G4) is the most commonly used material for dental implants due to its excellent mechanical properties, chemical stability and biocompatibility. A thin, self-passive oxide layer with protective properties to corrosion is formed on its surface. However, the spontaneous TiO_2 layer is chemically unstable. In this work, to increase the corrosion resistance and improve the osseointegration process of CpTi G4, biomimetic amorphous calcium phosphate (ACP) coatings were electrodeposited from an acetate bath with a Ca : P ratio of 1.67. ACP coatings were obtained on CpTi G4 substrate subjected to sandblasting and autoclaving using electrochemically assisted deposition in an acetate bath with pH = 7.4 at room temperature. Scanning Kelvin probe and tribological tests under reciprocating motion on a ball-on-disc tribometer in artificial saliva solution (ASS), were used for the surface characterization of the biomaterial under study. The bioactivity investigations were conducted in a protein-free simulated body fluid (SBF) at 37 °C, where the concentrations of ions were similar to that of human blood plasma. In vitro corrosion resistance tests were conducted in ASS using open circuit potential, polarization curves, and electrochemical impedance spectroscopy measurements. Bioactivity of the ACP coatings was confirmed by formation of apatite in SBF. The improvement in the long-term corrosion resistance of biomimetic ACP coatings was found due to their amorphous structure and chemical composition. Mechanism and kinetics of the pitting corrosion on the CpTi G4 | TiO_2 | ACP coating system has been discussed in details.

PIOTR PAŃTAK

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Poster 50: Citrus pectin and other polysaccharides as additives to injectable biomicroconcrete-type bone fillers

Among many commercially available implantable materials for bone substitution, only a few are injectable. In this study, new injectable biomicroconcretes with satisfactory properties were obtained and examined. Apart from developing the initial composition of the materials, the influence of polymer additives in the form of sodium alginate and hydroxypropyl methylcellulose (HPMC) on their properties was also investigated. The idea of using aggregates in the form of hybrid granules in order to obtain beneficial mechanical properties was taken from the characteristics of classic concretes.

The solid phase of developed biomicroconcretes consisted of highly reactive α-TCP powder and hybrid hydroxyapatite-chitosan (HAp/CTS) materials in the form of powder and granules (300-400 μm), with polymer concentration equal: 15, 20 and 25 wt.%. Moreover, these materials were modified with 2 and 4 wt.% of sodium alginate or hydroxypropyl methylcellulose (HPMC). The liquid phase in tested materials composed of an aqueous solution of citrus pectin (5 wt.%).

The conducted research confirmed the injectability of the biomicroconcretes, which was directly influenced by the use of polymers, which acted as the paste plasticizers. Moreover, due to the occurrence of dual setting originated from hydrolysis of α-TCP and cross-linking of polymers, a significant compressive strength of biomicroconcretes (reaching up to 17.2 ± 3.4 MPa) was obtained. Preliminary in vitro studies demonstrated the bioactivity of the developed materials and paves the way for further in vitro research.

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Poster 51: Hydrogel and polymer based bio composite functionalized with calcium carbonate and plasmonic nanoparticles as an effective substrate for surface enhance Raman signal and tissue engineering

Surface-enhanced Raman scattering (SERS) is an efficient technique allowing detection of extremely low concentrations of analytes. For such applications, polymeric matrices structures decorated with plasmonic metal nanoparticles can be used as flexible SERS substrates for analysis of analytes in many application. In this study, a three-dimensional SERS substrate consisting of a CaCO3-mineralized polycaprolactone fibrous matrix and hydrogel matrices decorated with silver nanoparticles is developed. Such modification of the fibrous substrate allows achieving a significant increase of the SERS signal amplification with enhancement factor up 10^5 order of magnitudes. Functionalization of matrices made of polycaprolactone and hydrogel by porous CaCO3 (vaterite) and Ag nanoparticles provides an effective approach of selective adsorption of biomolecules and their precise detection by SERS.
In the other way, additional functionalization of matrices by the calcium carbonate mineral in porous polycrystalline vaterite structure could provide a multiple functionalities: 1) improve the osteoblastic cell adhesion, stimulate their proliferation and ossification., 2) be the source of the calcium ions for bone reconstruction 3) possibility to functionalized the matrices with molecules like antibiotics, enzymes or growth factors.

MATTIA PARATI

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Poster 52: Poly-gamma-glutamic acid: at the epicentre of an integrated biorefinery concept

The current need of sustainably produced, biodegradable polymers is driving the demand for chemically and biologically synthesised 'green polymers'. However, both sectors presents solutions that are still relatively expensive and do not offer the same flexibility as their plastic counterparts. This review summarises current knowledge on the interplay between substrate components, microorganism and fermentation conditions and how these factors can modulate the chemico-physical properties of poly-gamma-glutamic acid (γ-PGA); a bioderived, biodegradable and non-immunogenic, biopolymer. Sector-specific requirements are presented and the methodologies to be employed have been described, for example: active pharmaceutical ingredient conjugation with low molecular weight (oligomeric) D/L-γ-PGA's, high molecular weight D/L-γ-PGA as cryoprotectants for probiotics, γ-PGAs high in D-glutamic acid as coating for gene-carrying viral particles and low-swelling material for dental fillings, water-interacting high L-glutamic acid γ-PGA as a component of moisturising cosmetics and D/L-γ-PGA as a biocomposite for tissue engineering applications. The concept has been further explored by proposing three different approaches to lower the cost of γ-PGA production, including: utilisation of waste complex media (brewery waste, cider waste and algal waste) as substrate, co-fermentation of γ-PGA producers with *Corynebacterium glutamicum*, an L-glutamic acid producer and the extraction of poly-hydroxyalkanoates as a value-added compound from the otherwise discarded biomass. With this, recent advancements in substrate optimisation, microorganismal genetics and fermentation techniques have been gathered to aid in the development of the proposed integrated biorefinery concept; with the aim to tackle cost, flexibility and circular economy issues faced by the 'green dreaming' polymer industry.

KATARZYNA PIEKLARZ

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Poster 53: Research of physico-chemical and biological properties of thermosensitive chitosan hydrogels developed for tissue engineering application

Over the past few years, there has been an avalanche development of research in the field of tissue engineering, which is an innovative, interdisciplinary field involving biomaterial science, cell biology, chemistry, cell-material interactions, and surface characterization. Particularly intensive work is devoted to hydrogels, which are three-dimensional networks composed of hydrophilic polymers crosslinked either through covalent bonds or held together via physical intramolecular and intermolecular attractions. The aim of the research is to create a new form of chitosan hydrogels with thermosensitive properties, intended for injectable scaffolds in tissue engineering. The obtained biomaterials are elastic, soft and their properties are similar to properties of living tissues, and are formed at the physiological temperature of the human body (37°C) with using uridine 5'-monophosphate (UMP) disodium salt and β-glycerol phosphate disodium salt pentahydrate. The study focused on determining the change in the gels structure after preparation and after conditioning in water for 24 h. The physico-chemical properties were based on the analysis of FTIR spectra and XRD diffraction patterns. The biocompatibility of the developed hydrogels was confirmed next by the In Vitro Toxicity Assay Kit Resazurin (analysis of the cytotoxicity) and the alkaline version of comet assay (analysis of the genotoxicity). The obtained research results induce to undertake further works in the field of biomedical engineering soon.

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Poster 54: Analysis of changes in the swelling ability of sodium alginate/gelatin hydrogels in degradation tests

In this work changes in the swelling ability of sodium alginate/gelatin hydrogels with different gelatin content after degradation test in phosphate buffer were examined. Hydrogels were obtained by cross-linking prepared aqueous solutions of sodium alginate and gelatin in dialysis membranes with the use of calcium ions. The obtained materials were then immersed in PBS phosphate buffer and incubated at 37°C for 14 days. The equilibrium swelling in water, swelling degree in PBS, pH and release of calcium ions were tested at each time point. For each incubation time, measurements were repeated 3x for each tested parameter. The results indicate that as the degradation time in phosphate buffer and 37°C increases, the equilibrium swelling ratio decreases, in particular for 6 and 9% w/v gelatin content in hydrogels. What is more, an increase in the swelling capacity of the hydrogels in the phosphate buffer was observed with the increase in the gelatin content. On the basis of the obtained results it was found that the properties of hydrogels depend on the concentration of individual components. Swelling ability in deionized water which refers to water retention ability and swelling degree in phosphate buffer connected with capacity to absorb body fluid were significantly enhanced by gelatin addition to the tested hydrogels. It was shown that incubation in conditions simulating the human body environment limits the ability to swell as a result of the degradation processes.

IZABELA RUTKOWSKA

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Poster 55: Sol-gel synthesized aluminum oxide as an additive for zinc polycarboxylate cement

A number of commercially available dental cements are various in chemical composition and therefore are characterized with significantly different physical, mechanical and biological properties. One of the most common and commercially available cements are zinc polycarboxylate cements, which are mainly used in the fixation of dental crowns and inlays, along with cavity linings. As a solid powder form, it mainly contains oxides of zinc, magnesium, bismuth, aluminum, and stannous. It is proved that the small additive of Al_2O_3 nanoparticles increase microhardness and the contact angle of the cement specimen. Moreover aluminum oxide displays catalytic effect during solidification of zinc polycarboxylate cement. The aim of this work is to present an alternative way to synthesize the aluminum oxide nanoparticles which may be used as reinforce material for zinc polycarboxylate cements. Sol-gel synthesis, which is based on hydrolysis and polycondensation of used reagents, is used as to obtain a sol from organic precursors, which after the proper thermal treatment leads to ceramic fine powder. In order to characterize the morphology and structure of the obtained additive the FTIR, XRD, SEM and EDS, which confirmed the presence of the Al_2O_3 nanoparticles. The specific surface area and porosity was determined by using the Brunauer-Emmett-Teller (BET) method.

SZYMON SALAGIERSKI

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Poster 56: Antioxidant activity and osteogenic potential of bioactive glasses doped with cerium, strontium and zinc

Bioglasses are materials that can create a permanent bond with bone tissue and stimulate it to faster regeneration. Moreover, it is possible to extend their multifunctionality by introducing structural modifications. The aim of the following study was modification of bioactive glasses with cerium, strontium and zinc to enhance their antioxidant activity and osteogenic potential. Various glasses from the SiO_2-CaO-P_2O_5 system (A2: 40SiO_2–54CaO–6P_2O_5, S2: 80SiO_2–16CaO–4P_2O_5) were obtained with the sol-gel method. The modifiers (ZnO, SrO and CeO_2) were introduced to the glass composition in substitution for CaO, in concentrations of 0 - 10% mol. Then, glasses has been fully characterized in terms of material properties. Bioglass powders were tested for antioxidant activity using ABTS (2,2-azinobis (3-ethylbenzothiazoline-6-sulfonic acid)) method. Bioglasses based on the A2 system exhibited better antioxidant performance than S2 system ones. Bioglass powders were incorporated into the polymer polycaprolactone matrix. The osteogenic potential of the obtained materials was assessed using the normal human osteoblast cells (NHOst). The proliferation and cytotoxicty were monitored, and the alkaline phosphate activity was assessed. The ability of cells mineralization was evaluated via the OsteoImage™ test, while the ELISA test detected levels of osteocalcin (OCN) and osteopontin (OPN) proteins in supernatant. Based on the conducted research, it was found that the addition of strontium and zinc to bioglasses have the best influence on their osteogenic potential *in vitro*.

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GIULIA SANTOMAURO

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Poster 57: Generation of magnetic microswimmers by incorporation of terbium into a microalga

Living microorganisms are able to take up non-bionic elements and incorporate them through detoxification mechanisms. Here we demonstrate that the microalga *Chlamydomonas reinhardtii* gains magnetic properties by incorporation of the lanthanide terbium. The unicellular microswimmers were incubated in presence of high amounts of terbium; afterwards the incorporation of the lanthanide into the cell was proven by chemical and fluorescence measurements. We could show by the following SQUID investigations that the cells gained superparamagnetic properties and that the magnetic moment of one magnetized *C. reinhardtii* cell is 1.6×10^{-11} emu, which is comparable to the magnetic moment of magnetotactic bacteria. We could achieve magnetic control along two-dimensional trajectories on a rotating magnet. Consequently, we produced magnetic microswimmers by incorporation of terbium. In addition, we tested the biocompatibility of *C. reinhardtii* and human cells by co-culture. Both cell types showed mutual biocompatibility, indicating that the algae cells are noncytotoxic.

SZYMON SKIBIŃSKI

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Poster 58: Tricalcium phosphate/polyhydroxyoctanoate (TCP/PHO) composites for bone tissue regeneration

Tricalcium phosphate based biomaterials (α-TCP, β-TCP) due to their excellent biocompatibility and bioactivity are one of the most commonly used bone substitutes. However, porous TCP ceramics exhibits poor mechanical properties (e.g. high brittleness and low compressive strength) limiting its range of applications. In order to improve the mechanical strength and additionally functionalize TCP-based scaffolds, they may be coated with a thin layer of a biopolymer. Bacteria-derived polyhydroxyoctanoate (PHO) used in this study is a biocompatible and bioresorbable polymer, which has not found many applications in hard tissue replacement yet.

In this work, ceramic TCP-based porous materials were prepared by a polyurethane matrix replica method. β-TCP powder used for the preparation of ceramic slurries was synthesized *via* a wet chemical method. Obtained ceramic scaffolds sintered in a conventional furnace at 1200˚C were immersed in 5% (w/v) polyhydroxyoctanoate in ethyl acetate solution, dried and subjected to further studies. Microstructure, porosity, compressive strength and bioactive potential of the obtained materials were determined.

Developed scaffolds possessed a network of interconnected spherical pores with sizes between 100 to 700 μm and had high total porosity (~60 vol%). The compressive strength of TCP/PHO composite was equal to 7.1 ± 2.0 MPa and it was higher when compared to uncoated TCP scaffold (4.7 ± 1.6 MPa). *In vitro* studies, carried out by soaking samples in simulated body fluid revealed an apatite-like layer formation confirming their bioactive potential. Obtained inorganic-organic composites might be a promising candidate for bone tissue regeneration. Further studies on their *in vitro* and *in vivo* behavior are still necessary.

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Poster 59: Influence of doping ions on the properties of PEDOT and its potential biomedical applications

Bioelectronic devices comprise a wide range of devices able to conduct electrical signals in contact with human tissue, including cochlear implants, biosensors, neural electrodes and many others. Their efficiency largely depends on how well the device is integrated within the target tissue. One of the most promising biocompatible materials with electroactive properties are conducting polymers, especially poly(3,4-ethylenedioxythiophene) (PEDOT). The properties of conducting polymers, such as surface morphology or electrical conductivity, can be easily tailored by modification of polymerization conditions and the choice of dopant molecules.

In this study, three different electrolyte solutions were used for electrochemical deposition of PEDOT, namely poly(sodium 4-styrenesulfonate), nBu_4NPF_6 and $LiClO_4$. Conducting polymer coatings were investigated and compared in terms of their electrochemical properties by means of cyclic voltammetry and electrochemical impedance spectroscopy. Morphological characterization was performed by analysis of scanning electron microscopic images. Eventually, B35 neuroblastoma cells were cultured on the polymeric matrices and the cell viability was estimated based on MTT assay. In this way, the overall influence of each doping ion on the coatings and their potential application for bioelectronic devices was demonstrated.

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NATALIA STACHOWIAK

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Poster 60: Polymer matrices containing microparticles based on sodium alginate and pectin with surfactant as a substitute for wet wipes

Wet wipes have become an increasingly popular item of daily use at home, in the workplace, and especially during traveling. They were originally offered as personal care baby products. However, their success has led to the development of many products with household and industrial applications. The global demand for wipes and non-woven consumption will be forecast to increase constantly. Worldwide, wet wipes sales are rising due to increased incomes and urbanization, also busier lifestyles will drive demand for these convenience products. The wet wipes are large consumer items in landfills and represent a significant proportion of non-biodegradable wastes. The plastics, including the wet wipes, accumulated in landfills and aquatic reservoirs, degrade for long periods under the influence of various factors in the environment. To sum up, a single-use plastic causes significant problems for the environment.

The objective of this research was to develop materials based on biodegradable polymers as a substitute for wet wipes. The matrices were obtained from gelatin, hydroxyethylcellulose, polyvinylpyrrolidone, and glycerol. The microparticles consisting of sodium alginate and pectin were formed by extrusion method using an encapsulator. During the encapsulation process, a surfactant was incorporated into the microparticles. The polymer matrices with microparticles were produced by the freeze-drying method. The prepared materials were characterized by different analyses, for example, measurements of porosity and swelling, mechanical and stability tests.

ALICJA STANISŁAWSKA

Alicja Stanisławska

Gdansk University of Technology, Department of Mechanics and Mechatronics

Poster 61: Mechanical and physicochemical properties of physically modified bacterial nanocellulose

The main aim of work was study about influence of the bacterial nanocelullose (BNC) manufacturing method on its mechanical and physicochemical properties. Chemically and physically modified BNC membranes were tested. Natural pig tissues fixed in 0.05% glutaraldehyde were the reference material. The chemical modification consisted in obtaining the composite material BNC-polyvinyl alcohol (PVA) and BNC-hyaluronic acid (HA). The physical modification consisted in sublimation or convection drying at the following temperatures: 25 ºC, 40 ºC, 80 ºC and 105 ºC. The influence of drying temperature and rehydratation BNC on its mechanical properties such as tensile strength (Rm) and elongation at break (A) were investigated.

The highest tensile strength of 11.8 MPa was obtained for the pericardial flap. BNC without modification had Rm = 4.8 MPa, and after modification with PVA and HA, 2.8 MPa and about 4.5 MPa, respectively.

The physical modification consisting in drying at 25 ° C and then soaking in distilled water was considered to be the best modification. Tensile strength of such modification was 17.4 MPa and elongation at break was 11,04%. For this modification structural analysis, thermogravimetry analysis (TGA) and X-ray diffraction analysis (XRD) were performed.

YULIA SVENSKAYA

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Poster 62: Transdermal delivery of antifungal drugs in the treatment of superficial mycoses

Topical therapy of superficial fungal infections allows the prevention of systemic side effects and provides drug targeting at the site of disease. However, an appropriate drug concentration in these sites should be provided to ensure the efficacy of such local treatment. The enhancement of intra- and transdermal penetration and accumulation of antifungal drugs is an important aspect here. Here report on a novel approach for topical antifungal treatment based on addressing of drug-loaded submicron vaterite particles into the deep layers of the skin through the hair follicles. The particles were demonstrated to be capable of providing a high antimycotic loading capacity (5-10 % w/w) and a long-term release of the payload (more than 72 h). High efficiency of the cellular uptake together with extremely low cytotoxicity were demonstrated. A prolonged antifungal drug release ensured the enhanced therapeutic effect of the proposed system both, *in vitro* and *in vivo*.

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Poster 63: The thermal study of chitosan crosslinked polyurethanes doped with nanohydroxyapatite for bone tissue engineering

Polyurethane scaffolds are valuing for bone tissue engineering and orthopedic implants due they provide proper environmental conditions for the growth of cells of bone tissue and the mineralization The good features of polyurethane are ascribed to soft domains that are mainly composed of polyester chains and hard domains that are mainly built of diisocyantes [1] For bone tissue engineering, hydroxyapatite is a one component of inorganic phase of the human bone. The hydroxyapatite is a outstanding material owing to its properties including non-inflammatory, non-cytotoxicity and osteo-conductive potential. It has ability to bonding with living tissues [2]. Chitosan is a polysaccharide and cationic polymer that has been studied due to its biocompatible and biodegradable character[3].

The study presents the polyurethane-based materials crosslinked with 1,5-pentane diol and chitosan, doped with nanohydroxyapatite. The polyurethane prepolymer was obtained in two-step bulk polymerization without toxic solvents. In the next step, the prepolymer was crosslinked with the 1,5-pentane diol and chitosan. The nanohydroxyapatite in different quantities was added. The thermal properties of samples was studied by DSC and TG. The structure of the material was confirmed by FTIR.

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Poster 64: Application of polysaccharides in medicine

The polysaccharide, thanks to its properties, such as biodegradability and biocompatibility, is of great interest to scientists. It is related to the growing interest in environmental protection and ecology. Polysaccharides can be used to produce biodegradable and human-friendly materials. Carboxymethyl chitosan is obtained from food industry waste such as shrimp, lobster, and crab shells. Carboxymethyl chitosan's belong to the group of biodegradable polymers, they are biocompatible, but may also have antibacterial or wound healing properties. Thanks to that, they can be used, among others, in medicine, tissue engineering and pharmacy.

The aim of the study was to compare the properties of carboxymethyl chitosan's obtained by various syntheses. Additionally, the properties of chitosan derivatives were compared with chitosan and commercial carboxymethyl chitosan.

Two syntheses were carried out, which differed in parameters such as synthesis time and temperature. Viscometry, potentiometric titration, and spectroscopic analysis were used to determine the properties of the obtained carboxymethyl chitosan's. It was determined that the synthesis parameters influence the average molecular weight of chitosan derivatives and the degree of substitution.

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Poster 65: Fabrication of fibroin and gelatin-coated magnetic particles as an injectable scaffold for bone repair

For ease of application, injectable scaffolds have received a lot of attention in the area of bone injury repair. In this study, the superparamagnetic iron oxide nanoparticles were synthesized by co-precipitation of ferric and ferrous salts and exposure to a temperature of 1400°C. The resulted particles were coated, layer-by-layer, in a sonicator bath with silk fibroin and gelatin. The microspheres were then resuspended in alginate solution. This injectable scaffold was solidified by calcium chloride. The particles were characterized by (1) measurement of magnetic properties using a vibration sample magnetometer (VSM) (2) transmission and scanning electron microscopic morphological studies and (3) assessment of FT-IR spectra of the Fe3O4. Also, the injectability of the final scaffold was evaluated by a rheological study and the extrusion through a 10-gauge needle. Cytotoxicity of the particles were assessed by culture with bone marrow-derived mesenchymal stem cells (MSCs) using the MTT assay. The FTIR spectra proved the presence of the Fe3O4/SiO2 in the particles. Also, the SEM and TEM studies and measurement of magnetic properties showed that the morphologies and the magnetic power of particles are in the expected range. No cytotoxicity was observed in MSCs cultured in the presence of the synthesized particles. In this study, we present fabrication of a biocompatible superparamagnetic nanoparticle which can be delivered as an injectable scaffold with properties suitable for bone repair applications.

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Poster 66: Aligned Polydroxyalkanoate Blend Fibres for Peripheral Nerve Repair

Nerve guide conduits (NGCs) are a favourable alternative repair strategy, to autografts, as they avoid issues such as donor site morbidity. Hollow NGCs lack natural guidance cues and so the addition of guidance scaffolds, such as electrospun fibres, is a popular research approach shown to increase nerve regeneration distances1. Polyhydroxyalkanoates (PHAs) are a favourable synthetic material, for tissue engineered scaffolds, due their biocompatibility and favourable mechanical properties.

P(3HB) and P(3HO) were produced by bacterial fermentation and characterised as previously described2. Electrospun aligned PHA fibres, with diameters of 5 and 8µm, were fabricated, and quantified by SEM and microCT for fibre alignment and diameter. Rat Dorsal Root Ganglion (DRG) bodies were extracted and explanted whole on to the ends of a 3D in vitro fibre testing method3. DRGs were labelled for β III tubulin and S100β for quantification.

Aligned PHA fibres supported neurite outgrowth, and primary Schwann cell migration from DRG explants. The highest average neurite outgrowth length was measured at 3.94 ± 0.38 mm on 5µm P(3HB):P(3HO) 50:50 fibres. Blends of PHAs can be fabricated into aligned fibre scaffolds using electrospinning, with known fibre diameters and are a promising material to aid and improve nerve regeneration.

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Poster 67: Polymer-ceramic biocomposites based on hydroxyapatite/PVP/histidine for tissue engineering with drug-delivery function

Polymer and hydroxyapatite (HAP) composites have growing interest in such medical areas as tissue engineering or bone regeneration. Despite drug delivery function of the synthetized biomaterials, has attracted very little attention. Polymer binders commonly used for these applications include polyvinylpyrrolidone (PVP), which represents excellent biological inertness, are biocompatible, and do not adversely interact with HA.

For this reason in our studies we have focused on 3-igreedient biocomposites based on HAP/PVP/histidine investigating their mechanical performance, SEM morphology, swelling property and incubation response.

Tensile strength tests have shown the best performing hydrogel composites consist of 15ml PVP and 15 ml histidine, and were selected for further studies with HAP. The best mechanically performing composite of HAP/PVP/histidine was the one containing 1.25g of HAP. Swelling ability was measured at distilled water (reference), Ringer's fluid, artificial saliva and haemoglobin. In HAP/PVP/histidine composite the highest swelling properties have the samples containing 0.5g and 0.75g of HAP and reach overall 4,5 g/g after 24 hours, which is ultimate rate desirable in drug delivery systems. The incubation studies in Ringer's Fluid turned out to be most interesting, where pH of tested solution increase at the beginning of incubation (from 7 to 8.2) and next in the course of further 7 days of the immersion pH values decrease (below 7), caused by the mineralisation of HAP. The SEM/EDX analysis of the composites after incubation showed the formation of apatite deposits on the surface, which confirms bioactivity of this material and it desirable features for orthopaedics.

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Poster 68: Polymeric blends as drug carriers for the treatment of periodontal disease

Periodontal pathogens that are present in the oral cavity can result in periodontal disease, i.e. a chronic, inflammatory disorder, causing progressive destruction of soft and hard periodontal tissues. Subgingival barrier materials intended for guided tissue regeneration (GTR) technique can be used to support regeneration of periodontal tissues.

Our aim was to obtain barrier membranes for GTR technique, which are made of polymeric blends enriched with antibiotic, to reduce amount of pathogenic bacteria in the treated area. Such materials are intended to: 1) deliver required amount of antibiotic locally, 2) allow separation of gingiva from the bonny defect to assure required condition for tissue regeneration and 3) degrade into non-toxic products after tissue regeneration is completed, to avoid the second surgery.

The barrier materials being the blends of two polymers: poly(L-lactide-co-glycolide) (PLGA) and poly(ethylene glycol) (PEG) and containing 1% gentamicin sulphate (GS) were produced by solvent casting from dichloromethane solution followed by solvent evaporation and drying. Microstructure of the samples was characterised under scanning electron microscopy (SEM). Fourier transform infrared (FTIR) and Raman spectroscopies were used to characterise chemical structure of the membranes and presence of GS. GS release was assessed at different time intervals using the OPA method. Membrane susceptibility to degradation was also studied.

The results show, that we developed a method of manufacturing of PLGA/PEG blend modified with GS. Presence of GS was confirmed with Raman spectroscopy, by presence of a band at 980 cm^{-1}, attributed to C-O-C stretching vibrations, which was not found in the spectra of PLGA nor PEG. Release study showed initial burst followed by sustainable delivery of GS. To sum up, obtained materials, might be considered for GTR in periodontology.

BOŻENA TYLISZCZAK

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Poster 69: Biocompatible PVP-based composites for application in tissue engineering

In the research, a methodology of the synthesis of biocompatible PVP-based composites has been developed. The main purpose of presented studies was to develop the methodology of the synthesis of such matrices which will provide them with adequate crosslinking degree and mechanical properties. A series of matrices consisting of various amounts of PVP and gelatin has been prepared via UV radiation. Furthermore, additional attention has also been paid on the impact of the amount and the type of the crosslinking agent and photoinitiator used for the synthesis. During the research diacrylate poly(ethylene glycol) with various average molecular weights has been used as crosslinking agent. The role of photoinitiator has been played e.g. by 2-hydroxy-2-methylpropiophenone. Adequately developed composition and the conditions of the synthesis of PVP-based composites are meaningful in viewpoint of such their physicochemical properties as sorption capability, the ability of the release of the active substance from the composite and also the cytotoxicity toward selected cell lines (possibility of the presence of non-crosslinked reagents in the composite matrix). Moreover, based on the performed investigations in the next part of the research selected compositions will be modified with such additives as e.g. collagen, hydroxyapatite, selected growth and anti-inflammatory factors and/or the active substance. Such developed composites seem to be promising materials which may support bone tissue regeneration while showing bacteriostatic and bactericidal effects and acting as a carrier of the active substance.

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Poster 70: Structural investigations of cerium-doped and copper-doped silicate glasses with antibacterial and angiogenic properties

Cerium-doped and copper- doped glasses were synthesized by traditional melting techniques to obtain bioactive amorphous materials with antibacterial and angiogenic properties. The influence of cerium and copper ions addition on glass structure was described using two spectroscopic methods (FTIR and 29Si MAS NMR). The study shows the different roles of these ions in the glass network, which influenced on thermal properties, microstructure, bioactivity, and biological response. It was proven that polymerization level and different role of dopants ions have a significant influence on dissolution products and rate of the researched glasses incubated in SBF. The polymerization of the glass structure slows down the formation of apatite overtime at the same time inhibiting bioactive properties. In order to evaluate the potential application of the obtained materials in the field of bioceramic implants, the indirect in vitro biocompatibility studies on two types of cell lines (MG-63 and ST-2) were carried out and the obtained results were associated with the glass structure. The evaluation of the potential angiogenic properties of researched glasses indicates that the presence of copper ions in the glass structure can increase the VEGF secretion and support the neovascularization process. Dissolution products of all samples were tested for antibacterial activity against gram-negative (E. coli) and gram-positive bacteria (S. aureus). The copper ions prove better antibacterial activity than cerium ions, what can be explained by more easily released Cu ions from the glass structure.

MACIEJ WARCABA

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Poster 71: Electrophoretic deposition and characterization of HA/sodium alginate coatings on commercially pure titanium

Titanium and titanium alloys are important metallic biomaterials due to their outstanding properties. They have low density, high specific strength, excellent electrochemical corrosion resistance and good biocompatibility. However, their osseointegration properties are poor. Therefore, bioactive coatings are often necessary. The aim of this work was to elaborate the conditions for electrophoretic deposition (EPD) of bioactive HA/sodium alginate coatings on the commercially pure titanium and to characterize the coatings microstructure and selected properties. Two types of titanium substrates were used, the as-received substrates and substrates after chemical treatment with solution of $Na_3PO_4 \cdot 12H_2O$ at 80 °C and a solution of 5 ml HF 40% + 35 ml HNO_3 70% at room temperature. The suspensions used for the EPD process consisted of 4 g/l sodium alginate and 1 g/l or 1.5 g/l or 2 g/l or 2.5 g/l of HA and the dispersion medium containing water (60 vol.%) and ethanol (40 vol.%). The zeta potential was negative in all investigated pH range of 3-12. Macroscopically homogeneous coatings were obtained from the suspensions containing 1, 1.5 and 2 g/l of HA at 7 V during 300 s. HA agglomerates were homogeneously distributed in the polymer matrix. The coatings containing HA in the range of 1-2 g/l exhibited high adhesion to the chemically treated substrates. All coatings were characterized by relatively high surface development and revealed hydrophilic character.

MARCIN WEKWEJT

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Poster 72: Mechanical properties and cytocompatibility of PMMA bone cement loaded with several biodegradable components

Despite the body's natural ability to self-healing, some bone fractures cannot be spontaneously repaired and PMMA bone cement (BC) is to be used to support tissues` regeneration. Its wide application originates mainly from its processability, fast polymerization and favorable mechanical properties. However, it is a non-biodegradable low-porous material without osseointegrative properties and this may result in limited integration with host bone tissue. In this work, we aimed to develope partially-degradable bioactive bone cement and compare five different commercially available components as potential BC additives. Acrylic BC Cemex (Tecres) was used as the base material modified with one of the following additives at three contents – 2.5, 5 and 10 wt% of cellulose, chitosan, magnesium, polydioxanone and tri-calcium phosphate. The following tests were performed to evaluate the influence of those additives on several BC properties: setting time, microstructure, surface wettability, mechanical and nanomechanical properties, MMA release, PBS exposure and DPSC cytocompatibility. The results show that it is possible to create partially-degradable bone cement and all studied modifiers fulfilled this purpose. Applying the additives significantly improved porosity of BC matrix, it did not affect its setting parameters, however slightly decreased its wettability and mechanical properties. Moreover, some of the modified BC showed relatively poor cytocompatibility, which was attributed to the unreacted MMA monomer release. Our studies suggest the optimal content of biodegradable component without significant deterioration of BC properties is 5 wt% and the most promising additive may be polydioxanone.

SEBASTIAN WILK

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Poster 73: Carbon nanofibers modified in mass with functionalized multi-walled carbon nanotubes – investigating the impact of physicochemical and electrochemical properties on cellular response

In the following research, carbon-carbon type composites of carbon nanofibers modified in mass with functionalized multi-walled carbon nanotubes were fabricated by the electrospinning technique. Different types of CNTs were used, both oxidized and amino-functionalized, to evaluate the impact on physicochemical and biological properties of nanofibrous mats obtained from PAN polymer precursor. The parameters of the electrospinning process and thermal treatment were optimized. The surface and electrical properties of materials were characterized. The mats with highly oxidized nanotubes were recognized as the most conductive material. Biological cytotoxicity and proliferation assays were carried out on L929 and HDF cells. The tested materials showed high biocompatibility, and cell adhesion and proliferation was guided by the nanofibrous morphology. Moreover, antibacterial tests on both gram negative and gram positive bacteria strains, as well as ROS test were performed to evaluate the bactericidal properties of the fabricated composites. Carbon nanofibers modified with highly oxidized and amino functionalized highly oxidized nanotubes showed excellent antimicrobial properties against antibiotic-resistant *S.aureus* and multi-drug resistant *E.coli* bacteria strains, due to the high ROS production and specific characteristics of used modifiers. Finally, the amino functionalized highly oxidized and highly oxidized carbon nanotubes were recognized as the most effective carbon nanofibers modifier.

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Poster 74: Cellular Studies on Stromal Cells and Piezoelectric Nanofibers Subjected to Ultrasounds Stimulations for Medical Devices

Smart piezoelectric materials are of great interest due to their unique properties. Piezoelectric materials can transform mechanical energy into electricity and vice versa. Recent years show progress in the applications of piezoelectric materials in biomedical devices due to their biocompatibility and biodegradability [1]. An example of smart materials are piezoelectric scaffolds, which can generate electrical signals in response to the applied stress [2]. The piezoelectric scaffolds can act as sensitive mechanoelectrical transduction systems. It is known that electrical charges are crucial for various activity of cells [3,4].

Polyvinylidene fluoride (PVDF, Mw = 530 000 g/mol) nanofibers were electrospun from 15% solution of dimethylformamide and acetone (DMF/Ac 4:1 weight ratio) at feed rate 0.2 mL/h (3 mm needle) and collected on drum collector (diameter 40 mm) at a distance between the needle and collector 180 mm.

Human adipose-derived stromal cells (ADSCs) were cultured in osteogenic medium on the piezoelectric PVDF scaffolds electrospun with different collector rotational speed (200, 1000 and 2000 rpm) and subjected to ultrasound stimulation (power 80 mW, frequency 1.7 MHz) for 30 minutes every 24 hours. As a control for each group, ADSCs seeded on piezoelectric PVDF scaffolds without ultrasonic stimulation were used (0 mW). In order to confirm the piezoelectric effect on ADSCs viability, PrestoBlue cell viability test was performed on day 3, 14 and 21. Results were statistically analyzed using Student's t-test. The observations of fibers and cell morphology were conducted using Scanning Electron Microscopy (SEM).

Conclusions PVDF nonwovens as piezoelectric polymer stimulated by ultrasounds is advantageous for cells' viability. The obtained preliminary results are promising from the perspective of tissue engineering applications.

NATALIA ZŁOCISTA-SZEWCZYK

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Poster 75: Composite hydrogels based on gellan gum and sodium alginate for the cartilage tissue regeneration

Cartilage tissue is a connective, non-vascularized tissue consisting of chondrocytes and protein fibers [1]. Sodium alginate (ALG) and Gellan Gum (GG) are biocompatible materials showing low toxicity, and they can be easily modified by incorporating additives. In our studies hydroxyapatite (HAp) and graphene oxide (GO) have been used as modifillers. HAp is bioactive ceramics, while GO has a positive effect on cell adhesion, exhibits exceptional mechanical properties and has a large specific surface area [2-3].

In this work materials based on gellan gum and sodium alginate have been investigated as potential scaffolds for cartilage regeneration. The effect of hydroxyapatite and graphene oxide additives on the thermal properties and water uptake of hydrogels based on GG and ALG in the ratio of 8:2 and with different content of nanoadditives has been evaluated. Based on DSC and water uptake investigation results the freezing and non-freezing water content, as well as the absorption ability of the materials have been determined. Slight variations in sample mass were observed during incubation. The research shows the positive effect of the additives on composite hydrogels selected properties - composite hydrogels were characterized by good water absorption whereby thermal properties remain unchanged. The tested materials are promising candidates for scaffolds in cartilage tissue engineering.

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