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CONTENTS

PLENARY AND KEYNOTE LECTURES

Athina Samara – *Biocompatibility assessment: current challenges and future considerations* **7**

Debora Puglia – *Furan-based polymers and copolymers; synthesis, applications and EoL options* **8**

Filippo Pierini – *Stimuli-responsive micro- and nanostructured materials for biomedical applications* **9**

Danijela Gregurec – *Wireless Magnetic Interactions Between Functional Nanomaterials and Neurobiology* **12**

Timothy Douglas – *Whey protein isolate: a versatile biomaterial for tissue engineering and drug delivery* **14**

ORAL PRESENTATIONS

Jakub Rybka – *Engineering Collagen-Based Biomaterials: dECM Bioinks, Marine Spongin, and Transcriptome-Driven Meniscus Regeneration* **16**

Artur Bonik – *Biopolymers in 3D Printing: limitations and perspectives in spinal implant applications* **18**

Konrad Szustakiewicz – *Advances in the polymer scaffolds preparation* **21**

Magdalena Mazurek-Budzyńska – *Electrospun poly(carbonate-urea-urethane)s nonwovens with shape-memory properties as a potential biomaterial* **22**

Jana Hlinková – *Using random fibers to study early stages of neural pseudospheroid formation* **25**

Moein Zarei – *Electrospun Hydrogel Nanofibers Loaded with Natural Antimicrobials for Wound Healing* **27**

Camilla Hjort Pagh – *Life cycle of materials in a Medical Device company* **29**

Peter Polyak – *Transformation of American rubber through domestic innovation for supply security: TARDISS (on-line)* **30**

Anne Eriksson Agger – *Investigating the role of graphene oxide in spontaneous spheroid formation & synthetic oral tissue models* **31**

Shukufe Amukarimi – *Tailoring GelMA for Tissue Engineering: Influence of Methacrylic Anhydride Concentration on Degree of Methacrylation and Material Properties* **32**

Agata Goszczyńska – *Synthesis and characterization of photo-crosslinkable furan-based methacrylate monomers with PEG segments* **34**

Agnieszka Piegat – *Mucoadhesive Nanoparticles for Drug Delivery: Versatile Tools for Improved Therapy* 36

Laura Bressanelli – *Sustainable Production of Bioactive Nanosystems from Rice Biomass Residues* 38

Mohamed Hasanin – *From potato peel waste to a nanoscale drug carrier system: Sustainability and Obstacles* 40

Regina Jeziórska – *Recent trends in thermoplastic starch modification* **42**

Bartłomiej Kryszak – *Surface modification of polymer-ceramic biocomposites using laser treatment* 43

Nicolas Maciejewicz-Kamiński – *Properties Comparison of Injectable Hydrogel Materials Derived from PEG_{600} and Dilinoleic Diol as Monomers* **44**

Cláudia A B dos Santos – *The effect of amber extract on poly(lactic acid) films obtained in solution casting* 45

Izabela Irska – *Increasing poly(ethylene 2,5-furanoate) glass transition temperature via copolymerization with poly(ethylene 2,6-naphthalate)* 47

Bio-Survivor: Who Does It Better – Biobased Polymers or Microbial Consortia of the Baltic Sea?

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Abstract

As most plastic waste ends up in the sea, the marine industry is looking for sustainable alternatives to conventional plastics and bio-based polymers are being explored for use in equipment and components. However, their long-term stability in the ocean remains uncertain - especially if these materials are lost or dumped at sea.

This study evaluates the resistance of these biobased polymers – namely poly(3-hydroxybutyrate) (PHB), poly(butylene succinate) (PBS) and poly(lactic acid) (PLA) – to degradation by marine microbial consortia from the Baltic Sea. The aim was to assess whether the materials could be degraded in marine environment by the sea microbial consortia, which could limit their durability and raise environmental concerns.

Initial screening of degrading ability of the microorganisms was performed using agar plate tests with emulsified polymers to detect the formation of halozones. To better investigate the degradability, the polymer samples of solid polymers in granular or foil form (prepared by hot pressing or solvent casting) were exposed to microbial consortia. The structural changes were investigated by scanning electron microscopy (SEM), while the chemical and physical changes were monitored by differential scanning calorimetry (DSC) and gel permeation chromatography (GPC/SEC-MALS). The bacterial growth was monitored by optical density (OD) measurements and the corresponding bacterial strains were identified by MALDI-TOF and DNA sequencing.

The results show that some bacteria naturally present in the Baltic Sea are able to degrade some biobased polymers. This suggests that if these materials enter the marine environment, they may not remain intact, which may not cause 'ghost fishing' if equipment is lost. While their biodegradability may provide environmental benefits in the case of waste, it may also pose a risk for long-term use in marine equipment if the materials are susceptible to microbial attack.