

1. PHD PROJECT DESCRIPTION (4000 characters max., including the aims and work plan, all in English)

Project title: Composite biopolymer materials for biomedical and cosmetic applications

- 1.1. Project goals:** The main goal of the project is fabrication of biopolymer based materials with good mechanical properties and thermal stability for potential biomedical and cosmetic applications. Several cross-linking methods will be employed to prepare new composite materials based on biopolymer mixtures. Inorganic particles will be used to improve mechanical properties and biocompatibility. Analysis of the biological properties of the biopolymers will be associated with the evaluation of their biocompatibility. The level of cell proliferation and potential toxicity of tested materials will be conducted using several assays and selected human and animal cell lines according to the ISO 10993-5 and ISO 10993-12 standards.

- 1.2. Outline:** Polymeric materials are widely applied in the biomedical field. Although it is much easier to use synthetic polymers in the biomedical field, natural polymers are also required due to their biocompatibility and biodegradability. New method for preparation of polymeric materials for biomedical and cosmetic applications is active blending of two or more natural polymers. During the last three decades an increasing interest in new materials based on the blends of two or more polymers has been observed. Blending of two or more biopolymers can compensate the weakness of each ones and may result in a new biocomposite. In this project biopolymers will be extracted from natural sources and new materials based on blends of two or more biopolymers will be studied. Moreover, inorganic nanoparticles will be incorporated into biopolymer blend. New materials will be shaped into films, 3D sponges and hydrogels. Appropriate cross-linking agents will be used to stabilize the material structure. Morphological and physicochemical properties of the materials will be studied. Biological properties of new composites will be studied for potential application as biomaterials using selected human and animal cell lines and the extract dilution method or the indirect/direct contact methods according to the ISO 10993-5 and ISO 10993-12 norms. The adhesion of biopolymer films on the skin and hair surface will be studied.

- 1.3. Work plan:** **1)** purification and characterization of biopolymers; **2)** development of new composite materials based on the blends of natural polymers; **3)** modification through a self-assembly, hydrogen bonding and chemical/UV crosslinking between components; **4)** characterization of the materials properties; **5)** intercalation of inorganic particles into biopolymer blends with different weight ratio of components; **6)** investigation of the structure of new materials, porosity and density (DSC, FTIR, UV-Vis spectroscopy, SEM, AFM, TEM); **7)** biological study related to the evaluation of the

biocompatibility of the tested biopolymers

1.4. Literature

- S. Grabska-Zielińska, J. M. Pin, B. Kaczmarek-Szczepańska, E. Olewnik-Kruszkowska, A. Sionkowska, F.J. Monteiro, K. Steinbrink, K. Kleszczyński. Scaffolds loaded with dialdehyde chitosan and collagen – their physico-chemical properties and biological assessment. *Polymers* 2022, 14, 1818. <https://doi.org/10.3390/polym14091818>
- A. Tuwalska, S. Grabska-Zielińska, A. Sionkowska. "Chitosan/Silk Fibroin Materials for Biomedical Applications—A Review". *Polymers* 2022, 14, 1343. <https://doi.org/10.3390/polym14071343>
- B. Mahesh, D. Kathyayani, D. Channe Gowda, A. Sionkowska, S. Ramakrishna. Miscibility and thermal stability of synthetic Glutamic acid comprising polypeptide with Polyvinyl alcohol: Fabrication of nanofibrous electrospun membranes. *Materials Chemistry and Physics* 2022; 281; 125847.
- P. Bełdowski, M. Przybyłek, A. Sionkowska, P. Cysewski, M. Gadomska, K. Musiał, A. Gadomski. Effect of chitosan deacetylation on its affinity to type III collagen: molecular dynamics study. *Materials* 2022, 1523716.
- A. Sionkowska. Collagen blended with natural polymers: Recent advances and trends. *Progress in Polymer Science* 2021; 122: 101452. pp. 1-12
- A. Doderò, S. Scarfi, S. Mirata, A. Sionkowska, S. Vicini, M. Alloisio, M. Castellano. Effect of crosslinking type on the physical-chemical properties and biocompatibility of chitosan-based electrospun membranes. *Polymers* 2021; 13(5), 831.
- S. Grabska-Zielińska, A. Sionkowska. How to improve physico-chemical properties of silk fibroin materials for biomedical applications?—blending and cross-linking of silk fibroin—a review. *Materials* 2021; 14(6), 1510.

1.5. Required initial knowledge and skills of the PhD candidate: basic knowledge of chemistry or biotechnology, basic skills in laboratory work, knowledge of speaking and writing English.

1.6. Expected development of the PhD candidate's knowledge and skills: It is expected that the PhD candidate will learn new techniques of biopolymer purification and characterization. The knowledge of the PhD candidate will be developed based on international workshops and tutorials.