

PHD PROJECT DESCRIPTION

(4000 characters max., including the aims and work plan to be published online)

Project title: New wound dressing materials based on polymer blends and composites

- 1.1. Project goals:** The main goal of the project is to develop new materials based on polymer blends and composites for biomedical and cosmetic applications.
- 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 ; **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, XRD); **7)** biological study related to the evaluation of the biocompatibility of the tested biopolymers
- 1.4. Literature** (*max. 7 listed, as a suggestion for a PhD candidate preliminary study*)
- Abhishek Bhattacharjee, Aniruddha Vijay Savargaonkar, Muhammad Tahir, Alina Sionkowska, Ketul C Popat. Surface modification strategies for improved hemocompatibility of polymeric materials: a comprehensive review. RSC Advances 2024; 14, 7440; DOI: 10.1039/d3ra08738g.
 - A. Sionkowska, K. Kulka-Kamińska, P. Brudzyńska, K. Lewandowska, L. Piwowarski. The influence of various cross-linking conditions of EDC/NHS on the properties of fish collagen film. Marine Drugs 2024, 22(5), 194; <https://doi.org/10.3390/md22050194>



- K. Adamiak, V.A. Gaida, J. Schäfer, L. Bosse, C. Diemer, R.J. Reiter, A.T. Slominski, K. Steinbrink, A. Sionkowska, K. Kleszczyński. Melatonin/sericin wound healing patches: their potential in melanoma treatment. *Int. J. Mol. Sci.* 2024, 25(9), 4858; <https://doi.org/10.3390/ijms25094858>
- K. Kulka-Kamińska, M. Kurzawa, A. Sionkowska. Films based on chitosan/konjac glucomannan blend containing resveratrol for potential skin application. *Materials* 2025; 8, 457, p. 1-25.
- Ajay Kumar Sahi, Shravanya Gundu, Pooja Kumari, Tomasz Klepka, Alina Sionkowska. Silk-Based Biomaterials for Designing Bioinspired Microarchitecture for Various Biomedical Applications. *Biomimetics* 2023, 8(1), 55; <https://doi.org/10.3390/biomimetics8010055>
- M. Castellano, A. Doderio, S. Scarfi, S. Mirata, M. Pozzolini, E. Tassara, A. Sionkowska, K. Adamiak, M. Alloisio, S. Vicini. Chitosan-collagen electrospun nanofibers loaded with curcumin as wound-healing patches. *Polymers* 2023; 15(13), 2931; <https://doi.org/10.3390/polym15132931>
- D. Kathyayani, B. Mahesh, H.R. Lokesh, Alina Sionkowska, D. Channe Gowda, Katarzyna Adamiak. Investigation of miscibility and physicochemical properties of synthetic polypeptide with collagen blends and their wound therapeutic characteristics. *Int. J. Biol. Macromol.* 2023; 5 July 2023, 125704 <https://doi.org/10.1016/j.ijbiomac.2023.125704>

1.5. Required initial knowledge and skills of the PhD candidate: basic knowledge on materials chemistry, polymer chemistry, biotechnology, pharmacy. 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 extraction and purification of natural compounds from food waste and byproducts. He/she will be able to use modern techniques for the characterization of the extracts and get skills for preparation of new cosmetic formulations and biomaterials. The knowledge of the PhD candidate will be developed base on international workshops and tutorials.