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 preparation 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.

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. 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.

1.4. Literature

- B. Kaczmarek, K. Nadolna, A. Owczarek, M. Michalska-Sionkowska, A. Sionkowska. The characterization of thin films based on chitosan and tannic acid mixture for potential applications as wound dressings. Polymer Testing 2019; 78: 106007.
- B. Kaczmarek, A. Sionkowska, K. Łukowicz, A.M. Osyczka. Characterization of scaffolds based on chitosan and collagen with glycosaminoglycan. Int Journal of Polym Analysis and Characterization. 2019; 24: 374-380.
- A. Sionkowska, S. Grabska. Incorporation of of magnetite particles in 3D matrices made from the blends of collagen, chitosan and hyaluronic acid. Advances in Polymer Technology 2018;
- A. Sionkowska, B. Kaczmarek. Preparation and characterization of composites based on the blends of collagen, chitosan and hyaluronic acid with nano-hydroxyapatite. International Journal of Biological Macromolecules 2017; 102: 658-666.

1.5. Required initial knowledge and skills of the PhD candidate: basic knowledge on 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 base on international workshops and tutorials.