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

Project title: Physicochemical properties and miscibility studies of polysaccharides and vinyl polymers with potential use in cosmetics and biomedical applications

1.1. Project goals:

The primary purposes of this project are:

- **To evaluate the miscibility of the selected polysaccharides with each other and/or with selected vinyl polymers**
- **To enhance the thermal stability and physical properties of polymer blends under specific conditions**
- **To identify blend composition variants with improved physicochemical and biological properties compared to the selected parent compounds**

1.2. Outline: There is a growing trend toward using natural polymers derived from renewable resources, particularly those sourced from food industry waste and the agricultural, pulp, and paper sectors. Over the past three decades, polymers from renewable sources have gained increasing attention, primarily due to environmental concerns and the recognition of the finite nature of petroleum resources. In this context, the present study focuses on developing and evaluating the physicochemical and biological properties of new blends comprising polysaccharides or their derivatives with selected vinyl polymers. Miscibility is a key factor in the successful preparation of such materials, as their final properties largely depend on the interactions between the blended components. When favorable interactions occur, mixing of chemically distinct polymers can take place at the molecular level, often leading to synergistic improvements in material properties. The chemical structure, morphology, and properties of the resulting materials will be characterized using a range of complementary analytical techniques, including infrared spectroscopy (IR), scanning electron microscopy (SEM), atomic force microscopy (AFM), thermogravimetric analysis (TGA), chemical analysis, tensile testing, swelling behavior, contact angle measurements, and microbiological assays. Additionally, viscometric and rheological studies will be conducted. Viscosity and flow properties are critical indicators of product quality in processes involving fluid dynamics, such as extraction, extrusion, and filtration. These studies will provide valuable insights into the stability, miscibility, and processing behavior of the polymer blends under various conditions. Ultimately, this

research aims to design innovative materials with tailored properties for targeted applications, including wound healing and tissue engineering.

1.3. Work plan

1. **Purification and characterization of the selected polysaccharides and vinyl polymers**
2. **Synthesis and characterization of polysaccharide derivatives**
3. **Evaluation of miscibility in ternary systems containing a common low molecular weight solvent using viscometric studies and flow measurement**
4. **Preparation of thin films and 3D porous structures based on insights gained from solution studies**
5. **Assessment of physicochemical and biological properties using spectroscopy, thermal analysis, microscopy, tensile testing, swelling behavior, contact angle measurements, and fibroblast cell proliferation analysis via MTT assay**
6. **Interpretation of observed changes in the blends' structure and properties**

1.4. Literature *(max. 7 listed, as a suggestion for a PhD candidate preliminary study)*

1. Yu, L.; Dean, K.; Li, L. Polymer blends and composites from renewable resources. Prog. Polym. Sci. **2006**, 31, 576–602
2. Wang, S.; He, L.; Guo, J.; Zhao, J.; Tang, H. Intrinsic viscosity and rheological properties of natural and substituted guar gum in seawater. Int. J. Biol. Macromol. **2015**, 76, 262–268.
3. Kostag, M.; El Seoud, O.A.; Sustainable biomaterials based on cellulose, chitin and chitosan composites - A review, Carbohydr. Polymer Technol. Appl. **2021**, 2 100079.
4. Teodorescu, M.; Bercea, M.; Morariu, S. Biomaterials of PVA and PVP in medical and pharmaceutical applications: perspective and challenges Biotechnol. Adv. **2019**, 37 109-131.
5. Santos, V.P.; Marques, N.S.S.; Maia, P.C.S.V.; Barbosa de Lima, M.A.; de Oliveira Franco, L.; de Campos-Takaki, G.M. Review: Seafood waste as attractive source of chitin and chitosan production and applications. Int. J. Mol. Sci. **2020**, 21, 42902.
6. Silva, A.C.Q.; Silvestre, A.J.D.; Vilela, C.; Freire, C.S.R. Natural Polymers-Based Materials: A Contribution to a Greener Future. Polymers **2022**, 27, 94.

1.5. Required initial knowledge and skills of the PhD candidate: basic knowledge in polymer chemistry, chemistry, fluent English, commitment to scientific work, permanent self-education, teamwork skills, the ability to interpret and describe experimental results and draw conclusions.

1.6. Expected development of the PhD candidate's knowledge and skills: Acquiring advanced knowledge in the field of polymer chemistry; practical skills: methodology of obtaining new and multifunctional polymer materials for cosmetics and biomedical applications and their characterisation using modern instrumental analyses; the ability to write scientific publications and presentation of results at international and national conferences; ability to write scientific projects (grant applications); formulate and solve problems related to contemporary technology challenges; prepare for independent scientific work.