

PHD PROJECT DESCRIPTION

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

Project title: Biointeractive polymer-based materials for skin barrier regeneration in inflammatory skin disorders

1.1. Project goals

The project aims to design and develop biointeractive, polymer-based materials that support the regeneration of the impaired skin barrier in inflammatory skin disorders. Specific goals include:

- development of biomaterials based on natural or hybrid polymer systems for topical skin applications,
- investigation of structural, mechanical, and other properties relevant to skin barrier support,
- incorporation of active compounds and evaluation of their interactions with polymer matrices and release behavior,
- evaluation of interactions between biomaterials and selected skin-relevant models in the context of inflammatory skin disorders.

1.2. Outline

Skin barrier dysfunction is a key feature of inflammatory skin disorders such as atopic dermatitis and psoriasis. Disruption of barrier integrity leads to increased transepidermal water loss, enhanced susceptibility to irritation and chronic inflammation. Although conventional formulations can provide temporary symptom relief, there remains a need for advanced materials capable of actively supporting barrier regeneration.

This project focuses on the development of biointeractive biomaterials designed to interact with the skin environment in a controlled manner. Natural polymers will be used to design multifunctional biomaterial systems with improved hydration, film-forming properties and delivery of active compounds. The project combines materials design, physicochemical characterization and biological evaluation to assess how these materials perform in epidermal applications.

1.3. Work plan

WP1. Design and preparation of biomaterials

Design and preparation of polymer-based systems for topical applications, including selection of polymers, formulation strategies and processing methods. Particular emphasis will be placed on the incorporation of active compounds into polymer matrices and optimization of their distribution and stability within the system.

WP2. Physicochemical and functional characterization

Characterization of structural, rheological, mechanical and barrier-related properties using selected analytical techniques. Evaluation of hydration-related performance and release behavior.

WP3. Biological assessment and skin-related evaluation

Investigation of cytocompatibility and interactions with selected skin-related models/skin cells, with emphasis on properties relevant to inflammatory skin conditions and barrier regeneration.

The expected outcome is polymer-based materials with controlled composition, structure and release behavior, and their verified performance in supporting skin barrier function.

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

Kaur G. et al., ACS Appl Bio Mater. 2022, 5(5):2069-2106. doi: 10.1021/acsabm.2c00035

Kim Y. et al., Mater Today Bio. 2025, 35:102517. doi: 10.1016/j.mtbio.2025.102517

Zhang H. et al., Bioact Mater. 2023, 33:355-376. doi: 10.1016/j.bioactmat.2023.11.012.

Wang M. et al. Bioact Mater. 2024, 39:492-520. doi: 10.1016/j.bioactmat.2024.04.011

1.5. Required initial knowledge and skills of the PhD candidate

Candidates should have a background in chemistry, materials science or related disciplines. Basic knowledge of polymers, soft materials or formulation science is required. Practical experience in laboratory work is expected, including basic analytical techniques. Familiarity with physicochemical characterization methods (e.g. spectroscopy, thermal analysis or microscopy) will be an advantage. Basic skills in data analysis and interpretation are desirable. Interest in materials design and willingness to work at the interface of chemistry and applied biomaterials are essential.

1.6. Expected development of the PhD candidate's knowledge and skills

The PhD candidate will gain practical experience in the design and preparation of polymer-based materials, including formulation strategies and incorporation of active compounds. The candidate will develop skills in experimental design, data analysis and interpretation of results. The PhD candidate will be involved in preparing scientific publications and presenting research results at national and international conferences. The project will support the development of independent research skills relevant to further academic or applied research careers.