

1. PHD PROJECT DESCRIPTION

Project title: Polymeric materials with antimicrobial activity

1.1. Project goals

- obtain novel antimicrobial materials based on polymers with an addition of active compounds;
- evaluation of physicochemical and biological properties of obtained materials;
- the improvement of antimicrobial activity of obtained materials;
- the obtainment of materials for potential application as biomaterials, packaging materials, cosmetics.

1.2. Outline

Materials based on polymers possess many advantages in their use to produce usable products as biomaterials, packaging materials, cosmetics, etc. However, they are characterized by pure antimicrobial activity. The increase of antimicrobial resistance has a significant impact on public health, global development, and even the global economy. Polymers, both natural (chitosan, hyaluronic acid, gelatin etc.) and synthetic ones (poly(vinyl alcohol), polylactide, poly(glycolic acid) have been brooded used to produce consumables. However, there is a need to search for the polymers additives which would enhance their properties.

Introducing active compounds e.g. phenolic acids or essential oils into polymer matrix will develop functional products with unique features. Moreover, active compounds may act as polymers cross-linkers and lead to the improvement of polymeric materials.

1.3. Work plan

The main goal will be achieved through implementations of working elements as followed:

WE1: Preparation of thin films and 3D structure materials based on polymeric-active compound systems.

WE2: Physicochemical characterization of prepared materials will be carried out by different methods e.g. ATR-FTIR, mechanical testing, contact angle measurement, AFM, swelling/degradation tests, thermal properties (by TG, DSC). Moreover, antioxidant properties of obtained materials will be studied.

WE3: Biological studies such as e.g. bacterial biofilm formation, analyzing the integrity of cell membranes by LIFE/DEAD staining, dehydrogenase activity in the oxygen chain reaction. Biological studies will be carried out in cooperation with the Faculty of Biological and Veterinary Sciences NCU.

1.4. Literature

Michalska-Sionkowska M. et al., Antimicrobial activity of new materials based on the blends of collagen/chitosan/hyaluronic acid with gentamicin sulfate addition, *Mater. Sci. Eng. C*, Vol. 86 (2018) 103-108

Olewnik-Kruszkowska E. et al. Antibacterial Films Based on PVA and PVA-Chitosan Modified with Poly(Hexamethylene Guanidine), *Polymers* 11 (2019) 2093

Kaczmarek B. et al., New composite materials prepared by calcium phosphate precipitation in chitosan/collagen/hyaluronic acid sponge cross-linked by EDC/NHS, *Int. J. Biol. Macromol.*, Vol. 107 (2018) 247-253

Kaczmarek B. et al., The characterization of thin films based on chitosan and tannic acid mixture for potential applications as wound dressings, *Polym. Test.*, Vol. 78 (2019) 106007- 1-4

Kaczmarek-Szczepańska B. et al., The preparation and characterization of chitosan-based hydrogels cross-linked by glyoxal, *Mater.*, Vol. 14 (2021) 2449

Kaczmarek B. et al., The mechanical properties and bactericidal degradation effectiveness of tannic acid-based thin films for wound care, *J. Mech. Beh. Biomed. Mater.* 110 (2020) 103916

Olewnik-Kruszkowska E. et al. Physicochemical and barrier properties of polylactide films including antimicrobial additives, *Materials Chemistry and Physics*, 230 (2019) 299-307.

1.5. Required initial knowledge and skills of the PhD candidate

- Analytical thinking
- Eager to learn
- Knowledge about polymers
- Knowledge about materials characterisation
- Basic knowledge about biological studies

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

- Acquiring advanced skills in analysing materials
- Learning advanced instrumental techniques
- Learning techniques of the laboratory work
- Learning biological research techniques
- Development of analytical thinking
- Personal development as young scientist