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

Project title: The fabrication of polymeric materials by various methods, dedicated for potential application as packaging, in medicine and cosmetics.

1.1. Projectgoals

- expand knowledge about different methods of polymeric materials preparation, including 3D printing;

- design novel materials based on polymers by Direk Ink Writing, lyophilization, and solvent evaporation

- evaluation of physicochemical and biological properties of the obtained materials;

- improvement of the bioactive properties of polymeric materials by addition of compounds with antimicrobial properties;

1.2. Outline

Direk Ink Writing (DIW) is having great success in various applications. DIW printing is becoming popular due to a wide range of materials accessible to screen printing, the ability to produce geometrically complex 3D shapes with high resolution, and the ability to make design and material changes during work.

Due to many advantages, polymers can be used to create utility products such as packaging materials, biomaterials, medical materials, etc., and can be used in the DIW method. Applying polymers in Direk Ink Writing printing affects the possibility of creating new materials with new properties, or improving the physicochemical properties of materials obtained by freeze-drying or solvent evaporation.

1.3. Workplan

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

WE1: Design and control of appropriate viscosity and properties of elastic inks[1].

WE2: Production of 3D structural polymeric materials by the Direct Ink Whiting method with the F-NIS 23151 3D printer.

WE3: PFabrication of polymeric materials by lyophilization and solvent evaporation.

WE4: Physicochemical characterization of the prepared materials will be carried out by various methods, including ATR-FTIR, mechanical tests, contact angle measurement, AFM, swelling/degradation tests, thermal properties (TG, DSC), etc.

WE5: Biological research, such as formation of bacterial biofilm, analysis of cell membrane integrity by LIFE/DEAD staining, dehydrogenase activity in oxygen chain reaction. Biological research will be carried out in cooperation with the Faculty of Biological and Veterinary Sciences of Nicolaus Copernicus University.

WE6: Comparison of the obtained results for materials obtained by different techniques.

1.4. Literature *(max. 10 listed, as a suggestion for a PhD candidate)*

[1] J.E. Smay, J. Cesarano, J.A. Lewis, Colloidal inks for directed assembly of 3-D periodic structures, Langmuir 18(14) (2002) 5429-5437.

[2] M. A. S. R. Saadi, Alianna Maguire, Neethu T. Pottackal, Md Shajedul Hoque Thakur, Maruf Md. Ikram, A. John Hart, Pulickel M. Ajayan, Muhammad M. Rahman, Direct Ink Writing: A 3D Printing

Technology for Diverse Materials, Advanced Materials 34 (28) (2022) 2108855 https://doi.org/10.1002/adma.202108855
[3] J. A. Lewis, Direct Ink Writing of 3D Functional Materials, Advanced Functional Materials, 16 (17) (2006) 2193-2204 https://doi.org/10.1002/adfm.200600434
[4] Dr. Longyu Li, Qianming Lin, Miao Tang, Dr. Andrew J. E. Duncan, Prof. Dr. ChenfengKe, Advanced Polymer Designs for Direct-Ink-Write 3D Printing, Chemistry – A European Journal, 25(46) (2019) 10768-10781 https://doi.org/10.1002/chem.201900975
[5] Hehao Chen, Xiaofeng Wang, FengdanXue , Yujuan Huang , Kechao Zhou , Dou Zhang, 3D printing of SiC ceramic: Direct hi hiting with a solution of preceramic polymers, Journal of the European Ceramic Society, 38(16) (2018) 5294-5300 https://doi.org/10.1016/j.jeurceramsoc.2018.08.009

1.5. Required initial knowledge and skills of the PhDcandidate

- Analytical thinking
- Eager to learn
- Knowledge about polymers
- Knowledge about materials preparation and characterization
- Basic knowledge about biological studiessuch as biocompatibility and antimicrobial

1.6. Expected development of the PhD candidate's knowledge andskills

- 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