DISSERTATION SUMMARY

Pressure-assisted methodology for the synthesis of ultrapure polymer materials for biomedical and pharmaceutical applications.

Presented PhD dissertation consisting of a series of four scientific papers aimed to develop a unique synthetic strategy based on a dually-catalyzed approach combining an *'internal'* non-toxic (organo)catalyst and *'external'* physical factor (elevated pressure), inducing/controlling the course of the polymerization process of various types of monomers. This work is mainly focused on the polymerization of monomers classified as *'hardly-polymerizable'* and *'less activated'*, especially γ-butyrolactone (GBL) and 1-vinyl-2-pyrrolidone (VP) – being precursors of particularly important polymers intended for biomedical and pharmaceutical applications. The main goal of this work was to develop innovative, highly efficient and controlled methods of polymerization (GBL ring-opening polymerization (ROP) and VP free-radical polymerization (FRP)), allowing to obtain ultra-pure polymers of well-defined parameters (i.e. tailored molecular weight, dispersity and chain topology).

The conducted research confirmed that the use of high pressure can force GBL ROP which is not possible at atmospheric pressure or proceeds with low efficiency, even at extremely low temperatures. The application of elevated pressure also enabled FRP of VP in a controlled manner yielding ultra-pure polymers of parameters currently unattainable in the industry (moderate dispersity) by applying a fast and efficient synthetic strategy without using any additional catalysts. The routine analysis of the obtained macromolecules (NMR, FT-IR, SEC-LALLS, MALDI-TOF) was extended to comprehensive, interdisciplinary research (including calorimetric, rheological and biological studies). It was also investigated if the polymer structure (topology and length of the PVP chains) affects both drug loading content and drug release profile and it was assessed as a key factor in the development of new formulations with active pharmaceutical ingredients.

To sum up, the results of the research discussed in this dissertation clearly demonstrated that the use of system compression allows to *i)* overcome the thermodynamic limitations of *'hardly-polymerizable'* systems, *ii)* reduce the reaction time and significantly increase the efficiency, *iii)* produce of tailored polymers of better or even unique parameters (higher molecular weight and smaller dispersity) in comparison to the polymerization performer at ambient pressure, *iv)* simplify the reaction system and reduce/eliminate the necessity of using toxic reagents.