ABSTRACT

The habilitation thesis entitled "SINGLE- AND MULTICOMPONENT POLYMER SYSTEMS WITH CONTROLLED 3D ARCHITECTURES" presents the most relevant scientific results of the author after defending her PhD thesis at "Petru Poni" Institute of Macromolecular Chemistry, Iasi (June 2009).

The thesis is structured as follows: **Section I** describes the main "***Professional and Academic Achievements***" of the candidate, **Section II** outlines her prominent "***Scientific Achievements***" in the area of single- and multicomponent polymer systems, namely hydrogel-based systems and vesicular polymer architectures obtained by self-assembly of amphiphilic block copolymers in aqueous media, **Section III** presents the "***Scientific and Professional Development Plans***", whereas **Section IV** includes a list of references used in this habilitation thesis.

Single- and multicomponent polymer systems with controlled 3D architectures have been prepared from synthetic or natural polymers or various combinations of them, which have been stabilized through physical or chemical cross-linking. The morphology of 3D architectures was controlled either by synthesis conditions for the hydrogel-type systems or by the intrinsic properties of the amphiphilic block copolymers used to prepare vesicles by self-assembly in aqueous media. These research topics, which were developed mainly after defending the PhD thesis, include: (i) hydrogels/cryogels prepared by conventional methods, ice-templating (cryogelation) and/or leaching techniques with applications in environmental protection (removal of heavy metal ions, dyes), medicine (drug delivery, tissue engineering), and food industry, and (ii) cross-linked polymer vesicles (polymersomes) as protective compartments for enzymes functionality, packing polymers/hydrogels into enzyme-loaded polymersomes (nanoreactors) via ARGET-ATRP, and enzymatic catalysis into the confined space of nanoreactors. By simply controlling several key parameters (monomer/polymer choice, initial monomer or polymer concentration, cross-linking degree, the molecular weight

of polymer, freezing and thawing temperature, the number of freeze-thawing cycles, the crystallization speed, and freeze-drying pressure), single- and multicomponent cross-linked porous systems with unique and tunable 3D architectures (porosity, thickness of pore walls, pore sizes, and pore interconnectivity) have been successfully designed. Moreover, using the synthesis conditions of atom transfer radical polymerization, where the reaction activators are regenerated by electron transfer (ARGET-ATRP), successful polymerization of poly(ethylene glycol) methyl ether acrylate have been achieved within the lumen of polymersome-based nanoreactors. Detailed supporting information related to the research topics mentioned above are included in this thesis, in **Section II "*Scientific Achievements"***. This section was separated in two chapters:

Chapter II.1 – Design of 3D Polymer Systems with Unique, Well-Structured Morphologies presents the advantages and disadvantages of cryogelation approach versus the conventional hydrogel preparation methods, the effect of various synthesis parameters on morphological structure of hydrogel-based materials, and how cryogels binding capacity and selectivity could be improved by ion-imprinting approach. Preparation of self-assembled vesicular architectures is also introduced in this chapter, including the formation of enzyme-loaded nanocompartments (nanoreactors) and biocatalytic synthesis of polymers within the lumen of polymersomes.

Chapter II.2 – **Applications of Polymer Systems with Controlled 3D Architecture** – introduces the most important application domains of these polymer systems: water purification, catalysis, drug delivery, food packaging, or biotechnology.

The current state-of-the-art in the field of single- and multicomponent cross-linked polymer systems with controlled micro- or nano-scale architectures is summarized in this habilitation thesis in comparison to the results of the candidate. The perspectives and future research directions that will further contribute to the scientific development of the author are presented in **Section III** – "***Scientific and Professional Development Plans***". The habilitation thesis ends with **Section IV** which consists of all cited references.