Department of Materials Science and Engineering

PhD Thesis Proposal

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Bossone 302

Structure and Properties of Advanced Polymeric Particles Templated by Miniemulsion Crystallization

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Polymeric micro/nanoparticles have attracted significant interest in the past few decades due to their relevance in a number of fields such as biomedical, cosmetics, and food industry. As more complex particles, in function and structure, are emerging as solutions to a variety of problems, simple and versatile methods to obtain them are a necessity. The methods commonly employed tend to provide particles that have simple morphology of spheres or cylinders that are inherently fluidic and dynamic due to the long chain nature of macromolecules.

The goal of this PhD thesis is to develop advanced polymeric micro/nanoparticles utilizing a recently developed miniemulsion crystallization system where polymer crystallization is carefully controlled in emulsion droplets to produce spherical, hollow single crystal-like polymer capsules termed "crystalsomes". Three thrusts will be investigated including 1) Fabricating multifunctional nanoparticle-containing crystalsomes by understanding the synergistic assembly/crystallization process in a nanoparticle/crystalline polymer emulsion crystallization system. 2) Synthesizing porous crystalsomes with controlled pore size and morphology. Blends of amphiphilic block co-polymers with chemically similar or dissimilar hydrophobic blocks will be introduced to the miniemulsion crystallization system. The interplay of phase separation at liquid/liquid interface and polymer crystallization will be used for morphological control of the particle. It will be shown how by varying the hydrophobic block chemical composition and degree of polymerization a library of particle morphologies can be obtained with controlled porosity and morphology. 3) While prior crystalsome study was focused on forming hollow crystalline shells with a 2D polymer lamellar crystal, this thrust will focus on how a 1D fibrous crystal fills a spherical surface. Towards this aim the crystalline structure of semiconducting Poly(3-hexylthiophene) (P3HT) crystalsomes will by studied and correlated to its optoelectronic properties. This thesis will lay a framework for producing particles of complex function and structure utilizing a relatively simple fabrication process while also providing insights into the fundamental physics of non-planar polymer crystal structure.