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Functionalized well-defined polymeric nanostructures for biomedical applications

Efrosyni Themistou, Thomas J. Gibson and **Marie Finnegan**
Queen's University Belfast, UK

Statement of the Problem: Novel polymers bearing functional groups are essential in various biomedical applications. Biocompatible polymeric nanostructures including star polymers and amphiphilic block copolymers that self-assemble to polymer micelles and vesicles in aqueous solutions, enable the intracellular delivery of hydrophobic and hydrophilic drugs, antibodies, proteins and DNA, without affecting cell metabolic activity. Amphiphilic block copolymers can be also used for the functionalization of nanofibers for tissue engineering applications. The purpose of this study is to explore the preparation of biodegradable star polymers and amphiphilic block copolymers using reversible addition-fragmentation chain transfer (RAFT) polymerization and ring opening polymerization (ROP).

Methodology & Theoretical Orientation: For the synthesis of the amphiphilic block copolymers the biocompatible water-soluble poly [2 (methacryloyloxy) ethyl phosphorylcholine) (MPC) and oligo(ethylene glycol) methacrylate (OEGMA) monomers were used for the formation of the RAFT macro- chain transfer agent (CTA). Various hydrophobic monomers were used for the efficient chain extension of these macro-CTAs, leading to the formation of amphiphilic block copolymers (either by RAFT polymerization or ROP). For the preparation of star polymers by aqueous RAFT polymerization, a degradable acetal-based cross-linker was used to connect the hydrophilic macro-CTA linear chains together to form star-shape polymeric nanostructures. All polymers were characterized by NMR and GPC, where the formation of the polymeric nanostructures, achieved either by self-assemble methods or chemical cross-linking, was indicated by TEM and DLS studies.

Findings: RAFT polymerization and ROP are great methods for producing well-defined polymeric nanostructures. Thin film rehydration, pH-switch, solvent-switch and polymerization-induced cell-assembly (PISA) can be used for the formation of various polymer morphologies in aqueous solutions (micelles and vesicles), which are important for biomedical applications.

Conclusion & Significance: The polymers prepared in this work are currently being evaluated for site-specific delivery of biologically important molecules, as well as for their use as protein sensors and tissue engineering matrices.

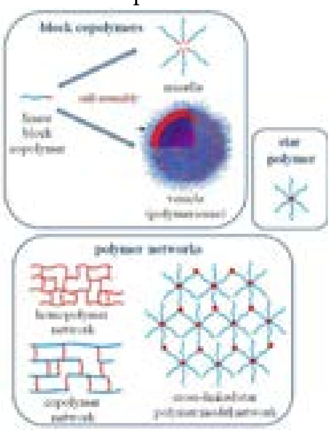

Figure: *Polymeric nanostructures prepared by 'Living' polymerization techniques*

Biography

Dr. Efrosyni Themistou is a chemical engineer with a PhD in Polymer Chemistry. She worked as a Post-doctoral research associate in the University of Cyprus, the State University of New York (SUNY) – University at Buffalo, USA and the University of Sheffield. She became a Lecturer in Materials in the School of Chemistry and Chemical Engineering at Queen's University Belfast, UK in 2013. Her current research is on the synthesis of well-defined polymeric materials using various advanced polymerization techniques. Techniques such as NMR, GPC, DLS, TEM, SEM and SAXS are used to characterize these materials. These polymers can find various applications as drug/protein/DNA delivery vehicles, sensors and tissue engineering matrices.

e.themistou@qub.ac.uk