Inducing an order-order morphological transition via chemical degradation of amphiphilic diblock copolymer nano-objects

Liam P. D. Ratcliffe[1*], Claudie Couchon[1], Steven P. Armes,[1]Jos M. J. Paulusse[2]

[1]*Department of Chemistry, The University of Sheffield, Sheffield, UK*

[2]*Faculty of Science and Technology, University of Twente, Enschede, The Netherlands*

**l.p.ratcliffe@sheffield.ac.uk*

The disulfide-based cyclic monomer, 3-methylidene-1,9-dioxa-5,12,13-trithiacyclopentadecane-2,8-dione (MTC), is statistically copolymerized with 2-hydroxypropyl methacrylate (HPMA) to form a range of diblock copolymer nano-objects via reversible addition–fragmentation chain transfer (RAFT) polymerization. Poly(glycerol monomethacrylate) (PGMA) is employed as the hydrophilic stabilizer block in this aqueous polymerization-induced self-assembly (PISA) formulation, which affords pure spheres, worms or vesicles depending on the target degree of polymerization for the core-forming block. When relatively low levels (< 1 mol %) of MTC are incorporated, high monomer conversions (> 99%) are achieved and high blocking efficiencies are observed, as judged by ^{1}H NMR spectroscopy and gel permeation chromatography (GPC), respectively. However, the side reactions that are known to occur when cyclic allylic sulfides such as MTC are statistically copolymerized with methacrylic comonomers lead to relatively broad molecular weight distributions. Nevertheless, the worm-like nanoparticles obtained via PISA can be successfully transformed into spherical nanoparticles by addition of excess tris(2-carboxyethyl)phosphine (TCEP) at pH 8-9. Surprisingly, DLS and TEM studies indicate that the time scale needed for this order-order transition is significantly longer than that required for cleavage of the disulfide bonds located in the worm cores indicated by GPC analysis. This reductive degradation pathway may enable the use of these chemically-degradable nanoparticles in biomedical applications, such as drug delivery systems and responsive biomaterials.

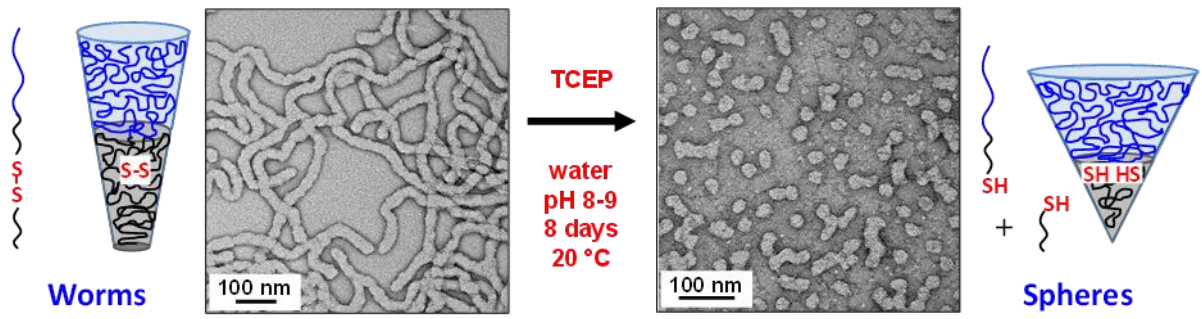

Figure 1 TEM images obtained for a 0.20 % w/w aqueous dispersion of $PGMA_{56}$-P($HPMA_{170}$- *stat*-$MTC_{0.85}$) before and after exposure to TCEP, including a Cartoon representation of how the worm-to-sphere transition is likely to have affected the copolymer chain packing.

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