Combining Crystallization-Driven Self-Assembly with Reverse Sequence Polymerization-Induced Self-Assembly Enables the Efficient Synthesis of Hydrolytically Degradable Anisotropic Block Copolymer Nano-objects Directly in Concentrated Aqueous Media

Polymerization-Induced Self-Assembly (PISA) is a platform technology that can be used for the synthesis of block copolymer nanoparticles as a concentrated colloidal dispersion. However, it typically involves the use of vinyl monomers, which leads to non-degradable copolymers that persist in the environment. In our previous work we have sought to tackle this limitation by developing a new protocol termed reverse sequence PISA that employs a poly(ε-caprolactone) (PCL) precursor that can be chain extended with *N,N'*-dimethylacrylamide (DMAC) monomer in concentrated aqueous media before being diluted further to result in degradable PCL-PDMAC nanoparticle dispersions. One unfortunate restriction of this system is that only spherical morphologies could be synthesized.

Herein we combine PISA with crystallization-driven self-assembly (CDSA) to achieve the efficient synthesis of hydrolytically degradable, highly anisotropic block copolymer nano-objects directly in aqueous solution at 30% w/w solids. This new strategy involves a reverse sequence PISA protocol that employs poly(l-lactide) (PLLA) as the crystallizable core-forming block and poly(*N,N'*-dimethylacrylamide) (PDMAC) as the water-soluble non-ionic coronal block. Such syntheses result in PDMAC-rich anisotropic nanoparticles. Depending on the target diblock copolymer composition, either rod-like nanoparticles or diamond-like platelets can be obtained. Furthermore, *N*-Acryloylmorpholine (NAM) is briefly evaluated as an alternative hydrophilic vinyl monomer to DMAC. Given that the PLLA block can undergo either hydrolytic or enzymatic degradation, such nanoparticles are expected to offer potential applications in various fields, including next-generation sustainable Pickering emulsifiers.