Hydrothermally Generated PI Microparticles and Their Composites

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We recently reported a novel synthetic approach towards PIs: *Hydrothermal polymerization* (HTP),[1,2] where the comonomers are simply dispersed in H_2O and the mixture is heated to elevated temperatures (> 180℃) in a closed vessel aka autoclave to finally yield PI microparticles as product. The generated microparticles are fully crystalline, which enhances the chemical and thermal stability of these polymers. Additionally, they show unique morphologies. Typically, the majority of obtained particles consists of intergrown and highly decorated microsheets (Figure 1A). In addition to that, usually also a second PI phase can be found comprising flower-like microstructures (Figure 1B).
However, tuning the morphology of the obtained microparticles while maintaining the promising property of fully crystallinity would be a truly crucial step for bringing PI particles from HTP closer to real-life applications. Two recently developed strategies for morphological tuning of PI particles are: (*i*) Applying a H_2O-soluble additive (*e.g.* PEG) during HTP that significantly influences the growth of PI crystallites during the reported dissolution-polymerization-crystallization mechanism for PI formation.[3] The resulting changes in morphology (see Figure 1C) are attributed to the adhesion of additive onto the growing crystallite facets and the subsequent induction of split growth to yield densely packed microflowers of partially oriented petals. (*ii*) Adjusting the solvent's physico-chemical properties by adding alcohols as co-solvents which affects the rates of comonomer dissolution, diffusion, polymerization and crystallization.[4] Thereby, it is even possible to generate a plethora of further microstructures – including even nanostructured microparticles (Figure 1D).

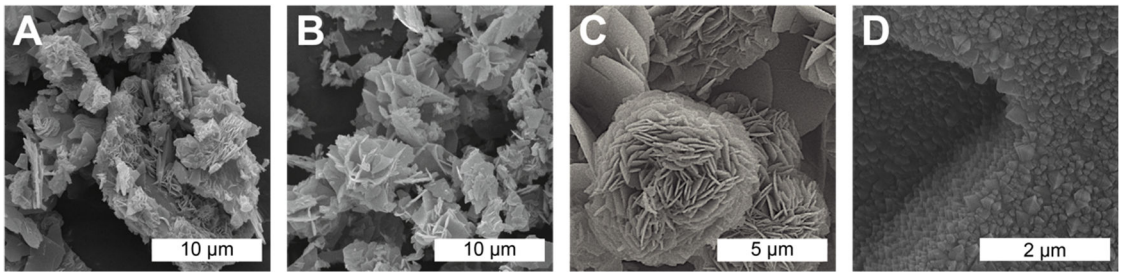

Figure 1: SEM micrographs of hydrothermally synthesized PI: A, B – intergrown and decorated PI microsheets as well as flower-like structures obtained using solely H_2O; C – densely packed PI microflower generated in the presence of an additive; D – nanostructured PI microparticle synthesized by applying an alcohol as co-solvent.

Such particles of different size, shape and morphology have different surface areas and show different degrees of anisotropy regarding various physical properties such as thermal conductivity and mechanical strength. By incorporating such microparticles as light-weight organic fillers in high-performance polymer matrices, composite materials with various properties can be obtained.
With this contribution, we present our recent studies on altering the morphology of hydrothermally generated PI particles. In addition to that, we will also present our first results of the fabrication and characterization of composite materials using highly crystalline PI particles as filler.

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