Crystal growth on curved Surfaces: Novel approaches for the synthesis of anisotropic nanostructured materials

Small particles are widely exploited in a broad range of functional materials, ranging from dense, close-packed layers to dilute dispersions. The interactions involved in such particle ensembles are generally isotropic and the properties of the resulting material can often be regarded as equivalent to those of an effective, isotropic medium. There is however, a rapidly growing interest in the development of particles with anisotropic character. This is driven, in part, by the promise of using such particles as components of adaptive devices or as building blocks for the self- or directed assembly of complex and functionally optimized hierarchical structures in applications as diverse as catalysts, special effect pigments, sensors and biomedical diagnostics and therapeutics.

In this presentation I will focus on the creation of interfacial anisotropy, a topic which has received rapidly growing attention in recent years. In particular the exciting promise for fundamental and applied research of so-called patchy and Janus particles will be introduced. In this regard, my own research group’s activities to synthesise patchy particles by extremely simple and scalable approaches will be highlighted. In contrast to most other reported methods, we avoid the use of templates and phase boundaries but rather employ electroless metallization reactions. Here we rely on the enrichment of the metal precursor and reducing agent at the core particle surface and subsequent heterogeneous nucleation and surface diffusion driven conformal growth of the metal. To ensure a narrow distribution of metal patch numbers and coverages, we have undertaken a programme of replacing the initially-developed batch processes\(^1,2\) with setups based on a continuous flow static mixers\(^3\). On the one hand, this has enabled systematic studies of the materials chemistry behind the surface conformal crystal growth. Here I will illustrate our use of advanced characterisation techniques such as analytical ultracentrifugation. On the other hand, we have expanded beyond the original core particle systems of colloidal silica\(^1\) and polystyrene\(^2\) to demonstrate our fabrication methodology for technical substrates of various compositions. Target applications are wide ranging, from plasmonic sensors and photovoltaic enhancement to catalysis and biomaterials.