Size and Shape Controlled Metal and Polymer Nanoparticles as well as Their Assemblies

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Abstract:

Metal nanoparticles are plasmon-active and potentially interact with light whereas polymer nanoparticles are responsive and swellable. Wide range of photonics, electronics and energy-related applications relied on the plasmonic nanoparticles, at one hand. Polymer nanoparticles, on other hand, widely useful for biomedical, sensing and labeling applications. Because of their crystalline chemical nature, metal nanoparticles adopt various shapes depending on applied reaction condition. But a challenge is to obtain metal nanoparticles of monodispersed size and homogeneous shape. In this regards, polyol process has provided detailed insight for precise control of the shape of silver nanostructures. However, despite significant progress in shape control, polyol process *via* 1,3-propanediol has been explored only in short context. Here we show that how versatile 1,3-propanediaol-based polyol synthesis is in order to investigate the tunability of shapes of the silver nanostructures. We found that high yield of monodispersed nanorods is the result from precise combination of mild reducing agent and PVP of moderate molecular weight at defined reaction temperature in 1,3-propanediol. Similarly, monodispersed nanocubes formation is dependent on PVP of high molecular weight in 1,3-propanediol. In direct contrast to metal nanoparticles, polymer nanoparticles are soft, swellable and amorphous in chemical nature and often adopt spherical shape, in general, to achieve lowest energy state. A real challenge is in controlling non-spherical shapes of polymer nanoparticles via single-step process due to high flexibility at nanoscale. Microfluidic reaction technique is highly promising to address this concern because of their advantages such as efficient reactant mixing and fast phase transfer over the conventional batch processes. In our work, with the precise combination of microfluidics and interfacial chemistry, a library of the shape-controlled polymer nanoparticles has been obtained. In addition, we have applied layer-by-layer surface modification approach to both metal and polymer nanoparticles for homogeneous and heterogeneous assembling purpose, and we anticipate our materials can be useful for the next level application towards hybrid nanomaterials.