Symmetry Control of Polymer-Coated Nanocrystal Superlattices

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Here, we present manipulation of polystyrene-coated Au nanoparticle (Au@PS NP) superlattices by controlling grafting density, molecular weight (Mn) of PS, and diameter of Au NPs. Au@PS NPs were prepared by simple ligand exchange process with thiol-terminated PS. In result, the interparticle distance was controlled from a few nm to more than 10 nm. The Au@PS NPs were self-assembled using liquid-air interface assembly. TEM images and grazing incidence small-angle X-ray scattering measurements indicated long range ordered Au@PS NP superlattices. Particularly, the self-assembly structure of Au@PS superlattices could be controlled between face-centered cubic and body-centered cubic symmetries by simultaneously controlling the grafting density and Mn of polymeric ligands. Finally, we explain the factors that determine the self-assembled structure by analyzing the soft shell to hard core ratio of various Au@PS NPs. This work presents a new approach to independently tune interparticle separation and packing symmetry of NP superlattices, which will have huge impact on the fabrication of devices with NPs.