Multipod-like Polystyrene/Silica Clusters Designed by Seeded-growth Emulsion Polymerization: Towards Colloidal Molecules and Unconventional Inorganic Nanoparticles

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Abstract

Hybrid organic-inorganic nanoparticles with well-controlled morphology are currently of great research interest. Synthetic routes leading to robust aggregates made of nanoparticles of different chemical natures which are associated in a controlled manner, *i.e.* number of nanoparticles and geometrical arrangement, are especially investigated. Clusters of spheres could mimic the space-filling models of simple molecules and are called “colloidal molecules” [1].

Our strategy is based on a seeded-growth emulsion polymerization process leading to biphasic particles, which are composed of spherical silica spheres (50-400 nm) surrounded by a varying number of polystyrene (PS) nodules (Figure 1) [2].

The hydrophilic surface of the silica seed particles needs to be previously functionalized with methacryloxymethyltrimethoxysilane (MMS). In such conditions, the nucleation/ growth of the PS nodules is highly promoted at the silica surface, leading to multipod-like morphologies (bipods, tetrapods, hexapods, octopods, etc.). While varying different experimental parameters, it was demonstrated that the key parameters to control the pod number and geometrical arrangement are (i) the ratio between the number of silica seeds and the number of growing PS nodules, (ii) the size of silica seeds and (iii) the silane grafting density. A key feature of this strategy is the synthetic process is reproducible, fast and may yield grams of biphasic submicronic particles up to 90% purity [3].

The aim of this communication is to release last-minute results:
(i) presenting a model of spheres growing on a sphere to predict the morphology yields of the PS/silica multipod-like clusters [4],
(ii) demonstrating the possible synthesis of triphasic clusters with an extra poly(methyl methacrylate) nodule obtained in a second-stage emulsion polymerization,
and (iii) showing how PS/silica multipod-like clusters may be derivatised in order to get unconventional nano-objects, e.g. tetrahedron-like and cube-like silica particles, and gold nanocages [6].

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References

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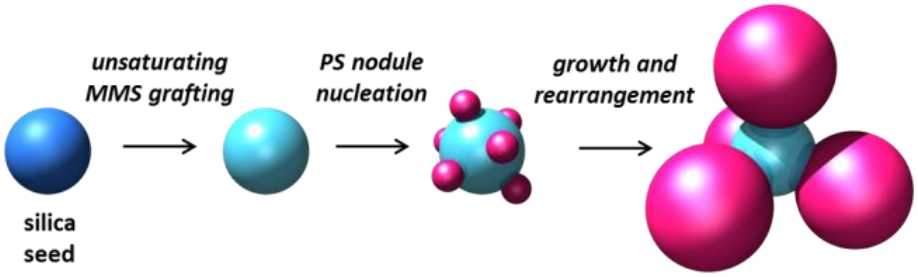
[6] To be published soon.

Figure 1


unsaturating
MMS grafting
PS nodule
nucleation
growth and
rearrangement
silica
seed