FROM SHAPE-CONTROLLED NANOPARTICLES TO "COLLOIDAL MOLECULES"

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Hybrid organic-inorganic nanoparticles with well-controlled morphology are currently of great interest for numerous applications. 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.

Our strategy is based on a seeded emulsion polymerization process leading to biphasic particles, which are composed of spherical silica spheres surrounded by a varying number of polystyrene (PS) nodules [1]. The hydrophilic surface of the silica seed particles (50-400 nm) needs to be previously functionalized by silane chemistry. Emulsion polymerization of styrene is carried out in presence of these particles. In such conditions, the nucleation/growth of the PS nodules is highly favoured at the silica surface, leading to multipod-like morphologies (bipods, tetrapods, hexapods, octopods, etc.) (Figure 1). While varying different experimental parameters, it was demonstrated that the key parameters to control the pod number and 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 [2].

In particular, we demonstrated that the number of PS latex per silica seed can be calculated from the size of the silica seed by solving an equation which results from the minimization of a two-term-energy. The first one is an attraction towards the centre and the contribution of the second one produces two-body particle repulsions, which can balance the attractive central force [2].

Original cryo-TEM images were recorded and 3D-reconstructions allowed measuring the contact angle between the PS nodules and the surface of silica seeds [3].

Lastly, original planar biphasic colloids may be also obtained by shaping these multipod-like particles on planar substrates by taking advantage of the softness of the PS nodules, leading to triangles, squares, pentagons, hexagons, octagons, etc (Figure 2).

A key feature of our approach is that our synthetic process is reproducible, fast and may yield grams of biphasic submicronic particles (up to 90% purity).

Therefore, it opens the way to the fabrication of large amounts of “colloidal molecules” and smart devices by self-assembly.

References:

[1] Reculusa S., Poncet-Legrand C., Perro A., Duguet E., Bourgeat-Lami E., Mingotaud C., Ravaine S., *Chemistry of Materials*, **17** (2005) 3338.

[2] Perro A., Duguet E., Lambert O., Taveau J.C., Bourgeat-Lami E., Ravaine S., *Angewandte Chemie, International Edition*, **48** (2009) 361.

[3] Taveau J.C., Nguyen D., Perro A., Ravaine S., Duguet E., Lambert O., *Soft Matter*, **4** (2008) 311.

Figure 1:

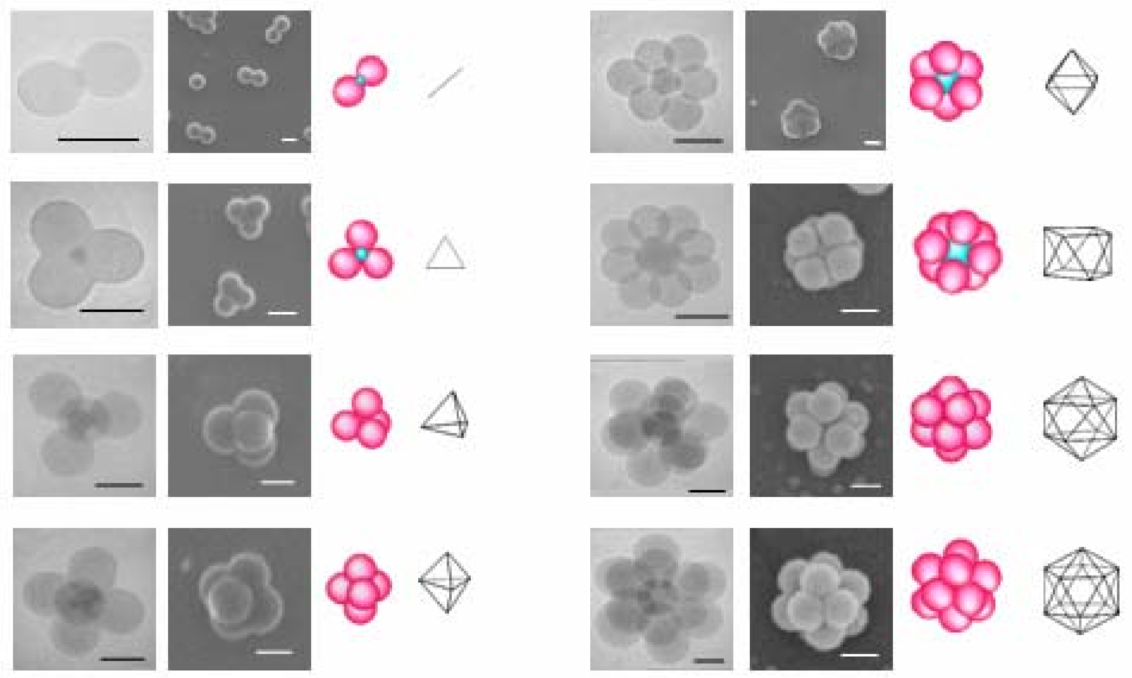

Figure 2: