Recent progress on patchy nanoparticles and their directional bonding

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Compared to standard fabrication methods based on top-down approaches such as optical lithography, colloidal self-assembly offers the potential for easier fabrication and manipulation of nano- and microstructures, especially in three dimensions. In most cases, these building blocks may not naturally assemble into any desired structures. One emerging approach to confer colloidal particles predetermined “instructions” for assembly is to decorate the surface of the particles with “sticky patches” made, for example, of synthetic organic or biological molecules. This strategy draws its inspiration in part from biology, where the precision of self-assembled structures such as viruses and organelles originates in the selectivity of the interactions between their constituents. In this talk, we report on a new route to synthesize patchy nanoparticles with a controlled number of patches or dimples as well as on their potential use as building blocks for the elaboration of new supracolloids with unusual morphology and optical properties.

The so-patchy particles were derived from colloidal molecules [1] made of a central silica core surrounded by a precise number, n, of polystyrene satellite nodules [2,3]. We succeeded in promoting the growth of the silica core of these colloidal molecules. While growing, the silica surface conforms to the shape of the PS nodules. After functionalization of the inter-nodule surface area and dissolution of the polystyrene nodules, homogeneous batches of silica particles with n well-located patches at their surface can be produced in large quantities [4]. The patchy character of the silica particles was evidenced by TEM characterization (see Figure). The controlled assembly of patchy nanoparticles offers the unique capability of creating new supraparticles [5] or superlattice structures. We will present some recent results on the self-assembly of the multivalent silica nanoparticles.

These patchy particles can also be used for creating new nano-objects suitable for many applications such as sensing, metamaterials, photonics, etc. For example, they can be used to elaborate nanocages of noble metal with a controlled number of holes.

References

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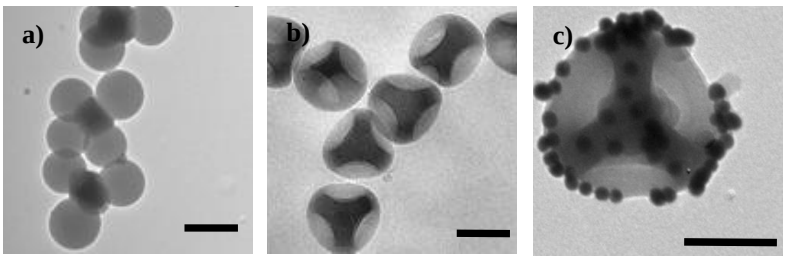

TEM images of a) silica particles surrounded by 4 polystyrene satellite nodules, b) silica particles with 4 dimples and c) a dimpled silica particle regioselectively decorated with gold nanoparticles [4].