Poster Presentation

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From sphere to hedgehog: On the complexity of nanocrystal shape

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Nanocrystals are produced by many different methods, such as hyfrothermal route, sputtering, epitaxy and many others. One of most original is the microbial route serving for fabrication of metallic and oxide nanoparticles. The obtained nanoparticles can adopt very simple and very complex forms. The variety of the reported shapes is quite large. The nanocrystal shape can be controlled by choice of the synthesis technique and its parameters as shown, e.g., in refs. [1,2]. Some technologies produce the simplest shapes of cubes and other simple polyhedra, spheres, discs and rods. Many others lead to various nanocrystalline forms of high geometrical, morphological and compositional complexity. These forms are typically named after shape of objects belonging to the macroworld (cylinders, nails, necklaces, ribbons, boxes, capsules, belts, pyramids, snowflowers), space objects (stars), plants (flowers, dendrites, forests), and animals (hedgehogs, multipods, corals, drones). Unusual forms include, for example, disordered pyramidal pits ('negative pyramids') on a ZnSe film surface and SiO2 hedgehogs built from a spherical gallium-based droplet and covered by short quasi-symmetrical cone-shaped needles, characterized by a composition gradient. Nanocrystals can be porous or hollow, single phase or polyphase, may have uniform or non-uniform composition. Many forms of crystals growing in the nanoscale do not resemble those growing in the macroscale. The smallest ones belong to the subnanoworld, whereas the upper size limit is not strictly defined (the frequently adopted limit is 1 micrometer in at least one dimension). Nanocrystals are organized or self-organized in various ways: as separate crystals, nano-objects deposited on films or as inclusions within bulk crystals, as more or less ordered objects. Some of them belong to the category of fractals, some others are organized hierarchically. Nanocrystals can form arrays, superlattices, complexes, nanoclusters, bunches, nanoinclusions, core-shell structures etc. Frequently, individual nanocrystals can be treated as building blocks of these complex structures. The organization of such small elements is usually termed as nanoarchitecture. The shape of a nanocrystal is an important factor determining the physicochemical properties of the material. A large free surface is one of known shape-dependent features enabling application of specific materials as catalysts. Specific nanoarchitectures have been designed and reported, being characterized by low density leading to possible construction of ultralight materials. Almost twenty simple shapes have been distinguished for metallic nanocrystals [3]. The anticipated extension of nanocrystal shape classification and analysis is expected to be helpful in further work on design of nanomaterials and in understanding of their properties.

[1] S. Kumar et al. (2006) Small 2, 316-329.
[2] J. Xiao et al. (2011) Nanoscale 3, 1383-1396.
[3] Y. Xia et al. (2009) Angew. Chem. Intern. Ed. 48, 60-103.

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