Giant Surfactants based on Precisely Functionalized POSS Nano-atoms: Tuning from Crystals to Frank-Kasper Phases and Quasicrystals

STEPHEN Z. D. CHENG, University of Akron

In creating new functional materials for advanced technologies, precisely control over functionality and their hierarchical ordered structures are vital for obtaining the desired properties. Giant polyhedra are a class of materials which are designed and constructed via deliberately placing precisely functionalized polyhedral oligomeric silsesquioxane (POSS) and fullerene (C_{60}) molecular nano-particles (MNPs) (so-called “nano-atoms”) at the vertices of a polyhedron. Giant surfactants are consisted of polymer tail-tethered “nano-atoms” which are deliberately and precisely functionalized POSS or C_{60} molecular nano-particles (MNPs). The “nano-atom” heads and polymer tails thus have drastic chemical differences to impart amphiphilicity. These giant surfactants capture the essential structural features of their small-molecule counterparts in many ways but possess much larger sizes, and therefore, they are recognized as size-amplified versions of small molecule surfactants. Two of the most illustrating examples are a series of novel giant tetrahedra and a series of giant giant surfactants as building blocks to construct into hierarchical ordered super-lattice structures ranging from crystals, Frank-Kasper phases and quasicrystals in the condensed bulk states, reveals evidently the interconnections between soft matters and hard matters in sharing their common structures and fundamental knowledge.

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