Giant Surfactants based on Precisely Functionalized POSS Nano-atoms: Tuning from Crystals to Frank-Kasper Phases and Quasicrystals[1]

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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.