Giant Molecules based on Nano-atoms: Size Amphilification, Function Diversification, and Self-Assembly Manipulation

Stephen Z. D. Cheng
Department of Polymer Science, College of Polymer Science and Polymer Engineering, The University of Akron, Akron, Ohio 44325-3909

To create new functional materials for advanced technologies, control over their hierarchical structures and orders is vital for obtaining the desired properties. We utilized and functionalized fullerene (C_{60}) and polyhedral oligomeric silsesquioxane (POSS), and assembled these particles with polymers to form those hierarchical structures. In order to achieve precisely defined molecular structures and functionalities, we have developed novel routes of functionalize C_{60} and POSS and attached them onto other organic materials in a highly efficient and controlled manner via "click" chemistry and other precise transformations. The structures of these assemblies along with the resulting ordered structures were analyzed to determine their structure-property relationships. One of the most illustrating examples is a series of novel giant surfactants and lipids possessing a well-defined amphiphilic head and polymeric tails. Various architectures of this class of materials have been constructed and their self-assembly processes in solution, in the condensed bulk and thin films have been investigated. Another set of examples are "nano-atoms". These classes of molecules are designed to possess features of molecular Janus particles with various symmetry breakings. When specific interactions are introduced, these "nano-atoms: are functioned as building blocks to construct different amplified molecules and further to self-assemble into hierarchical ordered structures. Their thermodynamic phase diagrams and kinetic pathways are explored to understand this new class of materials and their potential applications in modern technologies.