A new direction in materials assembly: using nanoparticles as atoms and DNA as linkers to make functional materials

George C. Schatz

Department of Chemistry, Northwestern University, Evanston IL 60208 USA

In this talk I describe recent advances in experiment and theory in which crystalline lattices are synthesized in which nanoparticles serve as atoms and DNA linkers provide the "glue" that binds the nanoparticles into complex materials with novel functionality. This work has been a joint collaboration with Chad Mirkin, and it began in 2008 with the fabrication of superlattices composed of identical gold particles that could either be fcc or bcc depending on whether the DNA is self-complementary or not. Subsequent work has resulted in a couple dozen different lattice structures, with theory providing guiding principles for assembly based on the principle that the equilibrium crystal structure is determined by maximizing DNA hybridization. Structures based on particles other than gold, and on RNA linkers are also described. In addition to simple analytical models, we have developed the theory of these structures using both all-atom and coarse-grained models, and this has enabled us to describe structures that include anisotropic nanoparticles in addition to the spherical particles that are commonly considered. Applications of these superlattices in plasmonics are described to illustrate how these materials can be used to provide new functionality that is not available in more traditional atom-based materials.