Stevens Institute of Technology

Nanotechnology Graduate Program

A Polymer Scientist Approach to Inorganic Nanoparticles

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Organized arrays of inorganic nanoparticles show electronic, optical, and magnetic properties that originate from the coupling of size- and shape-dependent properties of individual nanoparticles (NPs). Controllable and predictable organization of NPs in complex, hierarchical structures provides a route to the fabrication of new materials and functional devices. Substantial progress has been achieved in the bottom-top organization of NP arrays, however, currently, this approach remains largely empirical. In my lecture, I will present two new paradigms for the self-assembly of NPs. One of the approaches exploits a striking analogy between amphiphilic ABA triblock copolymers and polymer-tethered inorganic nanorods in structures with varying geometries and functions. The self-assembly was tunable and reversible, and it was achieved solely by changing the solvent quality for the constituent polymer or inorganic blocks. We mapped the self-assembly process by using the phase-like diagrams. The second approach relies on the similarity between the self assembly of inorganic nanaorods and reaction-controlled step-growth polymerization. We use this approach to explore the kinetics and statistics of nanorod self-assembly in 1D structures, and predict the aggregation number, the polydispersity and the "isomerism" of polymer-like nanostructures. We demonstrate the ability to control the optical properties of the self-assembled nanostructures. The proposed strategy provides a new route to the quantitatively predicted organization of nanoparticles in supracolloidal assemblies.

Eugenia Kumacheva is a Professor in the Department of Chemistry at the University of Toronto. She has cross-appointments at the Department of Chemical Engineering and Applied Chemistry, the Institute of Biomaterials and Biomedical Engineering and the Institute for Optics Sciences. Her research represents a combination of fundamental and applied Projects in the fields of polymer and materials science, nanoscience and nanotechnology and microfluidics. She received her M.Sc. degree from the Technical University (Saint Petersburg (Russia), and did her Ph.D. research in Physical Chemistry of Polymers at the Institute of Physical Chemistry (Russian Academy of Science). After PhD defence, she joined the Department of Chemistry at the Moscow State University. In 1991-1993 Eugenia Kumacheva worked as a postdoctoral fellow in the laboratory of Professor Jacob Klein at the Weizmann Institute of Science (Israel), where she studied surface forces in thin layers of simple liquids and polymers. In 1996 Eugenia Kumacheva became an Assistant Professor and in 2001 an Associate Professor in the Department of Chemistry at the University of Toronto. In 2005 Eugenia Kumacheva became a Full Professor. Her awards and distinctions include the Fellowship to the Royal Society of Canada, Killam Fellowship, International Chorafas Foundation Award in Physics and Engineering, International Schlumberger Award, and the L'Oreal-UNESCO Award “For Women in Science”, given to the best female scientist from each continent. Eugenia Kumacheva was a Visiting Scholar in Harvard University, and a Visiting Professor at the Universities of Oxford and Cambridge, the Universitè Louis Pasteur (France). Eugenia Kumacheva serves on the Advisory Board of the Waterloo Institute of Nanotechnology (Waterloo, Canada) and the Advisory Council of Advanced Science Institute of RIKEN (Japan). She served as an Editor-in-Chief of Polymer Bulletin. Currently, she serves on the Advisory Board of the Soft Matter and Colloid and Polymer Science journals.

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