NANOSTRUCTURE SYNTHESIS
To date, most of the nanostructures reported in the literature are of single-component and have simple geometries such as sphere and cube. Sophisticated nano-devices or nanomachines in the future will certainly require complex components and assembly techniques.

In a way, the synthetic development of nanostructures can be likened to that of organic chemistry. Two hundred years ago, people cannot make complex drug molecules or natural products. It was the development of synthetic methodologies and purification methods, and the understanding in reaction mechanisms, among others, that made everything possible.

OUR RESEARCH FOCUS
Our research mostly deals with colloidal nanostructures. We focus on the synthesis of (a) core-shell structures, (b) Janus (two-sided) nanoparticles, (c) dendritic nanostructures, (d) organic-inorganic composites, and (e) development of linear and 2D assembly techniques, and (f) study of conformational changes of nano-objects.

From application point of view, we are interested in (a) plasmonic and fluorescent nanostructures for sensing and detection, (b) drug delivery, (c) composite materials, and (d) magnetic materials for data storage.

ACTIVE NANOSTRUCTURES
A major thrust in advancing nanoscience, in my opinion, is to develop nanostructures that can move. Their conformational changes, when predictable, open doors to future development of smart nano-devices. In biology, conformational changes of proteins are the foundation of enzymatic activity (e.g., ATP synthase) and cell motility (e.g., myosin in muscle cells). In comparison to translational motion, conformational motion is less affected by random Brownian forces. To set nanostructures in predictable motion, we have to understand their intrinsic properties and devise corresponding strategies.

We show that polymer shells (PS-b-PAA) coated on Au nanowires act like liquid droplets. We can tune the solvent ratio to affect the polymer/solvent interfacial tension, and make the polymer contract in minimizing its surface/volume ratio. The embedded Au nanowire cannot escape and thus, is forced to coil into rings. The same strategy can be applied to coil carbon nanotube bundles into ring structures. Since carbon nanotubes are robust, we can reversibly compress and release these rings by tuning solvent ratio. Most recently, we report a new type of Au-Ag alloy nanowires; upon Pd deposition they wind around themselves to form double helices. The Au-Ag alloy nanowires have a special type of twisted lattice. The Pd growth induces lattice strain; the relieving of this strain forced the entire wire to untwist, giving a double helix.