Materials Science & Engineering Colloquium

Sculpting Nanostructures and Their Mesoarchitectures for Applications

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11:00 AM, Friday, March 9, 105 Nedderman Hall

This talk will highlight our recent efforts in developing a new toolbox of strategies to sculpt the structure and chemistry, and direct the assembly, of nanostructures for applications. I will first describe a substrate-selective chemical vapor deposition method to grow carbon nanotube bundles of controllable lengths and premeditated orientations at select locations on planar and curved surfaces. Key aspects of scaling behavior of oriented growth and electrical transport mechanisms in the nanotube assemblies will be discussed. I will then present new scalable approaches to fabricate hybrid nanostructures by derivatizing nanotubes with other nanostructures through the use of ion irradiation, microwave stimulation and current injection. These methods allow functionalization of preselected segments of nanotubes, or rapid (~seconds-minutes) derivatization via functionalization, *in situ* nanoparticle synthesis and anchoring—all in a single step, or chemically modification of selected portions of nanotube networks.

In the second part of my talk, I will demonstrate the first-time fabrication of assemblies of high magnetic coercivity FePt nanoparticles and nanorods of high figure-of-merit Bi_2Te_3 thermoelectrics. Encapsulating the nanoparticles by a silica shell during synthesis from microemulsions not only obviates particle coalescence during annealing treatments needed to obtain the high coercivity $L1_0$ phase, but also facilitates particle functionalization and thin film assembly. A method to molecularly braid the nanoparticles into chains using polyelectrolytes and dibinding molecular couplers will also be described. I will briefly illustrate the formation of straight and branched architectures of single-crystal bismuth telluride-sulfide core-shell nanorods, where crystallographic-twinning-induced branching is tailored by manipulating surfactant desorption dynamics. I will conclude with a first-time demonstration of a colossal factor-of-7 increase in fracture toughness of a Cu/silica thin film interface through the use of a molecular nanolayer, and elucidate the molecular-level toughening mechanisms.

Professor Ramanath received his Ph.D. in Materials Sci. & Eng. in 1997 at the University of Illinois at Urbana-Champaign. Before he joined the Rensselaer Polytechnic Institute in 1998, he was at Novellus Systems, CA as a member of technical staff and was a visiting scientist at the Physics Department, Linkoping University, Sweden. He received National Science Foundation CAREER Award, Prof. Bergamann Memorial Young Scientist Award, Alexander von Humboldt Fellowship at Max Planck Institute for Solid State Research, IBM Research Partnership Award, Materials Research Society Graduate Student Award (aka Gold Award). He published more than 110 journal and conference articles, has four patents with 14 pending patents. He gave more than 85 invited talks in conferences and colloquia at universities and laboratories. He has been serving an associate editor of IEEE Transactions on Nanotechnology since 2003.