275g Low-Temperature Synthesis of Molecularly-Capped Nanowires from Liquid Flux of Ions and Nanoparticles[Invited]

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This talk will describe two new, simple, scalable, low-temperature (<100 °C) strategies to synthesize nanowires using flux of ions (Bi, Te), or nanoparticles (Au, Ag) in aqueous-solutions. The nanowires are molecularly passivated by either a difunctional coupling agent to the aqueous solution, or a water-immiscible organic phase. The nanowire structure, surface chemistry, and key aspects of the formation mechanisms will be discussed based on electron microscopy, X-ray and electron diffraction, UV- visible spectroscopy, and thermogravimetry analyses. The thermoelectric properties of the Bi2Te3 nanowires will also be briefly described.

First, I will demonstrate a room-temperature method to assemble Au or Ag nanoparticles into nanowire networks by mechanically agitating a biphasic mixture of an aqueous hydrosol containing the nanoparticles, and toluene. The nanowires are passivated with toluene. The diameter of the wires can be adjusted from 5- to 35-nm by controlling the nanoparticle size. We will show that nanowires form by coalescence of the nanoparticles at the toluene-water interface, and the wire morphology is strongly dependent on the type of organic phase used in the biphasic liquid mixture. This approach is attractive for forming micro- and macro-foams of nanowires for possible applications in catalysis or composites.

Second, I will describe the synthesis of 27- to 130-nm-diameter single-crystal nanowires of bismuth telluride with a trigonal crystal structure at ~100 °C. Reduction of orthotelluric acid and bismuth chloride in the presence of thioglycolic acid or L-cysteine results in carboxyl- or amine-terminated nanowires due to thio-ligation of bismuth. High resolution TEM suggest that nanowire growth occurs by atom flux attaching to the growing front of the (101) planes. Dispersed films of nanowires exhibit n-type behavior due to sulfur incorporation, and yield a Seebeck coefficient of -100 . Preparing such single-crystal1−m 1−ΩμV/K, and a conductivity of 600 nanowires capped with desired functional groups are attractive for redispersing the wires in liquid media for further processing, and assembling on chemically tailored surfaces to realize novel thermoelectric devices.