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## Bottom-up approaches to plasma synthesis of nanomaterials

R. MOHAN SANKARAN, Case Western Reserve University

Large-scale, low-pressure plasmas play an essential role in the manufacturing of integrated circuits that are now ubiquitous in consumer electronics. In recent years, new challenges have arisen for these top-down approaches to materials processing. Future electronic devices will incorporate nanoscale materials such as nanoparticles, carbon nanotubes, and silicon nanowires that cannot be fabricated by current plasma technology because of limitations associated with photolithography. In addition, emerging applications in sensors, energy, and medicine require materials that must be prepared from the "bottom-up." The aim of our research is to develop a new class of plasmas, termed microplasmas, for nanomaterials synthesis. Microscale plasmas or microplasmas are a special class of electrical discharges formed in geometries where at least one dimension is less than 1 mm. As a result of their unique scaling, microplasmas operate stably at atmospheric pressure and contain large concentrations of energetic electrons (1-10 eV). These properties are attractive for a range of nanomaterials applications. Vapor-phase metal-organic precursors can be dissociated near ambient conditions (i.e. room temperature and atmospheric pressure) to homogeneously nucleate metal [1] and alloyed [2] nanoparticles. Metal nanoparticles are then continuously injected into a flow furnace to catalyze the growth of chirally-enriched carbon nanotubes or diameter-controlled silicon nanowires [3]. Recently, we have also coupled microplasmas with liquids or polymeric films to nucleate nanoparticles from metal ions [4]. In this talk, I will discuss these topics in detail, highlighting the advantages of microplasma-based systems for the synthesis of well-defined nanomaterials.

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