319h A Methodology for Controlled Growth of Silicon Nanowires

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Semiconductor nanowires are one-dimensional structures, with unique electrical and optical properties, that can be used as building blocks in nanoscale devices. Their low dimensionality means that they exhibit quantum confinement effects. Semiconductor nanowires have potential for applications in electronic devices including field-effect transistors, sensors, detectors and light-emitting diodes. Some of the critical factors include growing nanowires with desired dimensions and density and positioning them at desired locations in a controlled manner.

In this presentation, we demonstrate selective growth of vertically aligned silicon nanowires on a silicon dioxide substrate using a silicon quantum dots as "seed" layer. We describe a pathway to fabricate high-density silicon nanowires using conventional Low Pressure Chemical Vapor Deposition (LPCVD) and Atomic layer Deposition (ALD) techniques. Silicon nanoparticles deposited randomly on a SiO_2 substrate are used as "seeds" to grow nanowires. The diameter of the resulting wires depended on the size of the nanoparticles. We present results of growth of these self-assembled nanodots formed by thermal decomposition of silane in a LPCVD reactor. The size and density of the nanodots formed depend on the process conditions such as temperature, pressure, time of deposition and the surface treatment of the substrate. Atomic Force Microscopy combined with Scanning Electron Microscopy was utilized to characterize the size and density of the nanoparticles formed.

Finally, we investigate the growth reactions of dichlorosilane and silane precursors on silicon substrate by ALD. The surface reactions of these precursors were found to be complementary and self-limiting, thus providing highly uniform and controllable thickness of silicon deposition. Thus, ALD process should permit the growth of silicon nanowires off of the silicon "seed" nanoparticles. We expect to control the size and density of the nanowires formed by controlling the LPCVD process conditions for nanoparticle deposition and the length of the nanowires by controlling the ALD conditions.