4cv Functionalization and Transport of Nanoparticles

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Nanoparticles have been used in many industrial applications including microelectronics and biosensors. My current research focuses on the surface passivation of silicon nanoparticles with organic compounds. Silicon crystals were produced by silane plasma and selected by differential mobility analyzer (DMA). The resulting monodisperse aerosol is allowed to react with a gas-phase organic compound, such as tert-butylamine, hexene, or hexyne. When the aerosol/vapor mixture is heated to moderate temperatures (200-400oC, depending on the precursor used), organic layers form on the surface of silicon particles. The layer thickness, which is measured directly with tandem differential mobility analysis (TDMA), increases with increasing organic vapor pressure and/or residence time until a compact monolayer is formed. High-resolution transmission electron microscopy (TEM) is used to study the morphology of the silicon particles and the thickness of the deposited organic layers. The possible carbon- or nitrogen-silicon linkage on the surface of aerosolized silicon nanoparticles is also investigated by using infrared spectroscopy. The present study shows a direct measurement for thin film coating on aerosol particles when the film thickness can be controlled by varying the reaction conditions. The organic modified silicon particles can be used for applications such as quantum dots, bio-sensors, and semiconductors. My future research will focus on understanding and designing the transport and/or the adsorption processes of particles onto substrate surface with desired amount and patterns by fluid flow and/or applied electromagnetic fields. Research in transport phenomena of nanoparticles demands various skills, such as thermodynamics, transport phenomena, computational fluid dynamics, optics, and reaction kinetics. These skills are not only important to the subject matter of industry and technology, but can also help students build a strong foundation of knowledge.