174b Controlled Deposition and Modification of Antireflective Coatings from Silica Nanoparticles

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Our research efforts in colloidal materials are directed towards fundamentally simple systems with technologically feasible and scalable applications. This presentation will focus on antireflective (AR) films assembled from silica nanoparticles. The low refractive index required for AR coatings is difficult to achieve in natural or synthetic homogeneous materials, but can be achieved with porous or composite films that are prepared either by "top-down" or "bottom-up" techniques. The convective assembly method for particle deposition was originally designed for assembling colloidal crystals from monodisperse particles for photonic applications. However, the method allows facile controlled fabrication of nanoparticle coatings with a range of other useful properties. We will report on uniform nanocoatings that were deposited directly from aqueous suspensions via convective assembly at high volume fraction. The deposition process allows control over the coating thickness and optical properties of the films. The control over film structure and thickness provides an excellent means for making AR coatings from silica nanoparticles. In a single step, the reflectance of glass and silicon substrates was easily and reproducibly reduced by up to 75% and 50% respectively by coatings comprised of 70 nm particles. Microstructural investigations using SEM, AFM, profilometry, and ellipsometry provided good correlations to the observed macroscopic optical properties. The AR coatings were further optimized by using mixtures of 70 nm and 135 nm silica particles, which reduced the reflectance on glass by up to 89%. We are presently investigating colloidal deposition from alternative solvents such as liquid and/or supercritical carbon dioxide (CO_2), which is inexpensive, renewable, and offers tunable properties ranging from gas-like to liquid-like. These fluid properties provide potential for depositing conformal coatings that are free of surface tension induced defects inherent to other solvents. Additionally, the low viscosity and tunable properties of compressed CO_2 make controlled sedimentation an attractive means of deposition. Stable dispersions in liquid or supercritical CO_2 necessitate the use of either CO_2-philic surfactants, or covalently attached CO_2-philic ligands. As a result the nanoparticle coatings from CO2 could be superhydrophobic (water repellent) in addition to being antireflective or photonic. These coatings could make more efficient solar cells, better windows and displays, and may find applications in sensors and electronic devices.