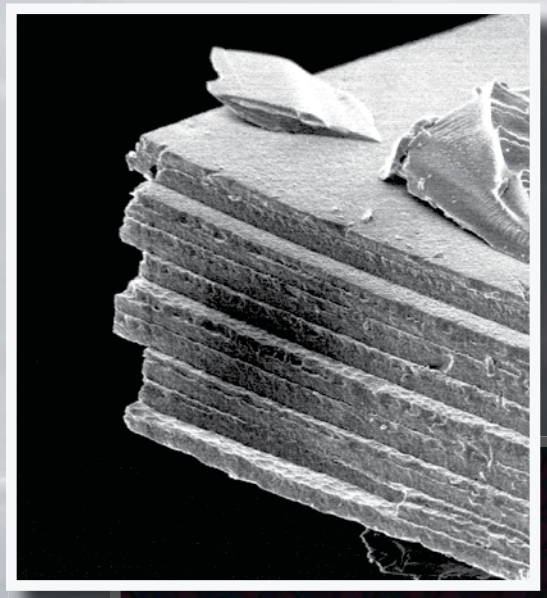
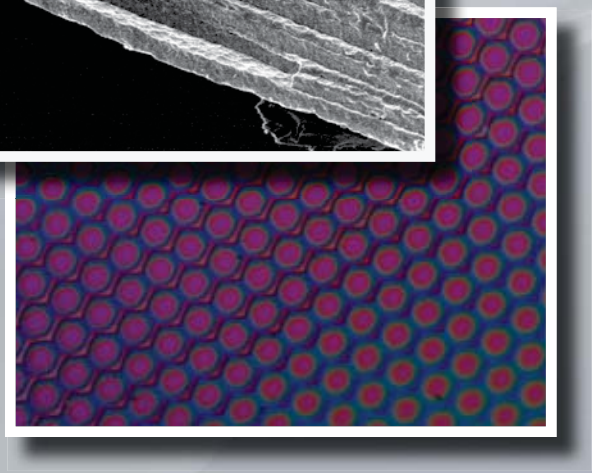
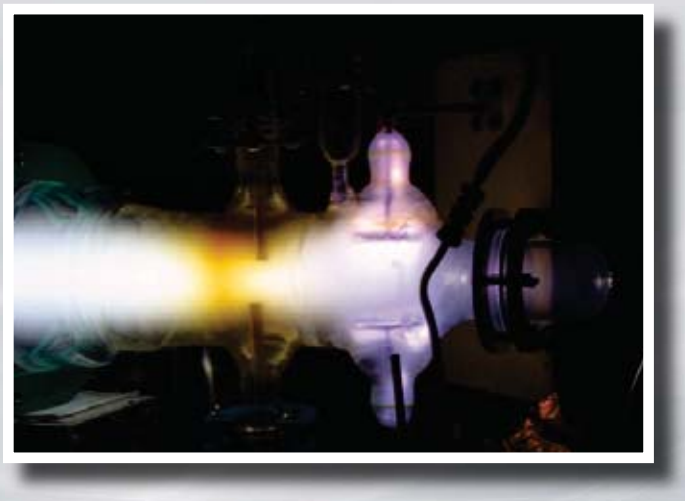
Polymer Nano-Layer Coatings for Optical Applications

Accomplishment: A deposition process enabling precise nanometer-scale thickness control in functional polymers has been demonstrated. Complex nano-structured polymeric thin film coatings of plasma polymerized monomers with unique optical properties are difficult to prepare by any other technique, but are now possible and have been demonstrated with this process.







Impact: Multi-layer optical coatings are used wherever the transmission, reflectance or absorption of light is required to achieve system functions, including optical sensors, aircraft canopies, display panels, heads-up displays, pilot glasses and helmet faceshields. Conventional optical coating properties are limited by the relatively small number of inorganic compounds that have desirable optical properties. This accomplishment greatly expands the range of properties that can be produced in optical coatings by enabling production of polymer-based coatings with the adhesion, durability and processibility necessary to achieve system functions.

Motivation and Approach: High performance optical coatings typically consist of inorganic materials that are relatively heavy and expensive and have a limited range of desirable optical properties. By comparison, polymer materials are less costly, much lighter and offer a much broader range and tailorability in optical properties. However, previously available deposition processes produce rough polymer films with defects that degrade optical properties, have poor durability and adhesion to the substrate, and often have poor chemical, thermal and environmental stability. A plasma-enhanced chemical vapor deposition process was modified in this accomplishment to overcome these deficiencies while retaining nano-scale control of the optical thickness. This new process technique can also polymerize organic monomer compounds that previously could not be used, greatly increasing the palette of candidate optical materials and properties. Single layer, multilayer, and graded refractive index nano-structured polymeric-thin film coatings for photonic applications have all been fashioned from organic monomers using this plasma enhanced chemical vapor deposition capability.

Team: This work was led by Dr. Tim Bunning in the Materials and Manufacturing Directorate. Funding came from the Air Force Office of Scientific Research (Dr. Charles Lee, Program Manager).