Mechanical & Aerospace Engineering

seminar

The Messy Mix of Photons and Polymer Matrix Nanocomposites: Properties, Processing and Performance

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abstract

Imagine inflatable structures covering tennis courts or other sports facilities that automatically adjust the amount of sunlight reaching the interior. Imagine draping films over windows or courtyards to harvest sunlight for chemical processing – maybe even artificial photosynthesis. What manufacturing process can be used to produce these types of multifunctional films to cover such large areas? What processing methods can be used to take advantage of the latest developments in nanotechnology that also permit production of large quantities of materials? This talk will focus on processing methodologies that have the potential to produce these materials and addresses fundamental issues connected to scalable processing of polymer matrix nanocomposites (PMNCs) for specific energy-related applications. In particular, an in situ vapor deposition process will be described that has been used to create photochromic, tungsten-oxide, polymer matrix nanocomposites. Under specific processing conditions, these composites consist of discrete tungsten-oxide nanoparticles distributed uniformly throughout the bulk of an optically transparent fluoropolymer matrix. Incorporating oxygen as a supplementary deposition agent in the synthesis process increases the transparency of these films in the visible and increases the change in transmission due to the photochromic effect. To improve the response of these materials, work has also been carried out to structure nanoparticles using laser irradiation. Starting with silver nanoparticle PMNCs, localized chemical vapor deposition in the near-particle environment was carried out using femtosecond, photothermal heating to decompose tungsten hexacarbonyl leading to the formation of tungsten oxide shells surrounding ***(cont'd.)***

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the silver nanoparticles. Control of the spatial and temporal characteristics of the excitation source allows for synthesis of nanocomposites with a high degree of control over the location, composition and size of nanoparticles in the matrix and presents the opportunity to produce patterned materials with spatially varying properties.

biosketch

James Spicer is a professor of Materials Science and Engineering at The Johns Hopkins University and is a member of the Principal Professional Staff at The Johns Hopkins Applied Physics Laboratory. His research focuses on the interactions of photons with materials and currently includes efforts related to ultrafast studies of nanoscale thermal and acoustic transport, polymer matrix nanocomposite processing and characterization, optical and ultrasonic characterization of texture in nuclear graphites and development of spectrally-tailored coatings for space probes. He is a member of ASME, IEEE, OSA and MRS.