Functional Nanocomposites – From Fabrication to Function

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Highly filled particulate nanocomposite films consisting of metal nanoparticles in a dielectric organic or ceramic matrix have unique functional properties with hosts of applications. In most applications, a high filling factor close to the percolation threshold with control of the particle separation on the nm scale is essential because the functional properties often require short range interaction between nanoparticles. The present talk demonstrates how vapor phase deposition techniques can be employed for tailoring the nanostructure and the resulting properties. Vapor phase deposition, inter alia, allows excellent control of the metallic filling factor and its depth profile as well as the incorporation of alloy nanoparticles with well-defined composition. We applied various methods such as sputtering, evaporation, and plasma polymerization for the deposition of the matrix component, while the metallic components were mostly sputter-deposited or evaporated. Moreover, a high-rate gas aggregation cluster source was utilized to obtain independent control of filling factor and size of the embedded nanoparticles. Examples include optical composites with tuned particle surface plasmon resonances for plasmonic applications [1], magnetic high frequency materials with cut-off frequencies well above 1 GHz [2], sensors and photoswitchable devices [3] that are based on the huge change in the electronic properties near the percolation threshold, and biocompatible antibacterial coatings with tailored release rate [4]. In addition to the particulate composites, a new concept of layered magnetoelectric composites will be presented for robust, fully integrable, broad band magnetic field sensors based on the delta E effect [5].

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