Fall 11-10-2015

Constructing nanocrystal-in-glass composites for smart windows

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CONSTRUCTING NANOCRYSTAL-IN-GLASS COMPOSITES FOR SMART WINDOWS

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The integration of inorganic nanocrystals as building units into mesoscale architectures yields materials wherein the components and their interfaces are both essential in defining structure and function. Randomly mesostructured nanocrystal-in-amorphous niobia composites can be formed by chemically linking niobium polyoxometalate (POM) clusters to colloidal nanocrystals in the solution phase. When films of these assemblies are thermally annealed, the clusters undergo condensation. They cross-link to form a continuous amorphous niobia matrix surrounding, and covalently linked to, the embedded nanocrystals. The resulting composite materials combine intrinsic characteristics of each component and exhibit unique functionality that we ascribe to reconstruction at the nanocrystal-glass interface. An architected nanocomposite can instead be formed when the arrangement of the nanocrystals into a mesoporous framework is accomplished first, using a block copolymer template. In this case, POMs are in-filled in a second step, then annealed to form the nanocrystal-niobia glass composite. Our composite metal oxide thin films exhibit a unique optical switching response to electrochemical reduction. Namely, they independently control the transmittance of visible and near infrared light as a function of voltage. These results highlight the tremendous opportunity to tune structure at both the atomic and nanometer length scales to realize new functionality.