Developing Multifunctional Materials by Controlling Morphology in Polymer Nanocomposites

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Abstract

A basic tenet of Materials Science is that structure governs properties, and this is borne out clearly in natural materials, where complex functional structures are developed at multiple length scales. Our ability to mimic these natural materials, however, remains immature, limited at best to controlling the dispersion of functional additives in a polymer matrix. A primary focus of polymers research at the Army Research Laboratory is the reduction of the weight burden for Soldiers in combat and developing lightweight materials for use in new vehicles. One route to achieving these goals is the development of materials that are "multifunctional," in that they combine functional characteristics of disparate materials into one, presumably allowing reduction in weight by combining desired performance characteristics into one new material.

At the most primitive level, a "multifunctional" polymer may be created by adding something to it that has a distinct characteristic desired in the final product. In this presentation, projects investigating routes to controlling the dispersion of functional nanoparticles added to polymers will be described, along with a project investigating the morphological behavior of a structured, ion-containing graft copolymer. In the case of the particulate-modified polymers, the effects of ligand molecular weight and functional ligand chemistry are considered. The ion-containing polymers were studied with the intent of probing the morphological effects of the relationship between the distribution of ionic functional groups along the polymer backbone and the microphase separation of the graft copolymer host. The unifying thread in these projects is the desire to exert control over morphology of the final material, at multiple levels, to generate new materials combining the functional characteristics of both components.