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Editorial

Polymer Nanocomposite Processing, Characterization, and Applications

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Nanoparticles, such as carbon nanotubes, carbon nanofibers, nanoclay, and exfoliated graphite, are of great interest due to their nanoscale dimensions and remarkable prospect for improvement of mechanical, thermal, electrical, and chemical properties when introduced in small quantities in polymer matrix composites. This prospect has spurred considerable research effort in the polymer community in seeking ways to leverage the properties of these nanoscale inclusions in the development of next generation polymeric materials, as either stand-alone inclusions or as components in hybrid, multiscale composite architectures, often with enhanced multifunctional properties, where simultaneous enhancements in two or more properties are sought. The relevance of these next-generation nanocomposite materials in numerous applications spanning, but not limited to, the biomedical, sensor, aerospace, and defense sectors, continues to motivate further research and development work.

While a number of advances have been made in the development of polymer nanocomposites, it is clear that significant research and development still need to be done. For example, the role of processing of these nanocomposite materials cannot be underestimated, as often a slight change in base polymer material, nanoparticle type, and/or processing conditions can drastically alter the dispersion, orientation, and/or microstructure of the nanocomposite, with corresponding changes in the resulting nanocomposite properties. There is also a need for enhanced, and more quantitative, techniques to characterize the distributions and orientations of nanoparticles, as well as to experimentally assess the properties of the interface between the polymer and the nanoparticles. The continued development of better, more rigorous multiscale computational models is also necessary to accurately predict the mechanical and other functional properties of the polymer nanocomposite as a function of critical factors such as nanoparticle geometry, nanoparticle orientation, type of functional groups or coupling agents, molecular weight of the polymer chain, and the interfacial properties. These and other advances in the realm of polymer nanocomposites will be necessary before the full potential of polymer nanocomposites can actually be realized.

The objective of this special issue is to bring together some selected examples of current research efforts related to the processing, characterization, and applications of polymer nanocomposites. In this regard, this issue includes samples of topical basic and applied materials research efforts focusing on nanocomposite preparation techniques, characterization, nanoparticle dispersion, morphology and functional properties of polymer nanocomposites for sensors, actuators, and other applications. The twelve research papers comprising this special issue cover topics in the realm of melt processing of polymer nanocomposites with exfoliated graphite to improve dielectric properties and electrical conductivity, the environmental degradation of nanocomposites containing nanoclays, the application of polymer nanoparticles as mechanical reinforcement for

elastomers and of water-soluble chitosan nanoparticles for protein delivery, the effects of coupling agents on the preparation of nanoscale thin films, the generation of hybrid nanocomposites using combinations of nanoparticles with different sizes and surface chemistries and foaming behavior, microstructure, and properties of nanocomposite foams. Additional papers report on the mechanical properties of different nanocomposite systems prepared via conventional processing methods such as extrusion and injection molding. We hope that the collection of articles comprising this special issue will be of interest to a wide range of the readers who are working in this exciting, challenging, and rapidly evolving field.

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