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Editorial
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Preface: Forum on Applications of Hierarchical Polymeric Materials from Nano to Macro

This issue of ACS Applied Materials & Interfaces features a Forum focused on the development and application of hierarchical polymeric materials from nano- to macroscale. The Forum is an outgrowth of the workshop entitled "Polymer Composites and High Performance Polymers" held in July 2013 in Santa Rosa, California, by the ACS Division of Polymer Chemistry. The workshop included talks on applications of biocomposites, fibers and interfaces, new resins, nanoporous materials, nanocomposites, and the Materials Genome effort, and brought together researchers from industrial, university, and national laboratories to review recent advances and challenges in this area. The objective of this Forum is to provide the readership with articles that capture the breadth of work discussed in the workshop and highlight some of the most exciting research and applications. Fourteen papers are included in the Forum.

The importance of carbon nanotube (CNT) research to the application of polymer nanocomposites with improved properties is highlighted in three articles in the Forum. The first is a comprehensive review article discussing the evolution of polymer/CNT fibers, their properties and prospects for application. The article by Liu and Kumar (http://pubs.acs.org/doi/abs/10.1021/am405136s) stresses the importance of polymer−CNT interaction, the type of polymer interphase, orientation of polymer and CNT, processing conditions, and others on the properties of the fibers. Interfacial interactions between CNT and polymer are also the subject of an article on polymer/CNT nanocomposites contributed by Khare et al. (http://pubs.acs.org/doi/abs/10.1021/am405317x). This article combines computer simulation and experiment to understand the effect of amido-amine functionalized CNT on mechanical properties of epoxy/CNT nanocomposites. Another contribution by Miller et al. details the improvement in tensile properties that can be achieved by chemical modification and e-beam curing of commercially available CNT yarns and sheets. The CNT yarns and sheets can be used as drop-in replacements for carbon fibers or fabric to improve the properties of polymer matrix composites.

Two contributions to the Forum describe the importance of characterization of nanofillers used in polymer nanocomposites. A simple direct measurement of CNT length utilizing cryo-TEM and statistical methods is demonstrated in a Forum contribution by Pasquali et al. (http://pubs.acs.org/doi/abs/10.1021/am500424u) CNT length is highly influential for controlling thermal, electrical, and mechanical properties of polymer/CNT nanocomposites. Biorenewable cellulose nanocrystals and nanofibrils, another viable reinforcement for polymer nanocomposites, is the subject of the contribution by Gilman et al. (http://pubs.acs.org/doi/abs/10.1021/am500359f). In this article, key properties of cellulose nanofibrils and nanocrystals from a variety of sources are measured and compared to illustrate the broad design space and tunable properties which can be accessed in this area.

Two papers in the Forum utilize nanoparticles functionalized with ligands to create novel materials. A Spotlight on Applications contributed by Schadler et al. (http://pubs.acs.org/doi/abs/10.1021/am405332a) focuses on use of brush ligands to tune the thermodynamic interactions between nanofiller and matrix. The surface ligand engineering provides the potential to create nanocomposites with novel properties for optoelectronic and dielectric applications. Another Spotlight on Applications contributed by Hill and Pyun (http://pubs.acs.org/doi/abs/10.1021/am405786u) describes the use of polystyrene coated magnetic nanoparticles to create 1D assemblies of particles described as colloidal polymers. This novel class of materials may enable fabrication of nanoactuating systems resembling artificial cilia and flagella, or nanowires with application as electrode materials for batteries.

Other types of polymer nanocomposites are explored in three other Forum contributions. Development of clay/polymer nanocomposites as gas barriers is highlighted in an article by Grunlan et al. (http://pubs.acs.org/doi/abs/10.1021/am403445z). The nanocomposite films made using layer by layer deposition have lower oxygen transmission rates when faster dipping times are use, a prospect that makes them especially useful for industrial scale-up. Another type of polymer nanocomposite, electrospun polystyrene fibers loaded with an energetic formulation of coated nano-Al particles, is described in an article by Clayton et al. (http://pubs.acs.org/doi/abs/10.1021/am404583h). Electrospinning provides a novel way to fabricate pyrolant mats without the problems associated with other techniques which can lead to aggregation of the energetic particles. Polyimide−organosilicate hybrid films are described in an article by Jung et al. (http://pubs.acs.org/doi/abs/10.1021/am405099r), utilizing a novel alkyl linked polysilsesquioxane functionalized by aminophenyl groups. The films have potential as substrates for display devices.

Four contributions to the Forum highlight new polymer development for various applications. These include a Spotlight on Applications contributed by Sottos et al. (http://pubs.acs.org/doi/abs/10.1021/am500536t) describing a capsule-based approach to self-healing polymers for autonomic recovery of interfacial shear strength of composites. Another article by Savin et al. (http://pubs.acs.org/doi/abs/10.1021/am405138e) describes fabrication of new thiol−ene networks modified with thiourethane or urethane. The polymers made in a facile one pot process have potential application as high-performance protective gear. A contribution by Bowman et al. (http://pubs.acs.org/doi/abs/10.1021/am405371r) describes thiol-isocyanates which utilize a two-stage polymerization strategy. The strategy enables novel shape memory polymers with intricate surface features that can be programmed and locked on

Special Issue: Applications of Hierarchical Polymer Materials from Nano to Macro

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demand or gradient properties that can be used to create hidden patterns visualized upon heating or straining. Yet another contribution by Meador et al. (http://pubs.acs.org/doi/abs/10.1021/am405106h) describes the low dielectric properties of polyimide aerogels with and without fluorine in the backbone. The aerogels, with dielectric constants as low as 1.08, can be used as substrates for lightweight antennas with improved performance.

As a whole, the articles in this Forum highlight the significant progress that continues to be made in the development and application of hierarchical polymeric materials, and the exciting future challenges that continue to be addressed. Look for a follow up to the workshop that inspired this Forum in 2016.

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■ AUTHOR INFORMATION

Notes

Views expressed in this editorial are those of the author and not necessarily the views of the ACS.