Editorial corner – a personal view

Polymer nanocomposites for energy applications

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The demand for developing sustainable and clean energy production, energy transportation, and storage, has grown rapidly in recent years due to the increase in fossil fuel consumption, environmental issue and global warming. Nanomaterials with different morphologies, properties and structures (e.g. barium titanate nanoparticles, carbon nanotubes, ZnO nanowires) offer superior chemical, mechanical or physical properties compared to their micrometer-scale counterparts. Accordingly, they are potential candidate materials for clean energy applications such as the energy storage, fuel cells, and solar cells (ISBN: 978-0-12-407796-6). The nanomaterials can be incorporated into polymers at low loading levels to form nanocomposites with greater mechanical flexibility, tailored properties and functionalities. These include bipolar plates of fuel cells (DOI: [10.1039/c0ee00689k](https://doi.org/10.1039/c0ee00689k)), high-energy density capacitors, solid polymer electrolytes, and hybrid polymer/nanoparticle solar cells (DOI: [10.1016/j.jcis.2011.12.016](https://doi.org/10.1016/j.jcis.2011.12.016)). Nanofillers offer larger interfacial area that allows better interaction with the polymer matrix. Polymers provide structural support and protection for nanomaterials during their industrial service lives. A wide variety of polymers can be selected for making nanocomposites for various fields of energy applications depending on the designed chemical, physical and mechanical properties.

The major challenges of achieving high-performance polymer nanocomposites are the attainment of uniform dispersion of nanofillers in the polymer matrix and the manipulation of nanofiller/polymer

interfaces. Typical approaches include surface modification of nanofillers via covalent and noncovalent functionalization. Significant research efforts have been devoted by chemists and materials scientist for developing polymer nanocomposites with novel functionalities using improved fabrication techniques recently. For instance, polymeric materials with high dielectric constant (k) and low loss find useful application for making supercapacitors. The β -phase of polyvinylidene fluoride is known to exhibit excellent ferroelectric and piezoelectric effects. This phase can be increased to ~46% by adding 0.5 wt% carbon nanotubes and processed through electrospinning. The process stretches polymer solution uniaxially under an electric potential. It can be further increased over 90% by mechanical drawing (DOI: [10.1021/jp4011026](https://doi.org/10.1021/jp4011026)). To reduce dielectric loss, core-shell nanoparticle strategy emerges as a powerful method for preparing high- k nanocomposites especially filled with conducting nanomaterials (DOI: [10.1002/adma.201401310](https://doi.org/10.1002/adma.201401310)). To fully realize widespread commercial applications of polymer nanocomposites, it is necessary to develop cost-effective processes for the mass production of these materials in large quantities.

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