Nanodiamond-containing polymers for structural and biological applications

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Due to their favorable strength to weight ratio, polymer composite materials find numerous applications in construction, transportation, biomedical, sports industry and other areas. A nanocomposite is a composite material in which at leaSt one of the components has at leaSt one spatial dimension smaller than 100 nm. At these small length scales, the specific surface area becomes large and polymer-filler interactions become increasingly important, since polymer properties change in the vicinity of the surface. The resulting third phase, called interphase, plays an important role in the overall properties of the nanocomposite since its volume fraction becomes significant at the nanoscale.

The small 5 nm diameter of detonation nanodiamond (ND) particles in combination with their rich surface chemistry [1] makes ND an optimal candidate for polymer reinforcement. Furthermore, ND can be used to engineer multifunctional composites due to its various properties. In the case of an epoxy matrix [2], ultimate mechanical reinforcement has been achieved by using high loadings of ND powder. Also, the effect of functionalized (aminated) ND on the epoxy stoichiometry and the resulting mechanical properties has been investigated and resulted in new insights in engineering nanocomposites. To reinforce a thermoplastic and biodegradable poly(L-lactic) acid (PLLA) polymer, ND's surface chemistry has been tailored to match this hydrophobic polymer, resulting in improved mechanical properties, along with biocompatibility and blue fluorescence [3]. Several complementary mechanical characterization techniques have been used to understand the reinforcing mechanisms of ND. Results of compression and fracture toughness measurements have been compared with depth-sensing indentation data. This research gives new insights in the reinforcing mechanisms of ND in polymer matrices.

[1] Osswald S., Yushin G., Mochalin V., Kucheyev S., Gogotsi Y., *JACS* **128**, 11635 (2006).
[2] Neitzel I., Mochalin V., Palmese G., Gogotsi Y., *Composites Science and Technology,* in press, (2011).
[3] Zhang Q., Mochalin V., Neitzel I., et al., *Biomaterials* **32**, 87 (2011).