McCormick News Article

By Adding Graphene, Researchers Create Superior Polymer

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Cate Brinson

Researchers at Northwestern University and Princeton University have created a new kind of polymer that, because of its extraordinary thermal and mechanical properties, could be used in everything from airplanes to solar cells.

The polymer, a nanocomposite that incorporates functionalized, exfoliated graphene sheets, even conducts electricity, and researchers hope to use that property to eventually create thermally stable, optically transparent conducting polymers.

The results of their research were published May 11 in the online version of *Nature Nanotechnology*.

Researcher at the McCormick School of Engineering originally teamed up with researchers at Princeton several years ago. McCormick researchers had experience working with polymer nanocomposites, and Princeton researchers had developed a way to exfoliate, or split apart, graphite sheets into very thin single layer, surface-functionalized graphene sheets.

Previous use of graphite in polymers did not garner significantly improved properties since researchers could never get the graphite exfoliated. That meant the graphite was rigid with a low surface area and could only minimally impact properties of the polymer.

But when researchers put even a small amount the newly exfoliated graphene sheets — enough to equal only .05 percent of the material — into the polymer, they found the graphene changed the polymer's thermal stability temperature by 30 degrees. Even adding graphene sheets equal to .01 percent of the material increased stiffness by 33 percent — far beyond what researchers had predicted. The drastic changes in both the thermal stability and the stiffness after adding just a tiny percentage of functionalized graphene indicated that the graphene changes large regions of the polymer radiating out from the nanoparticle surfaces in a percolating network structure.

The new polymer nanocomposite based on graphene also exhibited the same or superior thermal and mechanical properties as using functionalized single-wall nanotubes in polymer — but was much easier and cheaper to create.

"This is the first time people have been able to demonstrate dramatically altered properties like this with really small quantities of graphite-based materials," says Cate Brinson, Jerome B. Cohen Professor of Mechanical Engineering and corresponding author of the paper.

The graphene sheets also will inherently be able to block moisture and gases from penetrating the material as well as change the thermal stability temperature and improve mechanical properties, making the durable polymer a candidate for use in everything from aircrafts to sports equipment to solar cells

"I think it has enormous potential," Brinson says. "With the ready availability of graphite and the properties we have demonstrated, this new material will enable significant structural scale use of carbon-based nanocomposites."

Next researchers are studying the polymer's electroconductivity, quantifying and optimizing the results with the goal of creating optically transparent conducting polymers that are thermomechanically stable.

In addition to Brinson, other authors of the paper include paper include T. Ramanathan (Northwestern) A. A. Abdala (formerly Princeton, now The Petroleum Institute), S. Stankovich (Northwestern), D. A. Dikin (Northwestern), M. Herrera-Alonso (Princeton), R. D. Piner (formerly Northwestern, now the University of Texas at Austin), D. H. Adamson (Princeton), H. C. Schniepp (Princeton), X. Chen (Northwestern), R. S. Ruoff (Formerly Northwestern, now the University of Texas at Austin), S. T. Nguyen (Northwestern), I. A. Aksay (Princeton), and R. K. Prud'Homme (Princeton).

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