Nano World: Composites with nano-graphite

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Strong, lightweight plastic-like composites made with highly electrically conductive sheets of carbon just one atom thick could find use in electronics and protect aircraft from lightning strikes, experts told UPI's Nano World.

The graphite found in pencils is made of layers just a single carbon atom thick known as graphene. Carbon nanotubes are simply graphene that has been rolled into a cylindrical shape. Investigators worldwide are researching carbon nanotubes for use in electronics because they are capable of conducting electricity at high speed with little energy loss. However, scientists have encountered many challenges when it comes to generating nanotubes with consistent electronic properties and with integrating them into circuitry via processes suitable for mass production. Carbon nanotubes are quite expensive to make as well.

Graphene appears to have many of the electronic properties that make carbon nanotubes so attractive. Ideally, researchers could just take graphite and strip it apart into graphene sheets for use in devices. Graphite, which is sold for just a few dollars a pound with about 1 million metric tons sold annually worldwide, is far less expensive than carbon nanotubes. However, making isolated graphene sheets from graphite is not easy because they like to stick together.

Physical chemist and materials scientist Rod Ruoff at Northwestern University in Evanston, Ill., and his colleagues experimented with electrically insulating graphite oxide, an oxygenated form of graphite. They found a version of graphite oxide chemically modified with

organic compounds, when dipped in solvents and treated with ultrasound waves, dispersed into sheets of oxygenated graphene. From there, researchers then found they could fuse these sheets with commercial polymers such as rubbers or polystyrene and strip the oxygen away to make them electrically conductive graphene. The polymers help keep the graphene from sticking together.

The researchers found the electronic properties of their graphene-polystyrene hybrids compare well with the best values reported for nanotube-polymer composites. Moreover, unlike the nanotube-polymer materials, the graphene-polystyrene composites are easy to process using standard industrial processes such as injection molding or hot pressing. Ruoff and his colleagues reported their findings in the July 20 issue of the scientific journal Nature.

"They have shown it's possible to produce graphene from graphite using really industrial scale processes so it can be used even for composites," said physicist Andre Geim at the University of Manchester in England.

These materials could have applications in the transportation as well as the electronics industry, said researcher SonBinh Nguyen, a chemist at Northwestern. For instance, chemical engineer Nicholas Kotov at the University of Michigan at Ann Arbor said these composites might find use in aircraft fuselages, which must combine low weight, high strength and electrical conductivity. "It is quite important to have them conductive to prevent damage from lighting strikes and electromagnetic pulses. The two biggest companies in airplane production, Boeing and Airbus, consider it as one of the most important issues in future design of composite planes," Kotov explained.

The graphene in the composites are basically there as wrinkly sheets. Future research can explore how properties of composites alter by flattening these sheets out, and with higher concentrations of graphene,

Ruoff said.