US Navy eyes graphene nanoribbon for ultimate power control system

July 21 2015, by Cory Nealon

The U.S. Navy distributes electricity aboard most of its ships like a power company. It relies on conductors, transformers and other bulky infrastructure.

The setup works, but with powerful next generation weapons on the horizon and the omnipresent goal of energy efficiency, the Navy is seeking alternatives to conventional power control systems.

One option involves using graphene, which, since its discovery in 2004, has become the material of choice for researchers working to improve everything from solar cells to smartphone batteries.

Accordingly, the Office of Naval Research has awarded University at Buffalo engineers an $800,000 grant to develop narrow strips of graphene called nanoribbons that may someday revolutionize how power is controlled in ships, smartphones and other electronic devices.

"We need to develop new nanomaterials capable of handling greater amounts of energy densities in much smaller devices. Graphene nanoribbons show remarkable promise in this endeavor," says Cemal Basaran, PhD, a professor in UB's Department of Civil, Structural and Environmental Engineering, School of Engineering and Applied Sciences, and the grant's principal investigator.

Graphene is a single layer of carbon atoms packed together like a honeycomb. It is extremely thin, light and strong. It's also the best known conductor of heat and electricity.

"The beauty of graphene is that it can be grown like biological organisms as opposed to manufacturing materials with traditional techniques," says Basaran, director of UB's Electronic Packaging Laboratory. "These bio-inspired materials allow us to control their atomic organizations like controlling genetic DNA makeup of a lab-grown cell."

While promising, researchers are just beginning to understand graphene and its potential uses. One area of interest is power control systems.

Like overhead power lines, most ships rely on copper or other metals to move electricity. Unfortunately, this process is relatively inefficient; electrons bash into each other and create heat in a process called Joule heating.

"You lose a great deal of energy that way," Basaran says. "With graphene, you avoid those collisions because it conducts electricity in a different process, known as semi-ballistic conduction. It's like a high-speed bullet train versus bumper cars."

Another limitation of metal-based power distribution is the bulky infrastructure - transistors, copper wires, transformers, etc. - needed to move electricity. Whether in a ship or tablet computer, the components take up space and add weight.

Graphene nanoribbons offer a potential solution because they can act as both a conductor (instead of copper) and semiconductor (instead of silicon). Moreover, their ability to withstand failure under extreme energy loads is roughly 1,000 times greater than copper.

That bodes well for the Navy, which, like segments of the automotive industry, is pivoting toward electric vehicles.

It recently launched an all-electric destroyer; the ship's propellers and drive shafts are turned by electric motors, as opposed to being connected to combustion engines. The integrated power-generation and distribution system may also be used to fire next generation weapons, such as railguns and powerful lasers. And the automation has allowed the Navy to reduce the ship's crew, which places fewer sailors in potentially dangerous situations.

Graphene nanoribbons could improve these systems by making them more robust and energy-efficient, Basaran said. He and a team of researchers will:

- Design complex simulations that examine how graphene nanoribbons can be used as a power switch.
- Explore how adding hydrogen and other elements, a process

known as "doping," to graphene nanoribbons could improve their performance.

- Investigate graphene nanoribbons' failure limit under high power loads and try to find ways to improve it.

The research will be performed over the next four years.

Provided by University at Buffalo

Citation: US Navy eyes graphene nanoribbon for ultimate power control system (2015, July 21) retrieved 26 April 2024 from
https://phys.org/news/2015-07-navy-eyes-graphene-nanoribbon-ultimate.html