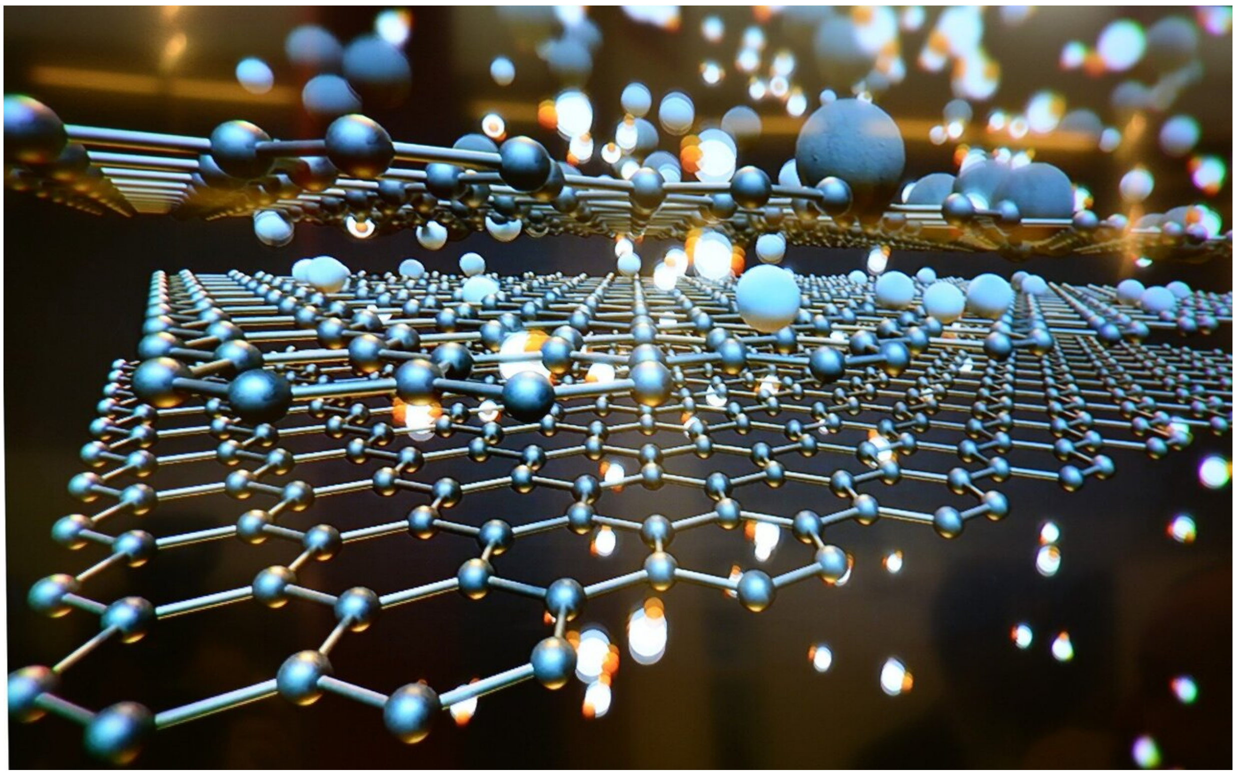
Bringing the green revolution to electronics

February 25 2020



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Researchers are investigating how to make electronic components from eco-friendly, biodegradable materials to help address a growing public health and environmental problem: around 50 million tonnes of electronic waste are produced every year.

Less than 20% of the e-waste we produce is formally recycled. Much of the rest ends up in landfills, contaminating soil and groundwater, or is informally recycled, exposing workers to hazardous substances like mercury, lead and cadmium. Improper e-waste management also leads to a significant loss of scarce and valuable raw materials, like gold, platinum and cobalt. According to a UN report, there is 100 times more gold in a tonne of e-waste than in a tonne of gold ore.

While natural biomaterials are flexible, cheap and biocompatible, they do not conduct an electric current very well. Researchers are exploring combinations with other materials to form viable biocomposite electronics, explain Ye Zhou of China's Shenzhen University and colleagues in the journal *Science and Technology of Advanced Materials*.

The scientists expect that including biocomposite materials in the design of electronic devices could lead to vast cost saving, open the door for new types of electronics due to the unique material properties, and find applications in implantable electronics due to their biodegradability.

For example, there is widespread interest in developing organic field effect transistors (FET), which use an electric field to control the flow of electric current and could be used in sensors and flexible flat-panel displays.

Flash memory devices and biosensor components made with biocomposites are also being studied. For example, one FET biosensor incorporated a calmodulin-modified nanowire transistor. Calmodulin is an acidic protein that can bind to different molecules, so the biosensor could be used for detecting calcium ions.

Researchers are especially keen to find biocomposite materials that work well in resistive random access memory (RRAM) devices. These devices have non-volatile memory: they can continue to store data even after the power switch is turned off. Biocomposite materials are used for the insulating layer sandwiched between two conductive layers. Researchers have experimented with dispersing different types of nanoparticles and quantum dots within natural materials, such as silk, gelatin and chitosan, to improve electron transfer. An RRAM made with cetyltrimethylammonium-treated DNA embedded with silver nanoparticles has also shown excellent performance.

"We believe that functional devices made with these fascinating materials will become promising candidates for commercial applications in the near future with the development of materials science and advances in device manufacturing and optimization technology," the researchers conclude.

More information: Xuechao Xing et al. Building memory devices from biocomposite electronic materials, *Science and Technology of Advanced Materials* (2020). DOI: 10.1080/14686996.2020.1725395

Provided by National Institute for Materials Science