Untwisting plastics for charging Internet-of-Things devices

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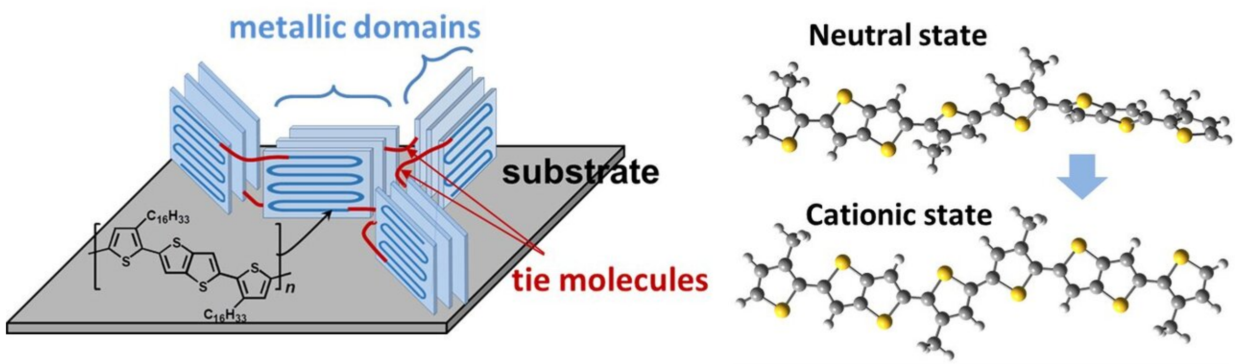

Left: The scientists found that their doping technique formed linkages (red) between PBTTT's crystalline parts (blue rectangles). Right: They also found that PBTTT was twisted in its natural state but became highly planar when doped with electrolyte. Credit: Takenobu Group

Untwisting chains of atoms within a plastic polymer improves its ability to conduct electricity, according to a report by researchers, led by Nagoya University applied physicist Hisaaki Tanaka, in the journal *Science Advances*. The insight could help accelerate the development of wearable power sources for a vast number of Internet-of-things devices.

The 'smart' societies of the future are expected to contain a large number of electronic devices that are interconnected through the Internet: the so-called Internet-of-things. Scientists have been looking for ways to use body heat to charge some types of micro-devices and sensors. But this requires lightweight, non-toxic, wearable, and flexible thermoelectric generators.

Plastics that can conduct electricity, called conducting polymers, could fill this bill, but their thermoelectric performance needs to be improved. Their thin films have highly disordered structures, formed of crystalline and non-crystalline parts, making it notoriously difficult to understand their properties and thus find ways to optimize their performance.

Tanaka worked with colleagues in Japan to understand the thermoelectric properties of a highly conductive thiophene-based polymer, called PBTTT. They added or 'doped' the polymer with a thin ion electrolyte gel, which is known to improve conductivity. The gel only infiltrates the polymer successfully when a specific electric voltage is applied.

They used a variety of measurement techniques to understand the polymer's electronic and structural changes when doped. They found that, without the electrolyte gel, the PBTTT chain is highly twisted. Doping it with a critical amount of electrolyte untwists the chain and creates links between its crystalline parts, improving electron conductivity.

The scientists report that the formation of this interconnected conductive network is what determines the polymer's maximum thermoelectric performance, which they were able to uniquely observe in this study.

They are now looking into ways to optimize the thermoelectric performance of thin film conducting polymers through material design and changing the fabrication conditions.

The article, "Thermoelectric properties of a semicrystalline polymer doped beyond the insulator-to-metal transition by electrolyte gating," was published in the journal *Science Advances* on February 14, 2020.

More information: Hisaaki Tanaka et al. Thermoelectric properties of a semicrystalline polymer doped beyond the insulator-to-metal transition by electrolyte gating, *Science Advances* (2020). DOI: 10.1126/sciadv.aay8065

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