Bending an organic semiconductor can boost electrical flow

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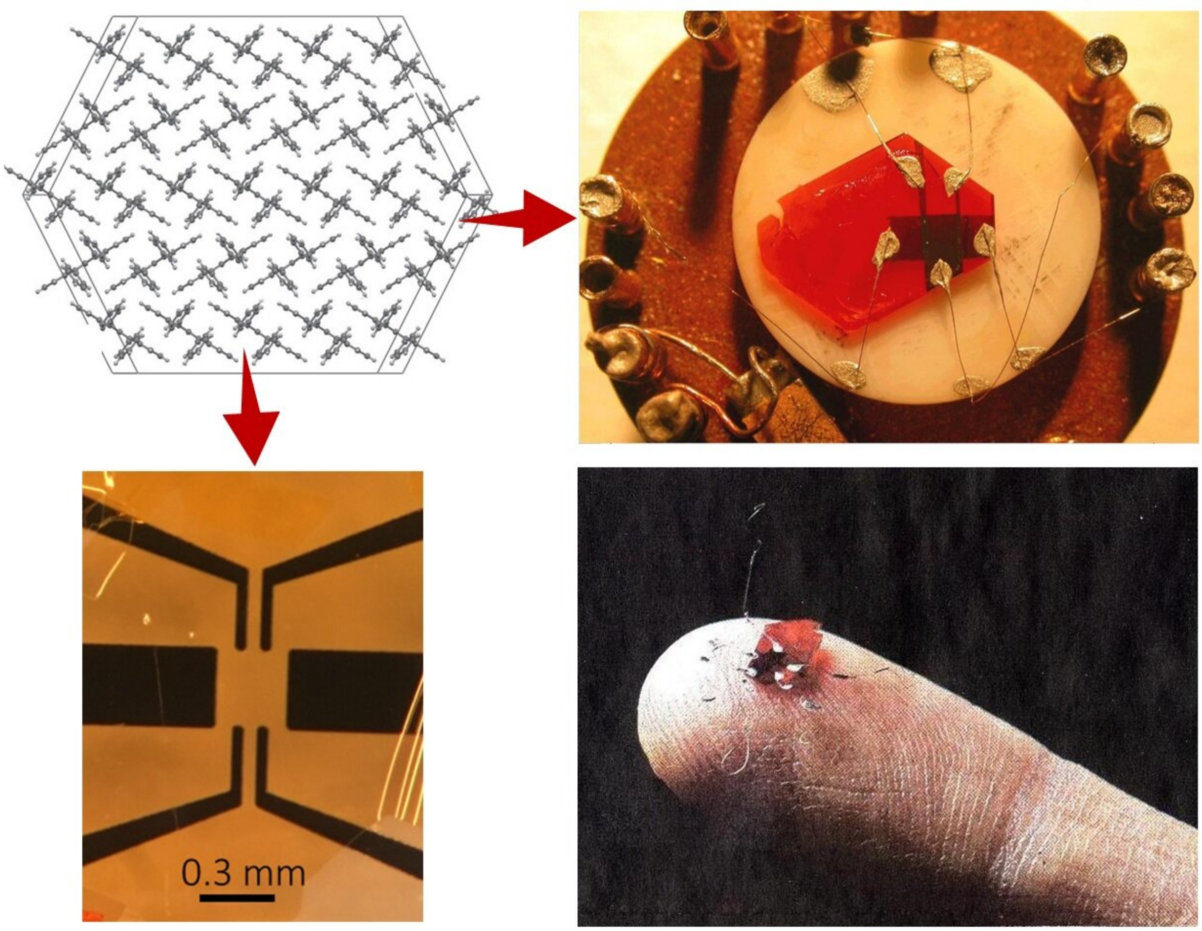

Organic transistors based on single crystals of rubrene, a hydrocarbon, can roughly double the speed of electricity flowing through them when a crystal is slightly bent (strained). This useful behavior cannot be easily achieved with traditional semiconductors made, for example, of silicon. Molecules of rubrene are arranged in a herringbone pattern (upper left), forming highly ordered semiconducting molecular crystals that can be used to create rigid (upper right) or flexible (lower left) high-performance organic transistors, based on thick or ultra-thin single crystals, respectively. An example of a freestanding rubrene transistor is shown on a finger tip (lower right). Credit: Vitaly Podzorov/Rutgers University-New Brunswick

Slightly bending semiconductors made of organic materials can roughly double the speed of electricity flowing through them and could benefit next-generation electronics such as sensors and solar cells, according to Rutgers-led research.

The study is published in the journal *Advanced Science*.

"If implemented in electrical circuits, such an enhancement—achieved by very slight bending—would mean a major leap toward realizing next-generation, high-performance organic electronics," said senior author Vitaly Podzorov, a professor in the Department of Physics and Astronomy in the School of Arts and Sciences at Rutgers University–New Brunswick.

Semiconductors include materials that conduct electricity and their conductivity can be tuned by different external stimuli, making them essential for all electronics. Organic semiconductors are made of organic molecules (mainly consisting of carbon and hydrogen atoms) that form light, flexible crystals called van der Waals molecular crystals. These novel materials are quite promising for applications in optoelectronics, which harness light and include flexible and printed electronics, sensors and solar cells. Traditional semiconductors made of silicon or germanium have limitations, including cost and rigidity.

One of the most important characteristics of organic and inorganic semiconductors is how fast electricity can flow through electronic devices. Thanks to progress over the last decade, organic semiconductors can perform roughly 10 times better than traditional amorphous silicon transistors. Tuning semiconductors by bending them is called "strain engineering," which would open a new avenue of development in the semiconductor industry if implemented successfully. But until now, there were no conclusive experimental results on how bending organic semiconductors, including those in transistors, may affect the speed of electricity flowing in them.

The Rutgers-led study reports the first such measurement, and a 1 percent bend in an organic transistor can roughly double the speed of electrons flowing through it.

More information: Hyun Ho Choi et al. A Large Anisotropic Enhancement of the Charge Carrier Mobility of Flexible Organic Transistors with Strain: A Hall Effect and Raman Study, *Advanced Science* (2019). DOI: 10.1002/advs.201901824

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