NEW ATLAS

MATERIALS

"Metallizing" diamond could switch from insulator to conductor at will

By Michael Irving
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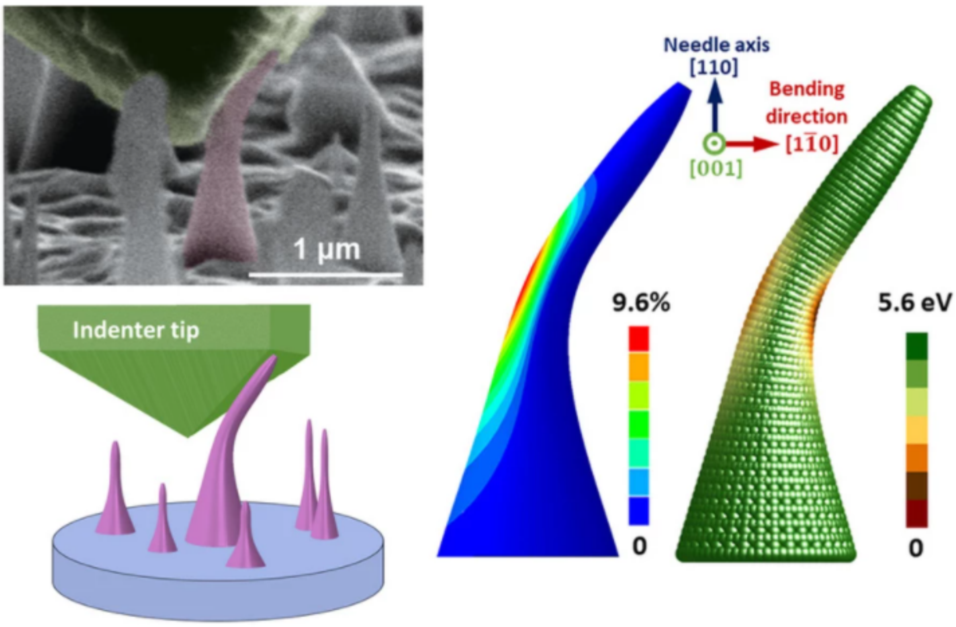
Researchers have found that it should be possible to "metallize" diamond, which could find a variety of uses in electronic devices jukai5/Depositphotos

Diamond is an effective electrical insulator, but that might not always be the case according to a new study from MIT and Nanyang Technological University (NTU) Singapore. The team has calculated that deforming diamond nano-needles would change their conductivity from an insulator to a semiconductor to a highly conductive metal – and back again at will.

Strain seems like something that you'd normally want to avoid, but in some cases it can change a material for the better. Strained silicon, for example, can allow electrons to move through it more easily, making for transistors that can switch up to 35 percent faster. The key is to apply enough strain to affect the arrangement of atoms in the crystal lattice, but not too much that the lattice itself is disrupted.

How easily electrons move through a material is measured as that material's "bandgap," and the higher that number the harder a time electrons have getting through. At 5.6 electron volts, diamond normally has an ultrawide bandgap that makes it a great insulator. But in the new study, the researchers found a way to strain diamond to change its bandgap.

Using computer simulations of quantum mechanics and mechanical deformation, the team found that a diamond probe could be used to bend diamond nano-needles to different levels of strain. The more strain that was applied, the narrower the bandgap became, until it disappeared completely just before the point where the needle would break. At that point the diamond becomes "metallized" and an excellent electrical conductor.



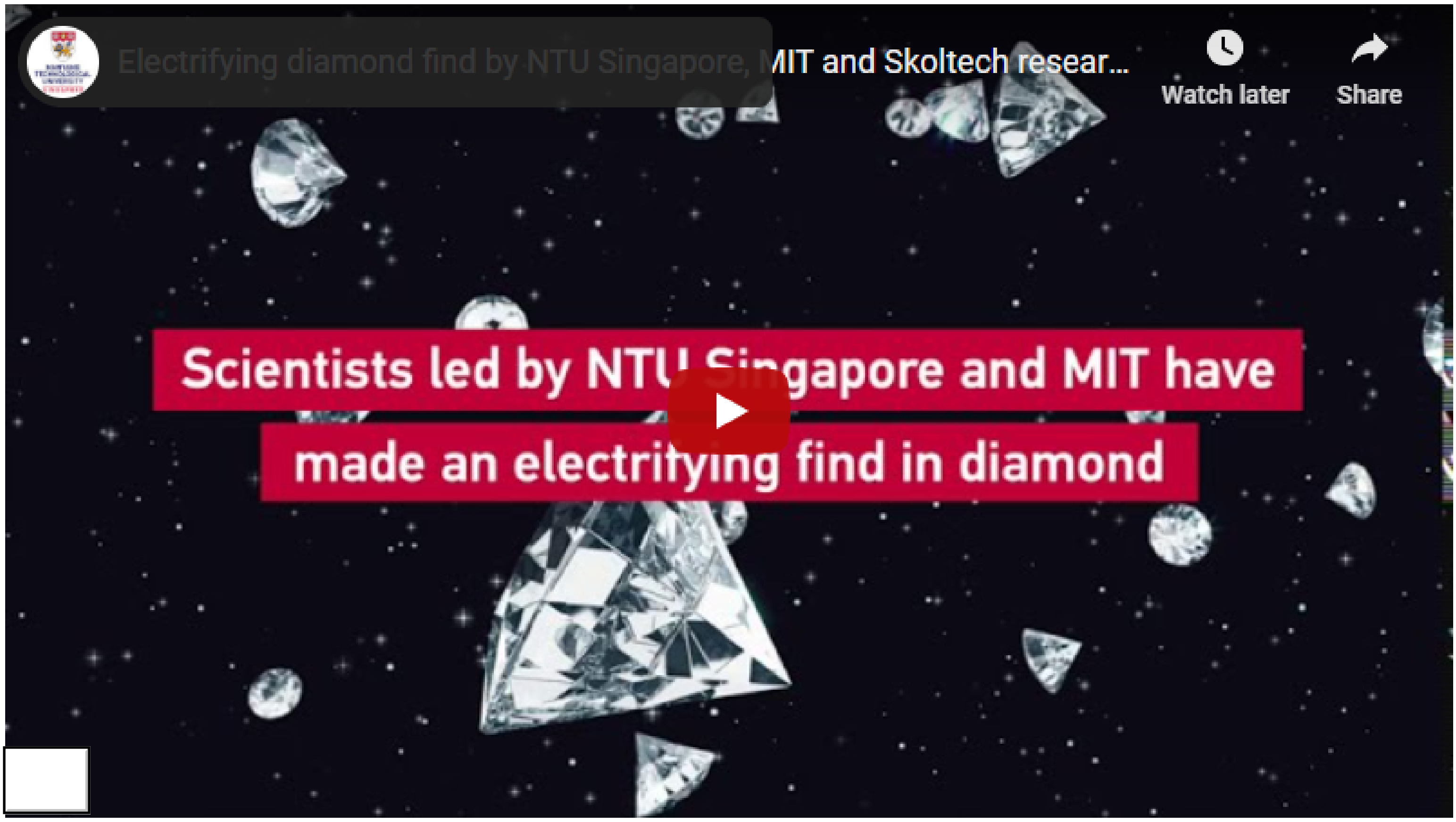
Top left: electron microscope image of nano-needles being bent. Right: Computer illustrations of the amount of strain being applied MIT News

"We found that it's possible to reduce the bandgap from 5.6 electron volts all the way to zero," says Ju Li, corresponding author of the study. "The point of this is that if you can change continuously from 5.6 to 0 electron volts, then you cover all the range of bandgaps. Through strain engineering, you can make diamond have the bandgap of silicon, which is most widely used as a semiconductor, or gallium nitride, which is used for LEDs. You can even have it become an infrared detector or detect a whole range of light all the way from the infrared to the ultraviolet part of the spectrum."

This could have a range of intriguing applications, the team says. For example, diamond bent to have a gradient of strain across it could make for a solar cell that can capture a wider frequency of light on a single device – a job that currently requires a stack of different materials. The technique could also make for new types of quantum detectors and sensors.

As intriguing as the research is, it currently remains at the early proof-of-concept stage, so it's premature for any practical devices to be designed.

The research was published in the journal *Proceedings of the National Academy of Sciences*. The team describes the work in the video below.



Electrifying diamond find by NTU Singapore, MIT and Skoltech researchers

Sources: MIT, NTU

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Michael has always been fascinated by space, technology, dinosaurs, and the weirder mysteries of the universe. With a Bachelor of Arts in Professional Writing and several years experience under his belt, he joined New Atlas as a staff writer in 2016.