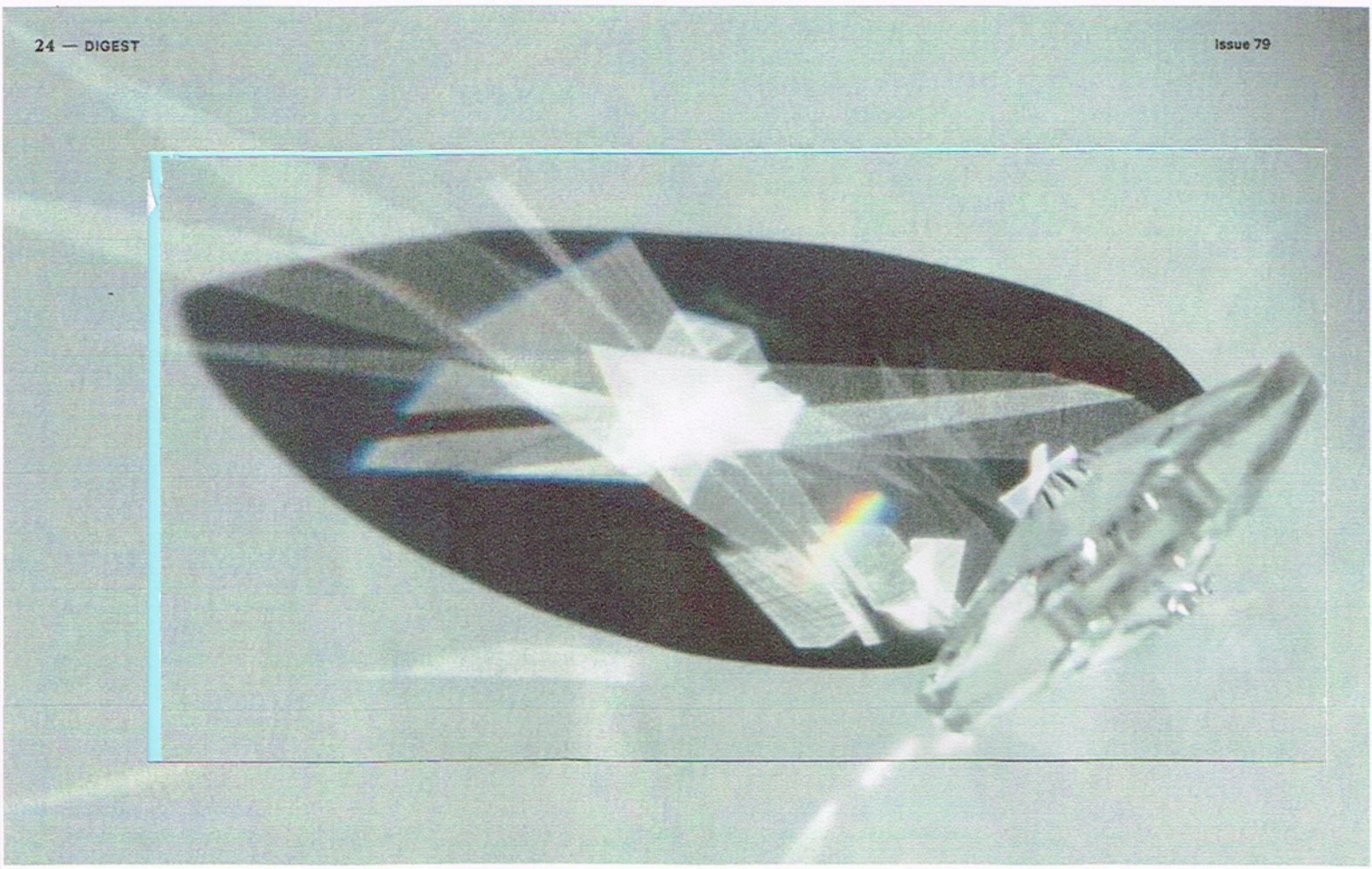


BIOLOGY

At the nano-scale diamonds turn out to be flexible. CREDIT: LARRY WASHBURN / GETTY IMAGES

A diamond's best bend

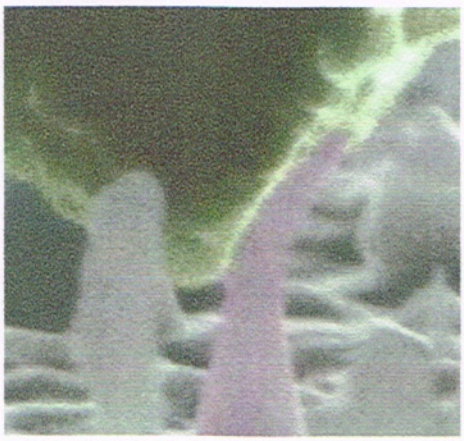
Renowned for their hardness, diamonds turn out to be remarkably flexible at the nano-scale.

Diamond is one of the hardest substances in the world, but an international team of scientists has discovered that nano-sized diamond needles can be stretched by as much as 9% before breaking.

The finding, described in the journal *Science*, raises the possibility of nano-diamond use in drug injections, more powerful lasers and quantum sensors.

Diamond owes its enormous strength to its atomic structure: a crystalline array of carbon atoms arranged in a cubic lattice. The bond between two carbon atoms is extremely difficult to break either by force or by chemical reaction.

To bend diamonds, the researchers first used hot hydrocarbon vapour to condense a thin diamond coating onto a silicon surface, like fog condensing on a window pane in a steamy bathroom.



Bendy diamond nanoneedles in action. CREDIT: BANNERJEE ET AL. / SCIENCE 2018

They then etched away much of the film to leave a miniature forest of conical diamond needles, each a few hundred nanometres tall and about 100 nanometres wide at the base. The needles' strength were tested by gently prodding them with a probe. The results were recorded using a video camera attached to an electron microscope.

The capacity of the needles to stretch by 9% corresponds to a tensile strength close to 90 Gigapascals, about 100 times that of stainless steel.

"What we discovered is a general physical phenomenon," says Subra Suresh of Nanyang Technological University in Singapore, who helped lead the international research team.

He says the flexibility is largely a 'size effect' of working with such tiny structures, and finding that flexible nano-diamonds are more durable than expected will make them more useful.

Possible applications include diamond nano-needle patches for delivering drugs or other molecules into cells, and tiny quantum sensors that use nitrogen atoms embedded in diamond.

Bending diamond can also minutely adjust the amount of space between the carbon atoms. This affects the amount of energy held by the electrons orbiting the atoms, which Suresh says could mean "revolutionary changes in diamond's electronic and optical properties".

The result is another reminder that the world is different at the nanoscale. "Even for super-hard, brittle crystalline materials like diamond," he says.