Nanosheet Handler Heralds New Era of Diamond Age Devices

A simple way to pick up and place diamond nanosheets finally makes it possible to test this wonder material in a wide range of devices, say materials scientists.

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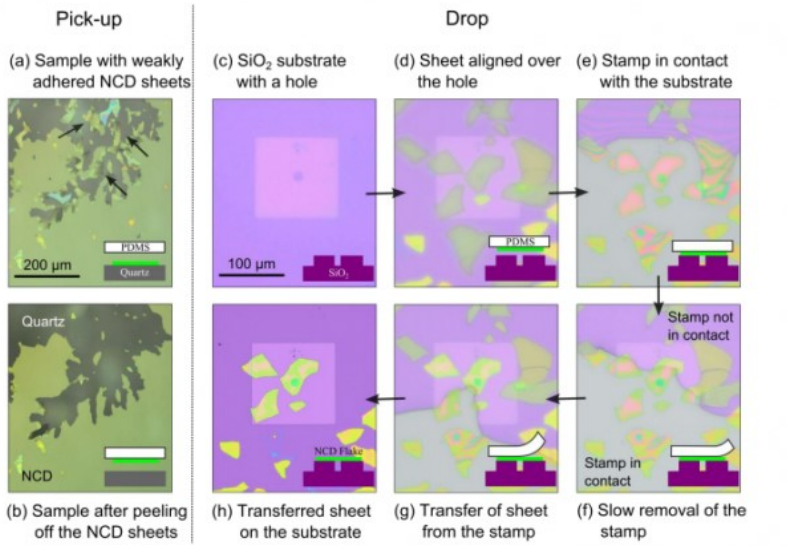
Diamond films are among the most extraordinary materials on the planet. They are strong, transparent, and conduct heat well. They are biologically inert but can also be chemically functionalized by attaching molecules to their surface. What's more, when doped, they become semiconductors and so can be used in electronic circuits.

So it's no wonder that materials scientists are licking their lips at the prospect of incorporating this wonder material into more or less any device they can think of.

But there's a problem. Diamond films have to be grown at high temperatures in an atmosphere of pure hydrogen, which is not compatible with the way other microdevices are made, such as silicon chips.

So a useful trick would be to have a way to make diamonds films in one place and then transfer them to another so that they can be placed onto chips and other devices.

Today, Venkatesh Seshan at the Kavli Institute of Nanoscience in the Netherlands and a few pals say they



the diamond film from this substrate. During the growth, these materials expand at different rates creating stresses that split one layer from the other.

“The conditions were purposefully chosen so that at a thickness of ~180 nm, this stress is sufficient to crack the film and to delaminate it from the quartz surface, forming numerous nanosheets,” say Seshan and co.

The team uses an optical microscope to identify the nanosheets and then lift them off using a sticky film, rather like picking up graphene sheets with Scotch tape. The sticky film is then positioned over the device, such as an electronic circuit, and then pressed into position. The team removes the sticky film by slowly peeling it off the nanosheet, a process that takes up to 10 minutes.

Seshan and co have tested their technique by creating a number of diamond nanosheet–based devices. These include drum-like resonators, an electronic circuit and even place the diamond sheets on top of other material sheets to show how it should be possible to create entirely new materials made of alternating material layers.

That’s handy because the team can then characterize the way nanodiamond films behave in a range of new situations. It also opens the way for its use in a wide range of other applications.

There is a caveat, of course. Identifying the nanosheets and positioning them is a time consuming process. So this technique will never be useful for mass producing diamond-based devices.

That will have to wait for the development of a technique to do the positioning automatically and in parallel on a massive scale.

But with machine vision techniques developing rapidly, it may be possible to take humans out of the loop in the near future. The massive parallelization of this kind of manufacturing technique will take more work, however.

The potential is clear. This kind of work could usher in a new kind of technology to complement the silicon and graphene ages we are currently experience. In other words, start looking forward to the diamond age.

Ref: arxiv.org/abs/1503.02844 : Pick-Up and Drop Transfer of Diamond Nanosheets