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WATCH: HOW CELL-SIZED ROBOTS ARE MADE

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MIT scientists have developed a method to mass produce robots no bigger than a cell that could be used to monitor conditions inside an oil or gas pipeline, or to search out disease while floating through the bloodstream.

The key to making such tiny devices, which the team calls “syncells” (short for synthetic cells), in large quantities lies in controlling the natural fracturing process of atomically-thin, brittle materials. The process, called “autoperforation,” directs the fracture lines so that they produce miniscule pockets of a predictable size and shape.

Embedded inside these pockets are electronic circuits and materials that can collect, record, and output data, according to the study published in the journal *Nature Materials*.

The system, developed by researchers at the Massachusetts Institute of Technology in the US, uses a two-dimensional form of carbon called graphene, which forms the outer structure of the tiny syncells. Ranging in size from that of a human red blood cell, about 10 micrometers across, up to about 10 times that size, these tiny objects “start to look and behave like a living biological cell,” said Michael Strano, a professor at MIT. “In fact, under a microscope, you could probably convince most people that it is a cell.”

One layer of the material is laid down on a surface, then tiny dots of a polymer material, containing the electronics for the devices, are deposited by a sophisticated laboratory version of an inkjet printer. Then, a second layer of graphene is laid on top.

“People think of graphene, an ultrathin but extremely strong material, as being ‘floppy,’ but it is actually brittle,” said Strano. However, rather than considering that brittleness a problem, the team figured out that it could be used to their advantage.

The system controls the fracturing process so that rather than generating random shards of material, like the remains of a broken window, it produces pieces of uniform shape and size. There are a wide range of potential new applications for such cell-sized robotic devices, said Strano. As a demonstration, the team “wrote” the letters M, I, and T into a memory array within a syncell, which stores the information as varying levels of electrical conductivity. This information can then be “read” using an electrical probe, showing that the material can function as a form of electronic memory into which data can be written, read, and erased at will. It can also retain the data without the need for power, allowing information to be collected at a later time.

The researchers have demonstrated that the particles are stable over a period of months even when floating around in water, which is a harsh solvent for electronics, according to Strano.

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