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# Plastic material imitates veins to heal itself

**Automatic delivery of patching liquid could seal cracks in spacecraft.**

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**Self-healers**
The self-healing mechanism automatically fills cracks and holes with two liquids, which react to form a gel and then solidify (video accelerated by a factor 75).

'Houston, we have a problem', that classic astronaut distress signal, is one step closer to obscurity thanks to the efforts of researchers who have developed a type of plastic that comes with its own self-healing mechanism. The material can patch holes of up to 1 centimetre in diameter, and restore most of its original strength in the process.

Self-healing polymeric materials, typically plastics, are not new. But until now, it has been possible to repair only very small defects — up to a few millimetres at most, says materials scientist Windy Santa Cruz of the University of Illinois at Urbana–Champaign.

In the new work, published today in *Science*[1], Santa Cruz and her colleagues rely on a combination of chemical and mechanical engineering. The advance points the way towards synthetic materials that can repair themselves after potentially catastrophic damage, for example from ballistic impacts or cracks that are difficult to access.

The researchers created two liquids that are chemically inert when kept separate. Mixing them however triggers two reactions — the first turns the mixture into a gel, and the second gradually solidifies it into hard plastic.

The team's challenge was to find a way to merge the liquids so that the two reactions would happen in a single system — and at separate times.

To do that, the researchers drew inspiration from the body's network of veins and arteries. They used ordinary plastic that contained tiny channels — created by adding fibres to the plastic in its liquid state and removing them after it had solidified. They then filled each 'microchannel' with one of the liquids. "You can think of these microchannels as a vascular system, like blood vessels," says co-author Jeffrey Moore, a chemist also at the University of Illinois.

The researchers then subjected the plastic to a controlled impact, producing a hole and numerous cracks, to test its self-healing ability. This ruptured the channels, causing the liquids to flow out, mix and solidify (see 'Self-healers').

"As more liquid was pumped through the channels, the gel eventually spanned the entire damaged region and resulted in filling of the void space," says Moore. A hole of about 1 centimetre in diameter filled in 20 minutes, and it took about three hours for the gel to solidify into hard plastic. The researchers are working on systems that heal at a faster rate.

Potential applications of the technology range from aerospace engineering to surgical implants, says Fraser Stoddart, a chemist at Northwestern University in Evanston, Illinois, who was not involved in the study. The work "shows that we can look forward to fixing breaks and cracks and holes automatically on much larger length scales than was thought possible previously", he says.

But, Stoddart adds, a real-life polymer fracture might be substantially more complex than one created in a laboratory test, so the self-healing mechanism may have to rely on a combination of techniques.

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## References

1. White, S. R. *et al*. *Science* **344**, 620–623 (2014).