New recipe for self-healing plastic includes dash of food additive

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Adding a food additive to damaged polymers can help restore them to full strength, say scientists at the University of Illinois who cooked up the novel, self-healing system.

The repair process, in which solvent-filled microcapsules embedded in an epoxy matrix rupture when a crack forms, is a major improvement over the original self-healing process first described in February 2001.

"While our previous solvent worked well for healing, it was also toxic," said Scott White, a professor of aerospace engineering and a researcher at the university's Beckman Institute. "Our new solvent is both non-toxic and less expensive."

During normal use, epoxy-based materials experience stresses that can cause cracking, which can lead to mechanical failure. Autonomic self-healing – a process in which the damage itself triggers the repair mechanism – can retain structural integrity and extend the lifetime of the material.

Designed to mimic the human body's ability to repair wounds, self-healing materials release a healing agent into the crack plane when damaged, and through chemical and physical processes, restore the material's initial fracture properties.

In November 2007, White and collaborators reported the use of chlorobenzene, a common – but toxic – organic solvent, which in epoxy

resins achieved a healing efficiency of up to 82 percent.

In their latest work, which combined a non-toxic and Kosher-certified food additive (ethyl phenylactate) and an unreacted epoxy monomer into microcapsules as small as 150 microns in diameter, the researchers achieved a healing efficiency of 100 percent.

"Previously, the microcapsules contained only solvent, which flowed into the crack and allowed some of the unreacted matrix material to become mobile, react and repair the damage," said graduate research assistant Mary Caruso. "By including a tiny amount of unreacted epoxy monomer with the solvent in the microcapsules, we can provide additional chemical reactivity to repair the material."

When the epoxy monomer enters the crack plane, it bonds with material in the matrix to coat the crack and regain structural properties. In tests, the solvent-epoxy monomer combination was able to recover 100 percent of a material's virgin strength after damage had occurred.

"This work helps move self-healing materials from the lab and into everyday applications," said graduate research assistant Benjamin Blaiszik. "We've only begun to scratch the surface of potential applications using encapsulated solvent and epoxy resin."

In addition to White, Caruso and Blaiszik, the other co-authors of the paper were materials science and engineering professor Nancy Sottos and chemistry professor Jeffrey Moore. The researchers reported their findings in the scientific journal *Advanced Functional Materials.*

Source: University of Illinois at Urbana-Champaign