Out Of The Labs

Paint, Heal Thyself

Jonathan Fahey, 03.12.09, 02:00 PM EDT

Chemicals in the shells of shrimp may lead to coatings that can heal themselves.

A scratch can be a real pain. Especially if it's a scratch down the door of your shiny new car.

Materials scientists have been working for years to develop coatings that will not just resist scratches, but also fix them on their own.

Some have looked to biology for inspiration, trying to build microvascular networks into materials that "bleed" when broken. Others have used nanotechnology, embedding tiny balls of catalysts or polymers into materials that spill salve when ruptured. Other materials heal by stretching or expanding when subjected to heat.

But these approaches can be difficult to manufacture in large scale, or they require some outside intervention, like heat. Or both.

In a paper published this week in the journal *Science*, Biswajit Ghosh and Marek Urban of the University of Southern Mississippi reveal a polyurethane "network" that self-repairs when exposed to sunlight. Although it's still laboratory research, the scientists hope their work could one day result in a low-cost coating that could be swabbed over just about anything.

"THERE ARE AN IMMENSE NUMBER OF OPPORTUNITIES FOR THIS," SAYS URBAN, A PROFESSOR OF POLYMER SCIENCE. "BASICALLY ANYTHING EXTERNALLY EXPOSED." LIKE THE PAINT ON A CAR, AN AIRPLANE, OR EVEN FURNITURE.

It's particularly handy that the compound is easy to make and uses well-known and readily available materials, namely organic compounds called oxetanes, and a material called chitosan which is produced in the shells of shrimp, lobsters and crabs, notes Craig Hawker, a polymer chemist at University of California, Santa Barbara who was not involved in the research project.

"The ability to combine industrially accepted and well-studied oxetane groups with a widely available renewable biomaterial such as chitosan is a powerful concept from an environmental and energy viewpoint," wrote Hawker in an e-mail exchange. "This could generate new materials with enhanced properties, yet be easy to prepare and dispose of."

Industry already employs some "self-repairing" materials:**Nissan**'s (nasdaq: NSANY - news - people) upscale Infiniti vehicles are covered with a clear coat of resin that can conceal shallow scratches from things like the brushes of car-wash machines. After the car is scratched, the resin slowly seeps into the scratches, covering them. The process takes about a week--less if it's hot outside.

But the resin only covers the most superficial scratches. Scratch the surface deeply enough to hit the paint, and your car is headed to the body shop after all.

Ghosh and Urban's material is different. Their self-repairing mechanism could be integrated into a polyurethane paint. Just how it works involves some impressive chemistical gymnastics.

They incorporated four-sided oxetane "rings" and a chitosan precursor into a polyurethane. When the material is scratched, oxetane rings split, exposing reactive sites, like arms that want to grab something. Ultraviolet light breaks open chitosan, a complex carbohydrate called a polysaccharide, revealing another set of reactive arms.

The chitosan arms and the oxetane arms attract one other, bond, and--presto!--your paint job is as good as new. To see the process in action, see "Better Than Watching Paint Dry."

This stuff isn't perfect. After a scratch, the rings bond with the chitosan, making this magical repair a one-shot deal. A scratch in the exact same spot would remain a scratch. That makes overlapping scratches awkward: When Ghosh and Urban scratched an 'x' in their material, it didn't repair at the center.

And Urban cautions that much work and testing still needs to be done. He's still puzzling out the chemical reactions at play. He knows that the binding reactions occur, for example, but he doesn't yet know exactly where along the molecules they happen. Even figuring out this much took years after his researchers had developed and tested the material.

"Visually it's pretty simple, but chemically it is very difficult to prove," he says.

Urban says chemical companies are interested in his work, but he declines to name them or say just how interested.

For all of the promise of self-repairing materials, big commercial successes have remained elusive. UC Santa Barbara's Hawker says that is bound to change. Perhaps even with Ghosh and Urban's polyurethane.

"It is just a matter of time for industry to appreciate the design advantages with these new materials and to develop procedures for large-scale production," he writes.

http://www.forbes.com/2009/03/11/self-repairing-paint-technology-breakthroughs-paint.html