New polymer has applications for dentistry, electronics, automobiles

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University of Colorado at Boulder researchers have developed a new polymer that resists cracking and shrinking, paving the way for creative breakthroughs in fields ranging from dentistry and microelectronics to the auto industry.

CU-Boulder chemical and biological engineering department Chair Christopher Bowman said polymers, or plastics -- which are made up of identical molecules linked by chemical bonds to form repeating chains or webs -- generally show an increase in strain and stress when they are treated with heat or chemicals to cure them. But the new polymer, which has a complex chemical formula like most polymers, maintains its strength even while showing reduced stress and strain when exposed to light, according to Bowman.

The researchers, who have filed for a patent on the novel polymerization process, said the new process may be ideal for use by dentists, who cure polymer fillings with light rather than high temperatures to achieve the desired strength and shape. Composite cavity-filling materials today have a tendency to shrink and even leak over time as the polymer cracks due to the stresses and becomes more rigid as it sets. This often leads to additional dental problems, he said.

Led by postdoctoral researcher Timothy Scott, the team published a paper on the subject in the June 10 issue of Science. Other authors include Bowman, CU undergraduate Andrew Schneider and Wayne Cook from Monash University in Victoria, Australia. The National

Institutes of Health provided funding support for the project.

The new polymer also would be helpful in electronic packaging, the CU researchers said. Electronic processing chips are often sealed in computer "mother boards" with polymers, which may shrink as they cure and cause wires to touch one another, triggering malfunctions.

Polymers are ubiquitous in today's world and are used to make everything from shampoo bottles, tennis shoes and garden hoses to toilet seats, automobile tires and bowling balls. While the simplest polymers essentially are just large molecules strung together like beads on a string, more complex types, called cross-linked polymers, resemble microscopic mesh netting with individual strands of molecules linked together by chemical bonds, Scott said.

When such polymers are treated with heat or light to cure them, they generally become more rigid and strained as they shrink, said Scott. But when the new CU polymer was treated with UV light, the chemical bonds linking the molecules, or monomers, continually broke and reformed during light exposure, "relaxing" the stress and strain in the polymer as it became more dense.

"It really doesn't matter how much stress there is, because this process just erases it," said Bowman. "It remains fundamentally the same material, but just changes shape by reforming itself as it adapts to the new conditions. We think this process solves a significant problem in polymer science."

Scott said the original concept for the polymer was followed by intense research by faculty and students in CU-Boulder's College of Engineering and Applied Science. "It only took about one second to come up with the idea," he said. "But it has taken months to implement it and make it work in the lab."

In addition to dentistry and electronics, Scott and Bowman said the new cross-linked polymer may have applications for boats, automobiles and structural materials, including its use in coatings and adhesives. "This research has plenty of basic science for us to continue investigating it," said Scott. "But we expect it to generate a fair amount of interest in a wide range of industries."

Source: University of Colorado at Boulder

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