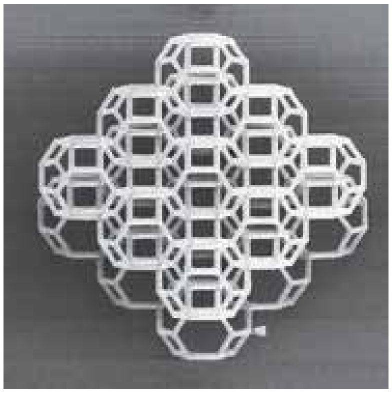

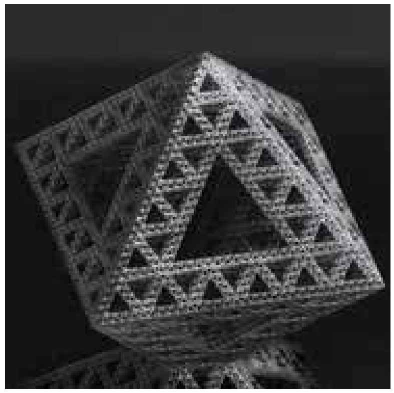

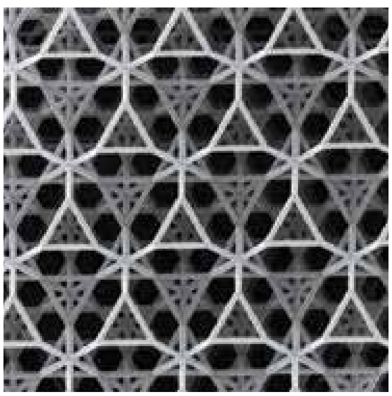

Fine-tuning materials' architecture at the nanoscale yields distinctive patterns—and unusual properties.

COURTESY OF JULIA R. GREER

The key to creating such wondrous materials is an arsenal of specialized machines—some of which Greer has rebuilt to suit her purposes—that make it possible to precisely control structure at the nanoscale over relatively large areas. Greer jogs down two floors of stairs to the basement lab where she keeps these precision instruments to isolate them from vibrations. One machine, found behind two heavy black curtains, is a sort of 3-D printer that uses flashes of laser light to very slowly build intricate polymer scaffolds. A student of Greer's coats the polymer with metals, ceramics, or other materials and then shaves off the sides, making it possible to etch away the polymer inside. The result is a little block of material made up of nanoscale trusses crisscrossed like the struts in the Eiffel Tower—but each strut's walls are only about 10 nanometers thick.

Without Greer's method, building something like this is impossible. She shows me a sample that came about from an earlier collaboration with researchers at HRL Laboratories in Malibu, California, who are producing materials with larger, microscale trusses. It's made out of nickel and looks somewhat like a metal scouring sponge. When she lets it drift onto my palm, I can barely feel it touch down, and the subversion of expectations is confusing. This metal is, literally, lighter than a feather. It could make for ultralight thermal insulation—an application her HRL colleagues are pursuing.

The featherweight nickel shows the promise of architectural control in making new materials with weird properties. But it's also a reminder of how far Greer has to go in scaling up her methods: so far, she can't make enough of the nanostructured materials to cover your palm.

Greer is determined to use her nanofabrication methods for a variety of materials, and a long list of collaborators are interested in their unusual properties. She can space the nanoscale walls in light-emitting materials or thermal insulation to precisely control the flow of light or heat. She's working with two battery makers to use her nanostructures to study electrochemistry. And she is teaming with biologists to see whether the nanostructured ceramic could serve as a scaffold for growing bones—such as the tiny ones in the ear whose degeneration is one cause of deafness.

In hopes of making such applications feasible, she is working to speed up the high-resolution laser-printing process. Greer has a six-millimeter-square fleck of the nanostructured ceramic she made last year. It is about as thick as a sheet of paper but took about a week to make.

"For us to do scientific experiments, we don't need a large amount," she says. "The question now is: how do you scale this?"