Nanolattice engineering

This glassy carbon nanolattice, with struts only 970 nm long and 200 nm in diameter, didn't start off that small—the original lattice was five times that size. Jens Bauer and colleagues at the Karlsruhe Institute of Technology created the larger version by using a tightly focused laser to directly write the three-dimensional tetrahedral lattice pattern in a photosensitive resin via two-photon lithography (see PHYSICS TODAY, April 2012, page 80). They then shrank it down isotropically by pyrolysis: Heating the lattice in vacuum to 900 °C drove off some 80% of the original mass, leaving a vitrified carbon residue that's remarkably strong.

In the realm of structural metamaterials, mechanical properties derive from the shapes and sizes of the constituent building blocks, and smaller often translates into stronger. To explore and exploit those size effects, many groups are working to shrink the dimensions of micro- and nanolattices (see PHYSICS TODAY, January 2012, page 13, and November 2013, page 14). The pyrolyzed Karlsruhe structures are the smallest lattices yet reported, and they set new highs for strength-to-density ratio. Moreover, the technique is straightforward and versatile, and it offers potential benefits for other metamaterial applications, especially optics. (J. Bauer et al., *Nat. Mater.*, in press; photo by J. Bauer/KIT.)