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Researchers Bend Light Through Waveguides In Colloidal Crystals

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Champaign, IL — Researchers at the University of Illinois are the first to achieve optical waveguiding of near-infrared light through features embedded in self-assembled, three-dimensional photonic crystals. Applications for the optically active crystals include low-loss waveguides, low-threshold lasers and on-chip optical circuitry.

Key to the fabrication technique – which uses multi-photon polymerization and a laser scanning confocal microscope – is a self-assembled, colloidal material that exhibits a photonic band gap, said Paul Braun, a University Scholar and professor of materials science and engineering.

In previous work, reported in 2002, Braun's research group was the first to show that through multi-photon polymerization they could embed a polymer feature inside a silicon dioxide, self-assembled colloidal crystal.

Now, in a paper accepted for publication in *Nature Photonics*, and posted on the journal's Web site, Braun and his team demonstrate actual optical activity in waveguides and cavities created in their colloidal crystals.



“Taking our earlier work as a starting point, we built upon recent advances in theory and computation, improvements in materials growth techniques, and better colloidal crystallization capabilities to produce this new photonic material,” said Braun, who also is affiliated with the university's Beckman Institute, Frederick Seitz Materials Research Laboratory, and Micro and Nanotechnology Laboratory.

To make their optically active devices, the researchers begin by assembling a colloidal crystal of uniform silica spheres that are 900 nanometers in diameter. After removing the solvent, the researchers fill the spaces between the spheres with a photoactive monomer. Then they shine laser light through a microscope and into the crystal, polymerizing the monomer at the desired locations.

Next, they remove the unpolymerized liquid, and then fill the structure with silicon. Finally, they etch away the silica spheres, leaving the desired optical features embedded in a three-dimensional photonic crystal.

“Using spheres 900 nanometers in diameter creates a band gap at 1.5 microns, which is the wavelength used by the telecommunications industry for transmissions through fiber-optical cables,” Braun said. “Creating these waveguides by coupling colloidal assembly and multi-photon polymerization is simpler and less expensive than conventional fabrication techniques, especially for large-area photonic crystals.”

With Braun, co-authors of the paper are Stephanie A. Rinne, a postdoctoral fellow at the Beckman Institute, and Florencio García-Santamaría, a postdoctoral research associate in the department of materials science and engineering.

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SOURCE: James E. Kloeppel, University of Illinois

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