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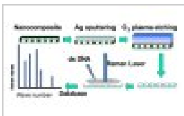

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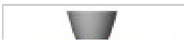

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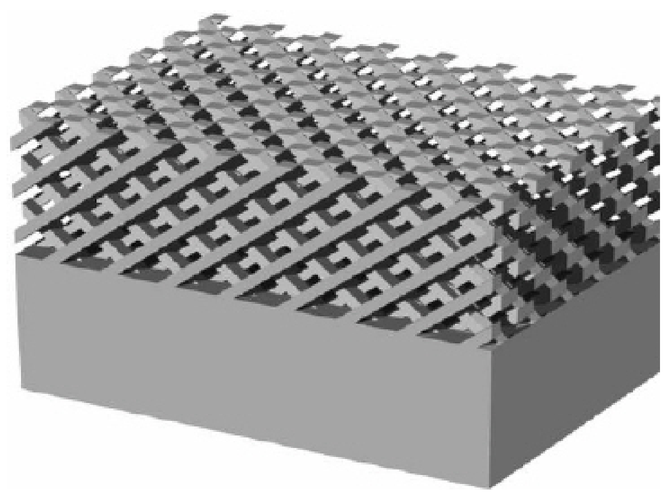
TECHNOLOGY UPDATE

Aug 20, 2009

Angular approach produces excellent photonic crystals

Making high-quality 3D photonic crystals - artificial nanostructures for photons - that do not contain any unintentional defects at optical wavelengths remains a challenge. Now, a team from Kyoto University has developed a new, simple, top-down method that produces such crystals - a result that paves the way for real-world applications using these materials.



3D photonic crystal

Photonic crystals are nanostructured materials in which periodic variations of some property - usually the material's electric permittivity - produce a photonic band gap. This affects how photons propagate through the material and the effect is similar to how a periodic potential in semiconductors affects the flow of electrons by defining allowed and forbidden energy bands. In particular, photons with wavelengths or energies in the photonic band gap cannot travel through the crystal, which allows scientists to control and manipulate the flow of light by introducing carefully selected defects in the form of artificial waveguides. The structures can then be made into 3D optical circuits.

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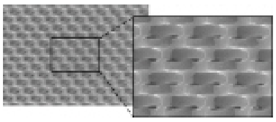
- *Nature Materials* doi:10.1038/nmat2507

Scientists use 3D nanofabrication techniques to make the crystals but these inevitably introduce defects at optical wavelengths that seriously degrade the optical quality of the finished materials. More complicated techniques, such as micromachining, can produce better crystals but the processes are time consuming.



SEM of crystal

The new method, devised by Susumu Noda and colleagues, involves etching silicon wafers at angles of 45° with respect to a substrate surface. "We noticed that if we rotate the structure by 90°, we can form a 3D crystal in a twice-etching process that makes holes with +45° and -45° in a base material," Noda told *nanotechweb.org*. "This greatly simplifies the fabrication process for 3D photonic crystals."

The technique is a big improvement on typical plasma-etching techniques widely used in CMOS or MEMS processing in which angular etching is impossible. The method is also five to 10 times faster than nanomachining and is compatible with CMOS and MEMS.

The crystals produced have excellent optical properties and might be used in advanced photonic chips, in highly efficient LEDs and solar cells, and even as optical quantum computing elements. The team would now like to be able to etch deeper into the silicon wafers because this would result in a stronger photonic band-gap effect.

"We hope that our technique will lead to 3D photonic crystals with excellent and versatile properties that could be commercially available in the near future," added Noda.

The researchers reported their work in *Nature Materials*.

About the author
Belle Dumé is contributing editor at *nanotechweb.org*