Feather Nanostructures Inspire Two Laser Designs

The nanostructures that give bird feathers their brilliant colors inspired the design of lasers that may someday self-assemble.

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The structure in feathers that gives bluebirds (among other animals) such brilliant color inspired researchers at Yale University, U.S.A., to copy the pattern to create lasers. At OSA's Frontiers in Optics meeting last year, Hui Cao of Yale described the lasers in his presentation,"Bio-inspired photonic nanostructures and lasers" (paper FWW1, 2011).

An animal's color does not come from pigment, but from reflective nanostructures. Unlike diffraction gratings, however, the structures appear disordered and reflect the same color from many angles. The materials don't contain large-area order, but there is some short-range order that scatters light preferentially at specific wavelengths. Based on those natural structures, Cao and her group at Yale created two lasers that use short-range order to control light.

In May, Heeso Noh and colleagues in Cao's group reported building a laser by recreating the structure of bird feathers in semiconductors (Phys. Rev. Lett. **106**, 183901). Tiny spheres of air embedded in the feathers' proteins reflect light at specific wavelengths. The group etched an array of roughly 150-nm-wide holes into a gallium arsenide film. Indium arsenide quantum dots were used as a gain medium. When optically pumped, the film lased with wavelengths that depended on the size of the holes and the distance between them.

Researchers also found a second structure in the feathers: a series of twisty interconnecting nanochannels. Like the spheres, their structure also appears random in the larger scale, with only short-range order. The "network" laser based on this design blocks certain colors of light while allowing others to propagate (Opt. Lett. **36**, 3560). In both cases, the lasers' colors depend on the width of the nanochannels or the spacing between the nanoholes. The network laser works better, Cao says. "It outperformed the first one because the photonic bandgap can be formed now without long range order."

Building lasers without mirrors and the strict requirements for long-range order of photonic crystals could make it easier to fabricate lasers—and possibly to use self-assembly methods that have been used in the production of color-producing nanostructures in bird feathers.

—Yvonne Carts-Powell

Imaging on a Cellphone? There's an App for That

A group of California scientists has developed small, inexpensive attachments that allow high-definition cellphone cameras to perform microscopy and spectroscopy in the visible region. Although the resolution of the device is not as good as dedicated commercial equipment, it is good enough to distinguish between healthy and diseased blood samples and to detect fluorescent dyes, according to Sebastian Wachsmann-Hogiu of the University of California Davis Medical Center's Center for Biophotonics, U.S.A.

The Davis team is one of several research groups leveraging recent advances in cellphone camera technology to make low-cost imaging applications for medical care in the developing world. Davis postdoctoral fellow Kaiqin Chu presented her group's work at the Frontiers in Optics meeting in San Jose, Calif., U.S.A. (paper JWA8, 2011).

The microscopy attachment consists of a 1-mm ball lens mounted in a rubber aperture to exclude light from outside the region of interest. Unlike comparison images from a commercial microscope, the cellphone images have edge distortions because the detector is relatively large compared to the lens.

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An iPhone microscope, which consists of a 1-mm-diameter ball lens embedded in a rubber sheet and taped over the iPhone's camera.

Still, the cellphone microscope achieved 1.5-µm resolution (most modern phones have pixels 1 to 2 µm in size)—not as fine as 0.5 µm on a

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