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Hairy Worm Wears Photonic Crystals

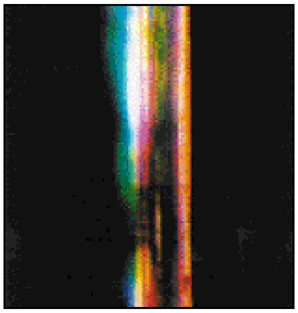
SYDNEY, Australia -- Once upon a time, there was a mouse that wasn't really a mouse, with fur that wasn't really fur but photonic crystals. It may sound like a fairy tale, but researchers have discovered that the colorful spines of a marine worm commonly known as the sea mouse are actually complicated structures with such pronounced optical effects that they may lead to the development of more efficient fiber optics and other technologies.

The sea mouse may not look like a mouse, but its hairs are photonic marvels. As the angle of incident light changes, the photonic crystal structure of the spines tunes their reflectance, making new colors appear (below).

"The sea mouse attracted our attention because its iridescence is extraordinarily marked for a bottom-dwelling sea creature," said Ross C. McPhedran, a professor of physics at the University of Sydney. His team member, Andrew R. Parker of the University of Oxford in the UK, specializes in the study of structural coloration, including natural diffraction gratings found in the 500-million-year-old fossil oddities of the Burgess shale in the Canadian Rocky Mountains, and suspected that the creature employs such a technique.

The sea mouse, in the genus *Aphrodita*, is a

The sea mouse, in the genus *Aphrodita*, is a predatory worm that lives at depths of up to half a mile. Up to 8 inches long and 2 inches across, the creature is covered with a pelt of iridescent feltlike hairs. When light is incident to the axis of the hairs at different angles, other colors of the visible spectrum appear, ranging from red to green and blue. In other words, the hairs tune their reflectance, which approaches 100 percent, with the angle of incidence.



Look Closer

McPhedran and team members from the University of Sydney, Oxford and the University of Technology, also in Sydney, decided to investigate further. They prepared transverse sections of a spine for examination under an electron microscope and found an array of holes in a hexagonal pattern with a period of less than a micron.

"It bears a striking resemblance to those found in photonic crystal fibers," McPhedran said. Calculating the optical characteristics of stacked gratings with the refractive index of chitin and filled with seawater, they found that only the tight packing of the voids in the real hairs could produce such an effect. "Regarded either as a photonic crystal or a photonic bandgap material, the sea mouse spines would be state of the art," he said.

Research with laser microphotometry is under way at the University of Utah in Salt Lake City to more accurately measure the hairs' reflectance. The team, which published its preliminary results in the Jan. 4 issue of *Nature* and which has submitted an article to the *Australian Journal of Physics*, hopes the work will lead to the development of permanent color displays, photonic crystal fiber for visible wavelengths and other technologies.

Daniel S. Burgess

Internet: www.Photonics.com
E-mail: photonics@laurin.com
Phone: (413) 499-0514, Fax: (413) 442-3180