BY SAREN JOHNSTON

Filtering out the Noise

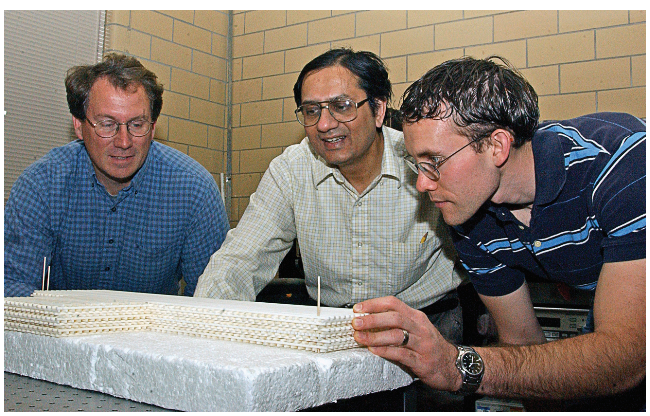
3-D photonic crystals help clear up fiber optic data transmission

AMES LABORATORY RESEARCHERS HAVE come up with a potentially perfect way to sort and distribute the massive amounts of data that travel daily over optical fibers to people throughout the world. The new technology, a three-dimensional photonic crystal add-drop filter, promises greatly enhanced transmission of multiple wavelength channels (wavelengths of light) traveling along the same optical fiber.

The innovative filter is a significant achievement in the effort to develop all-optical transport networks that would eliminate electrical components from optical transmission links and guarantee virtually flawless data reception to end users of the Internet and other fiber-based telecommunications systems.

"There are up to 160 wavelength channels traveling through an optical fiber at the same time," says Rana Biswas, physicist and one of the developers of the new add-drop filter. "That means a lot of dialogue is going on simultaneously."

Biswas, who is also an Iowa State University adjunct associate professor of physics and astronomy and electrical



Researchers (from left) Gary Tuttle, Rana Biswas and graduate student Dan Stieler examine defects in a photonic crystal.

and computer engineering, explains that as information is transported over multiple channels, it's necessary to drop off individual wavelength channels at different points on the fiber. At the same time, it's essential to be able to add data streams into unfilled wavelength channels.

"When the data being transported in multiple frequency channels over an optical fiber comes to a receiving station, you want to be able to pick off just one of those frequencies and send it to an individual end user," says Biswas. "That's where these 3-D photonic crystals come into play."

Biswas and his colleagues, Kai-Ming Ho, senior physicist and an ISU Distinguished Professor of Liberal Arts and Sciences; Gary Tuttle, an ISU associate professor of electrical and computer engineering and a researcher at the university's Microelectronics Research Center; and Preeti Kohli, a former Iowa State Ph.D. student now at Micron in Manassas, Va. successfully demonstrated that 3-D photonic crystals could serve as add-drop filters, providing greatly enhanced data transmission.

To prove their concept, the researchers used a three-dimensional, microwave-scale photonic crystal constructed from layered alumina rods and containing a full bandgap – a wavelength range in which electromagnetic waves cannot transmit. Just as electronic bandgaps prevent electrons within a certain energy range from passing through a semiconductor, photonic crystals create photonic bandgaps that confine light of certain wavelengths.

Although the team has shown that 3-D photonic crystals would make highly efficient add-drop filters, there are still problems to address. Getting the size of the photonic crystals down to work at the wavelengths used for Internet communications – 1.5 microns – is the big challenge. The group now has some of these photonic crystals working in that range, but to make these controlled structures with one input, another output and a defect … that definitely takes some work. A future direction is to simplify the design of the add-drop filter by reducing the layers in the photonic crystal – perhaps having all the action happen in one layer.

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