Fibers that Carry Light and Sense Pressure could be used for Medical Imaging and Structural Monitoring

Katherine Bourzac

Researchers at MIT have developed optical fibers that not only carry and modulate light, but also generate and sense pressure changes. The multifunctional fibers could be used to make various types of sensors. The fibers can also be squeezed in a way that modulates an optical signal, making them promising for "smart" textiles.

"We want to increase the level of complexity and sophistication of fibers," says Yoel Fink, professor of materials science and engineering at MIT.

By integrating heat- and light-sensitive materials during the manufacture of optical fibers, Fink's group has previously made fibers that act as simple sensors and even cameras. They've now added a new level of functionality to optical fibers by introducing a layer of piezoelectric material. This material converts electrical signals into a mechanical change, and vice versa, meaning pressure can be applied, or sensed, in the fiber.

The main challenge in making these fibers is in precisely arranging layers of multiple materials and processing them under conditions that lead to quality layers. Over the past several years, Fink's group has developed a process for carefully layering materials to form a thick "preform" rod that is heated and stretched to make a very thin, kilometers-long fiber that contains different materials, including polymers and metals.

The key to the approach is selecting materials that not only have the desired properties but that also melt and flow at the same temperature. For the piezoelectric fibers, Fink makes a preform that is 40 millimeters in diameter. It contains a polymer that forms a high-quality piezoelectric crystal as it cools down, and a polycarbonate material that is both viscous and conductive. When heated and stretched, the dimensions of these layers shrink from millimeters to nanometers, while maintaining the same ratio of thicknesses.

The new fibers could be especially useful for distributed sensing and imaging because they're so thin, flexible, and lightweight.

"The big challenge in integrating functionality is integrating very different materials, and this is a big step forward," says Ritesh Agarwal, professor of materials science and engineering at the University of Pennsylvania. Agarwal says it's impressive that the piezoelectric layer retains its properties after being stretched out - the MIT researchers have developed manufacturing conditions that ensure that the crystalline structure of this material, which is important to retaining

its pressure-to-electricity converting properties, is maintained.

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