Matter & Energy

"The light goes right around any obstacle, which is pretty remarkable." —MICHAL LIPSON

Etched glass lets light pass around

Optical topological insulator transparent on surface only

By Andrew Grant

Throw some electrons onto the surface of a topological insulator and they seemingly become invincible, effortlessly bypassing obstructions along their route. Now researchers have crafted a structure that empowers particles of light to do the same thing. The first demonstration of a topological insulator for photons, reported April 11 in *Nature*, could lead to improved optical transmissions that are crucial for global communication.

"I think it's wonderful," says Michal Lipson, a physicist at Cornell University who was not involved with the study. "The light goes right around any obstacles, which is pretty remarkable."

Materials are typically either conductors or insulators, but topological insulators such as bismuth telluride are exotic hybrids: They block electric current in their interiors yet allow electrons to flow along their surfaces.

What's more, these surface electrons can move unimpeded through bumps and grooves that would normally block their path. That useful property makes topological insulators intriguing candidates for future electronics.

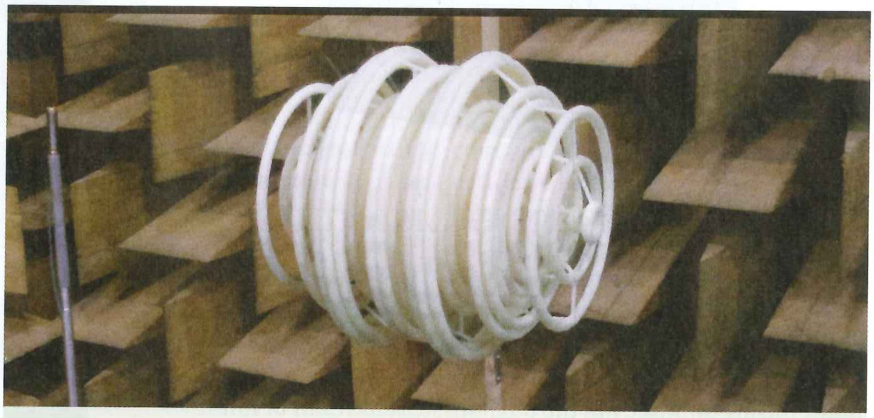
The ability to enable electrons to surf along the surface and avoid obstacles is so enticing that some physicists have investigated whether other particles, particularly photons, could do the same thing. Electrons flow through chips in computers and smartphones, while photons are the information carriers that enable high-speed communication over fiber-optic cables. One key to faster, more efficient communication networks is minimizing the scattering of photons when they encounter obstacles.

With that goal in mind, physicist Mordechai Segev and his team at the Technion-Israel Institute of Technology in Haifa, along with colleagues from Friedrich Schiller University Jena in Germany, set out to demonstrate the first photonic topological insulator. They started with a block of glass and etched in hundreds of helical waveguides, which are essentially wires for light. The waveguides were tightly packed in a honeycomb-like structure so that light trying to make its way through one waveguide interfered with light in the others and canceled out.

The only part of each waveguide that didn't cancel out light was its outer edge. As a result, photons got steered along the outside of the bundled waveguides, confining this light to the block's surface.

When the researchers shined a beam of red light on one face of the glass, the photons moved along the surface, easily made a turn once they reached an edge and then continued on their way along the surface. None of the light got scattered by surface imperfections.

Segev says the team's photonic topological insulator will lead to improved optical transmissions. Jacob Taylor, a physicist at the University of Maryland's Joint Quantum Institute, adds that the impressive light-harnessing properties of Segev and his colleagues' creation could allow people to send more data over a popular type of wire known as a multimode optical fiber.



L. SANCHIS *ET AL*

Sound cloak silences in 3-D

A simple plastic shell has cloaked a three-dimensional object from sound waves for the first time. With some improvements, a similar design could eventually be used to reduce noise pollution or to allow ships and submarines to evade enemy detection. The device is described March 20 in *Physical Review Letters*. Instead of preventing sound waves from hitting an object—in this case an 8-centimeter plastic sphere—electrical engineer José Sánchez-Dehesa of the Polytechnic University of Valencia in Spain and his colleagues built a cloak to eliminate the waves of sound bouncing off the sphere. Using computer algorithms, the researchers came up with a design of 60 rings of various sizes that form a cagelike structure around the sphere (shown). Simulations indicated that sound waves scattering off the sphere and the ringed cloak would interfere with each other and cancel out. The researchers hung their creation from the ceiling of an echo-free chamber, pointed a speaker at it and played a range of sound frequencies. At a frequency of 8.55 kilohertz—an audible high pitch—the cloaked sphere became imperceptible to the sensors behind it. —*Andrew Grant*