

History of Fiber Optics

The Romans must have been particularly pleased with themselves the day they invented lead pipes around 2000 years ago. At last, they had an easy way to carry their water from one place to another. Imagine what they'd make of modern fiber-optic cables—"pipes" that can carry telephone calls and emails right around the world in a seventh of a second!

What is fiber optics?

We're used to the idea of information traveling in different ways. When we speak into a landline telephone, a wire cable carries the sounds from our voice into a socket in the wall, where another cable takes it to the local telephone exchange. Cellphones work a different way: they send and receive information using invisible radio waves—a technology called wireless because it uses no cables. Fiber optics works a third way. It sends information coded in a beam of light down a glass or plastic pipe. It was originally developed for endoscopes in the 1950s to help doctors see inside the human body without having to cut it open first. In the 1960s, engineers found a way of using the same technology to transmit telephone calls at the speed of light (186,000 miles or 300,000 km per second).

Optical technology

A fiber-optic cable is made up of 100 or more incredibly thin strands of glass or plastic known as optical fibers. Each one is less than a tenth as thick as a human hair and can carry 10 million telephone calls.

Fiber-optic cables carry information between two places using entirely optical (light-based) technology. Suppose you wanted to send information from your computer to a friend's house down the street using fiber optics. You could hook your computer up to a laser, which would convert electrical information from the computer into a series of light pulses. Then you'd fire the laser down the fiber-optic cable. After traveling down the cable, the light beams would emerge at the other end. Your friend would need a photoelectric cell (light-detecting component) to turn the pulses of light back into electrical information his or her computer could understand. So the whole apparatus would be like a really neat, hi-tech version of the kind of telephone you can make out of two baked-bean cans and a length of string!

How fiber-optics works

Light travels down a fiber-optic cable by bouncing repeatedly off the walls. Each tiny photon (particle of light) bounces down the pipe like a bobsleigh going down an ice run. Now you might expect a beam of light, traveling in a clear glass pipe, simply to leak out of the edges. But if light hits glass at a really shallow angle (less than 42 degrees), it reflects back in again—as though the glass were really a mirror. This phenomenon is called total internal reflection. It's one of the things that keeps light inside the pipe.

The other thing that keeps light in the pipe is the structure of the cable, which is made up of two separate parts. The main part of the cable—in the middle—is called the core and that's the bit the light travels through. Wrapped around the outside of the core is another layer of glass called the cladding. The cladding's job is to keep the light signals inside the core. It can do this because it is made of a different type of glass to the core. (More technically, the cladding has a lower refractive index than the core. This causes total internal reflection that stops the light escaping and keeps it bouncing down the core.)

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Types of fiber-optic cables

Optical fibers carry light signals down them in what are called modes. That sounds technical but it just means different ways of traveling: a mode is simply the path that a light beam follows down the fiber. One mode is to go straight down the middle of the fiber. Another is to bounce down the fiber at a shallow angle. Other modes involve bouncing down the fiber at other angles, more or less steep.

Single mode and multi-mode fiber-optic cables

The simplest type of optical fiber is called single-mode. It has a very thin core about 5-10 microns (millionths of a meter) in diameter. In a single-mode fiber, all signals travel straight down the middle without bouncing off the edges (red line in diagram). Cable TV, Internet, and telephone signals are generally carried by single-mode fibers, wrapped together into a huge bundle. Cables like this can send information over 100 km (60 miles).

Another type of fiber-optic cable is called multi-mode. Each optical fiber in a multi-mode cable is about 10 times bigger than one in a single-mode cable. This means light beams can travel through the core by following a variety of different paths (purple, green, and blue lines)—in other words, in multiple different modes. Multi-mode cables can send information only over relatively short distances and are used (among other things) to link computer networks together.

Even thicker fibers are used in a medical tool called a gastroscope (a type of endoscope), which doctors poke down someone's throat for detecting illnesses inside their stomach. A gastroscope is a thick fiber-optic cable consisting of many optical fibers. At the top end of a gastroscope, there is an eyepiece and a lamp. The lamp shines its light down one part of the cable into the patient's stomach. When the light reaches the stomach, it reflects off the stomach walls into a lens at the bottom of the cable. Then it travels back up another part of the cable into the doctor's eyepiece. Other types of endoscopes work the same way and can be used to inspect different parts of the body. There is also an industrial version of the tool, called a fiberscope, which can be used to examine things like inaccessible pieces of machinery in airplane engines.

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Who invented fiber optics?

- 1840s: Swiss physicist Daniel Colladon (1802–1893) discovered he could shine light along a water pipe. The water carried the light by internal reflection.
- 1870: An Irish physicist called John Tyndall (1820–1893) demonstrated internal reflection at London's Royal Society. He shone light into a jug of water. When he poured some of the water out from the jug, the light curved round following the water's path. This idea of "bending light" is exactly what happens in fiber optics. Although Colladon is the true grandfather of fiber-optics, Tyndall often earns the credit.
- 1930s: Heinrich Lamm and Walter Gerlach, two German students, tried to use light pipes to make a gastroscope—an instrument for looking inside someone's stomach.
- 1950s: In London, England, Indian physicist Narinder Kapany (1927–) and British physicist Harold Hopkins (1918–1994) managed to send a simple picture down a light pipe made from thousands of glass fibers. After publishing many scientific papers, Kapany earned a reputation as the "father of fiber optics."
- 1957: Three American scientists at the University of Michigan, Lawrence Curtiss, Basil Hirschowitz, and Wilbur Peters, successfully used fiber-optic technology to make the world's first gastroscope.
- 1960s: Chinese-born US physicist Charles Kao (1933–) and his colleague George Hockham realized that impure glass was no use for long-range fiber optics. Kao suggested that a fiber-optic cable made from very pure glass would be able to carry telephone signals over much longer distances and was awarded the 2009 Nobel Prize in Physics for this ground-breaking discovery.
- 1960s: Researchers at the Corning Glass Company made the first fiber-optic cable capable of carrying telephone signals.
- 1977: The first fiber-optic telephone cable was laid between Long Beach and Artesia, California.
- 1997: A huge transatlantic fiber-optic telephone cable called FLAG (Fiber-optic Link Around the Globe) was laid between London, England and Tokyo, Japan.