Fibre Optics

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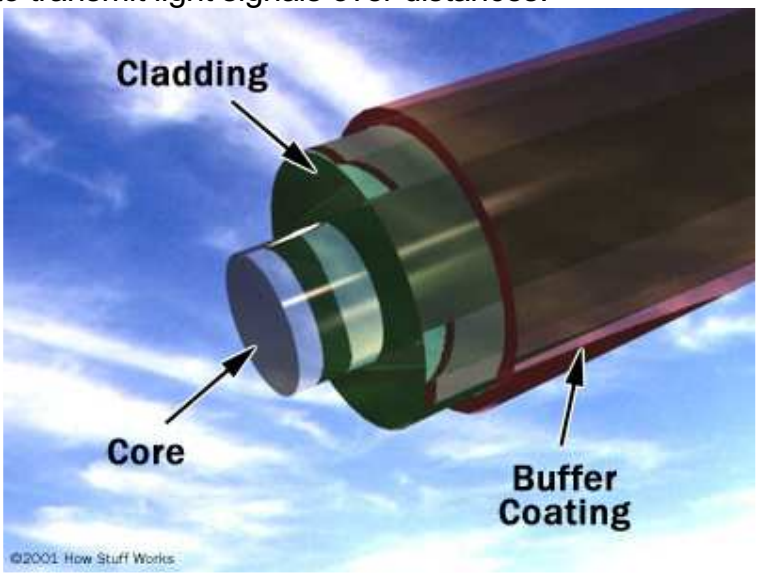
Advantages of sending information down a Fibre Optic cable over traditional copper cable.	**Disadvantages** of sending information down a Fibre Optic cable over traditional copper cable.
Much cheaper. Several miles of optical cable can be made cheaper then equivalent lengths of copper wire.	The raw material for making optical fibres, sand, is abundant and cheap optical fibres are still more expensive per metre than copper. Although this can be said one fibre can carry many more signals than a single copper cable.
Thinner. Fibre optical cable can be drawn into much thinner diameters and still offer the same performance.	Optical fibres cannot be joined together as easily as copper cable and requires additional training of personnel and expensive precision splicing and measurement equipment.
Higher carrying capacity. As the fibres can be drawn into much thinner diameters, many more can be bundled together.	Fairly difficult when it comes to installing fibre cables. Need trained people to fit cables.
Less signal degradation. Fibre optics has a much lower signal loss compared to copper wire.	
Digital signals. This is helpful when using in network situations.	
Lightweight. An optical cable weighs much less than an ordinary copper cable. Once again many more can be bundled.	
Non-flammable. As no current is passed through the cable, no risk of fire is apparent.	
Flexible. Once again as the fibres are very thin, it is possible to use them in conjunction with small digital cameras. They can be used in Medical and Mechanical imaging and Plumbing among many other uses.	

How fibre optics work

The talk of fibre optic cables has become much more popular within the past few years. In addition to this, the use of fibre optic cable has also become much more popular. It is now used in telephone systems, cable TV and much recently the Internet. The structure of a fibre is much like a human hair and made out of pure glass. The cables carry digital information over long distances which little data loss. There are other such uses as medical and engineering.

What is a Fibre Optic cable?

Fibre optics are long, thin strands of very pure glass about the diameter of a human hair. They are arranged in bundles called Optical cable, and are used to transmit light signals over distances.



Above shows a diagram of the structure of an optical fibre.
(Source: howstuffworks.com)

The key parts shown are: -
Core – thin glass centre where the light travels.
Cladding – Outer optical material surrounding core which reflects light back into the core.
Buffer Coating – Made of Plastic that protects the fibre from damage.

Optical fibres come in two types:

- Single mode fibres,
- Multi mode fibres.

Single mode fibres have the smallest core (about 3.5×10^{-4} inches) and transmit laser light.
Multi mode fibres have a slightly larger diameter (about 2.5×10^{-3} inches) and transmit infrared light from LEDs.

Some optical fibres are made from plastic. These have the largest diameter core approximately 1mm. These transmit infrared light from LEDs.

How does an Optical Fibre transmit light?

The light signals sent down through the fibre optic is constantly bounced off of the cladding, a principle called Total Internal reflection. As the cladding does not absorb any of the light, the signal can travel for long distances. However, some of the light signal degrades with the fibre. This is mainly caused due to impurities in the glass. The extent of how much the signal degrades depends on the purity of the glass and the wavelength of the transmitted light.

The Physics behind Total Internal reflection

When light passes from a medium with one index of refraction (m 1) to another medium with a lower index of refraction (m 2), it bends or refracts away from an imaginary line perpendicular to the surface (normal line). As the angle of the beam through m 1 becomes greater with respect to the normal line, the refracted light through m 2 bends further away from the line.

- At one particular angle (critical angle), the refracted light will not go into m2, but instead will travel along the surface between the two media. If the beam through m 1 is greater than the critical angle, then the refracted beam will be reflected entirely back into m 1, even though m2 may be transparent!
- In physics, the critical angle is described with respect to the normal line. In fibre optics, the critical angle is described with respect to the parallel axis running down the middle of the fibre.
- In an optical fibre, the light travels through the core (m 1, high index of refraction) by constantly reflecting from the cladding (m 2, lower index of refraction) because the angle of the light is always greater than the critical angle. Light reflects from the cladding no matter what angle the fibre itself gets bent at, even if it's a full circle!