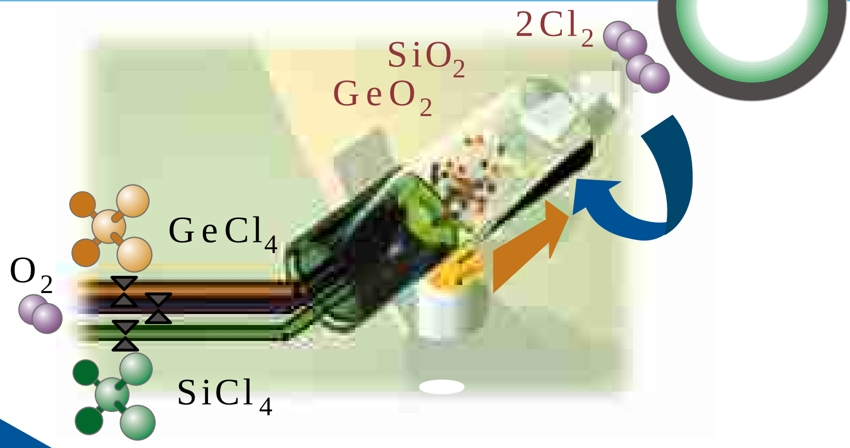
Optical Fibre Manufacturing Process



1 Raw Materials

The raw materials used in the initial stages of optical fibre manufacture include high quality synthetic quartz substrate tubes, ultra-pure halides such as silicon tetrachloride ($SiCl_4$) and germanium tetrachloride ($GeCl_4$), as well as the gaseous forms of pure oxygen (O_2), Helium (He), Chlorine (Cl_2), Sulphurhexafluoride (SF_6) and Nitrogen.

It is important that the above materials are free from foreign articles, and contain very low concentrations (<5 ppm) of water molecules.

2 Deposition

An oxy-hydrogen burner heats a section of the rotating quartz substrate tube to 1700 °C. This creates a radial reaction zone where the oxidation of the halides occurs. The silicon dioxide (SiO_2) and germanuim dioxide (GeO_2) particles are deposited in the inside of the tube, downstream from the burner, by a process known as thermophoresis. Chlorine which acts as a drying agent, is produced as a waste product. As the burner repeatedly passes over the tube, it sinters and melts the layers of sooty particles into successive layers of glass. In the final few layers, the concentration of germanuim dioxide (GeO_2) is increased, thereby creating a region of higher refractive index that will become the fibre core.

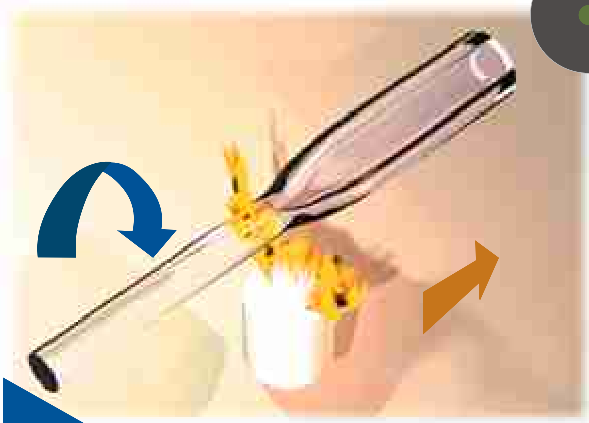
Optical Fibre Cable Manufacturing Process

Optical fibres in a cable are normally protected in one of two ways, either being *tight buffered* or contained in *loose tubes*. When *tight buffered* the individual optical fibre is covered directly with a layer of thermoplastic material or one or more fibres can be contained within a *loose tube* which is filled with a thixotropic gel. These processes are performed on specially equipped extrusion lines.

SZ-stranding

The tight buffered fibres or loose tubes are then stranded, mostly incorporating aramid yarn as tensile strength members and a glass reinforced polymer (GRP) rod as central strength members. SZ or conventional concentric stranders are used for this process. Interstices (open spaces) can be filled with petroleum jelly (PJ) or dry water swellable materials may be incorporated to protect against water penetration in the final cable. The stranded assembly is then sheathed (covered with a layer of polyethylene or other polymer material) on an extrusion line. For specific purposes an additional layer of material can be added such as aramid yarn for additional strength or a corrugated steel tape for increased mechanical protection (e.g. rodent proofing).

Test and measurement of cable parameters are conducted at various stages of production and prior to despatch to the customer.



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Collapse

Once the required number of layers of glass with the appropriate refractive index have been deposited and sintered by the burner, the tube is collapsed to form a solid glass rod called a preform.

4

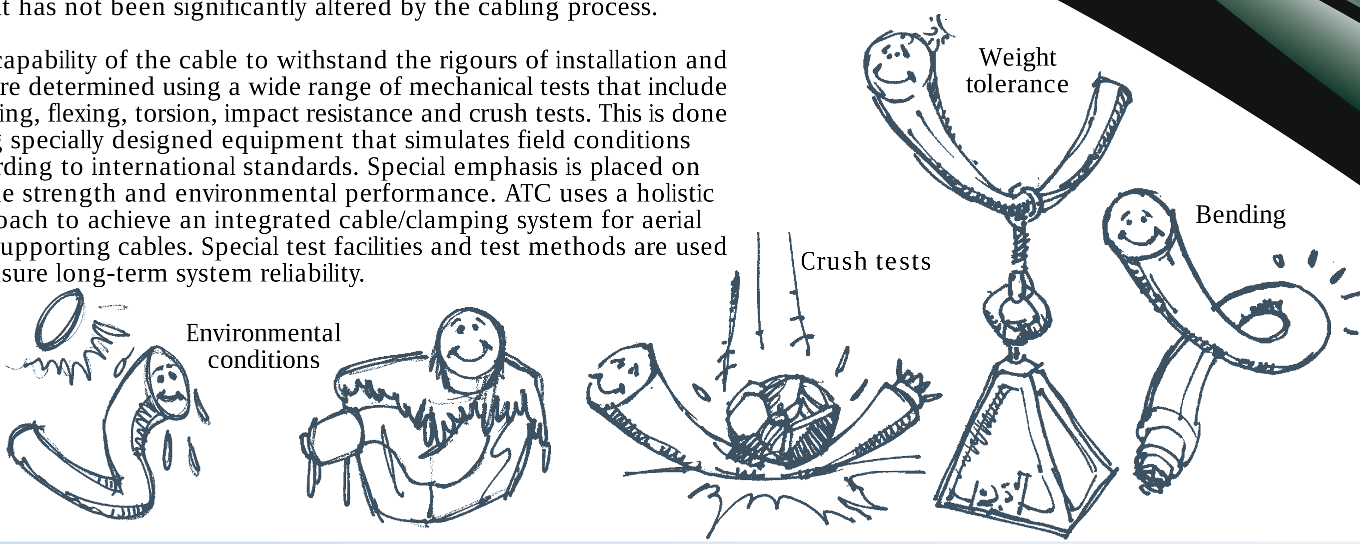
Sleeving

In order to increase the length of fibre that can be drawn cost effectively from a single preform, the preform volume is increased by sleeving. This is done by inserting the preform into a thick syntetic quartz glass tube. The two are then fused together at 2000 °C using an oxy-hydrogen ring burner, which moves vertically upwards.

Optical Fibre and Cable Testing

Performance verification forms an integral part of the manufacturing of optical fibre. The capability of each length of optical fibre to meet the required optical, geometrical, mechanical and dispersion characteristics is determined for each length of fibre before it is cabled. The optical attenuation is rechecked after cabling, in order to verify that it has not been significantly altered by the cabling process.

The capability of the cable to withstand the rigours of installation and use are determined using a wide range of mechanical tests that include bending, flexing, torsion, impact resistance and crush tests. This is done using specially designed equipment that simulates field conditions according to international standards. Special emphasis is placed on tensile strength and environmental performance. ATC uses a holistic approach to achieve an integrated cable/clamping system for aerial self-supporting cables. Special test facilities and test methods are used to ensure long-term system reliability.



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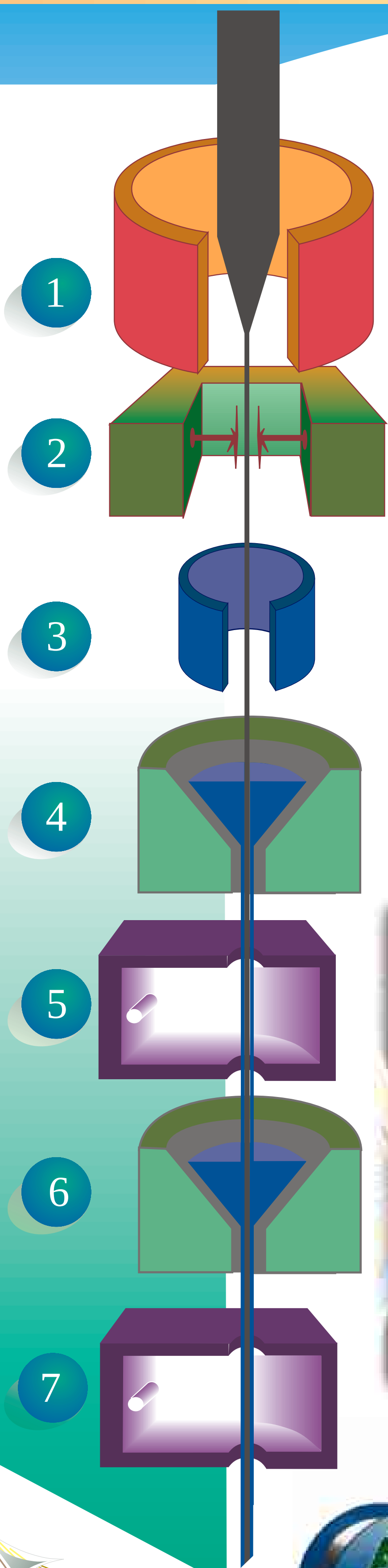
Optical Fibre Drawing

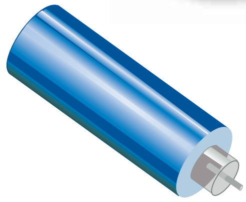
Optical fibre is drawn by inserting the preform into a high temperature graphite resistance furnace at 2100 °C. Argon and nitrogen gases provide an inert atmosphere to prevent oxidation of the graphite. A laminar, filtered airflow ensures that the preform surface remains clean.

The furnace is located at the top of the tower in a Class 100 clean room environment. The latter is very important as any particles that adhere to the optical fibre during the drawing process may act as a defect centre for crack propagation, causing the fibre to break.

The preform's tip softens in the furnace and is drawn down to a 125 µm diameter optical fibre in a free-flow process (no dies are used). The core to cladding ratio is maintained from the preform to the fibre. The optical fibre is cooled in a helium cooling tube and coated with dual layers of ultraviolet radiation cured acrylate resin, which provide protection against mechanical damage and moisture ingress.

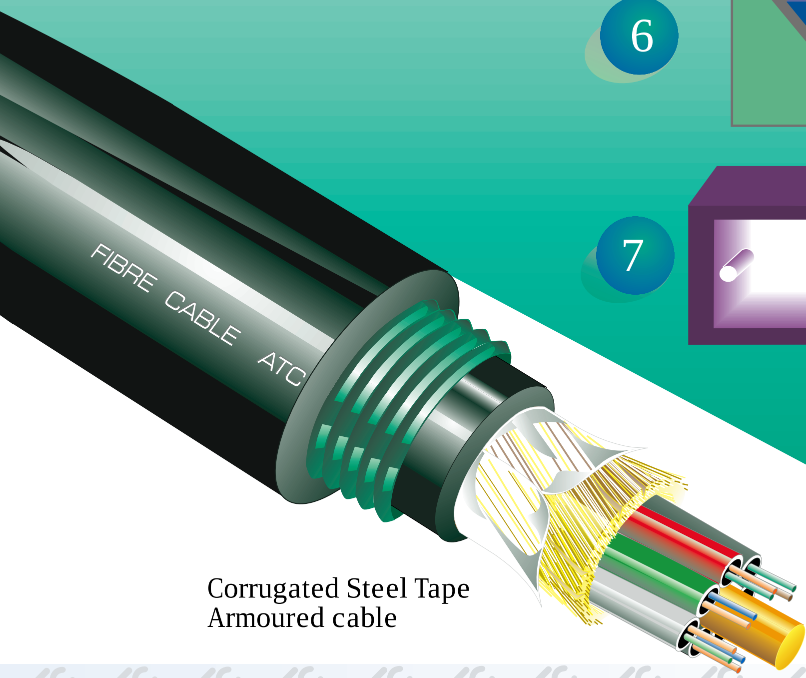
For identification purposes, optical fibres are coloured either by inking or by pigmentation in the coating process during fibre drawing.





Singlemode
9.5/125/245

1. Furnace
2. Laser diameter measurement (125 µm)
3. Cooling tube
4. Acrylate coating applicator (190 µm)
5. UV lamps
6. Acrylate coating applicator (245 µm)
7. UV lamps



Corrugated Steel Tape
Armoured cable