Making the Preform Blank

The glass for the preform is made by a process called **modified chemical vapor deposition** (MCVD).

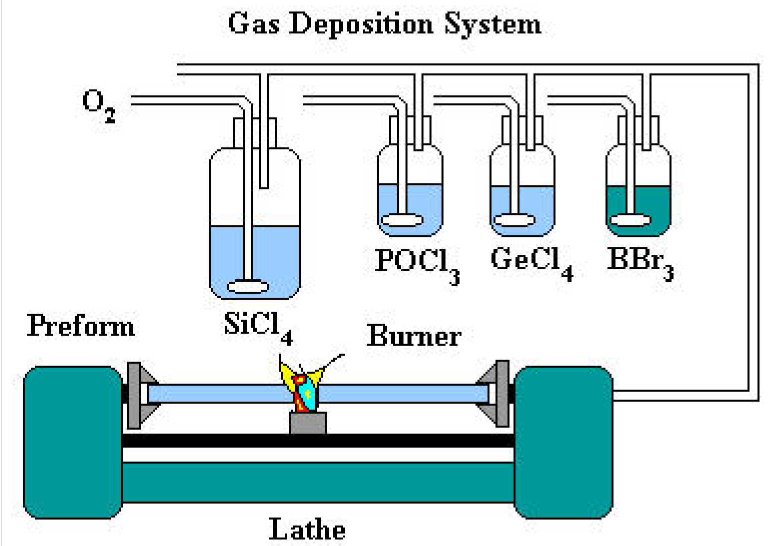


Image courtesy Fibercore Ltd.

MCVD process for making the preform blank

In MCVD, oxygen is bubbled through solutions of silicon chloride ($SiCl_4$), germanium chloride ($GeCl_4$) and/or other chemicals. The precise mixture governs the various physical and optical properties (index of refraction, coefficient of expansion, melting point, etc.). The gas vapors are then conducted to the inside of a **synthetic silica** or **quartz tube** (cladding) in a special **lathe**. As the lathe turns, a torch is moved up and down the outside of the tube. The extreme heat from the torch causes two things to happen:

Photo courtesy Fibercore Ltd.

Lathe used in preparing the preform blank

- The silicon and germanium react with oxygen, forming silicon dioxide (SiO_2) and germanium dioxide (GeO_2).
- The silicon dioxide and germanium dioxide deposit on the inside of the tube and fuse together to form glass.

The lathe turns continuously to make an even coating and consistent blank. The purity of the glass is maintained by using corrosion-resistant plastic in the gas delivery system (valve blocks, pipes, seals) and by precisely controlling the flow and composition of the mixture. The process of making the preform blank is highly automated and takes several hours. After the preform blank cools, it is tested for quality control (index of refraction).

Drawing Fibers from the Preform Blank

Once the preform blank has been tested, it gets loaded into a **fiber drawing tower**.

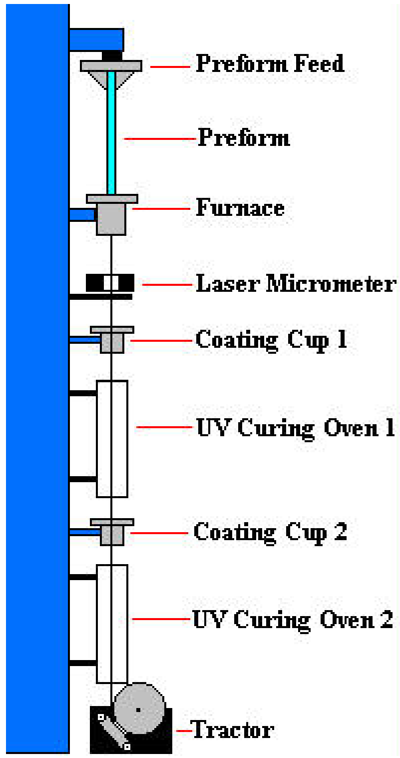


Diagram of a fiber drawing tower used to draw optical glass fibers from a preform blank

The blank gets lowered into a graphite furnace (3,452 to 3,992 degrees Fahrenheit or 1,900 to 2,200 degrees Celsius) and the tip gets melted until a molten glob falls down by gravity. As it drops, it cools and forms a thread.

The operator threads the strand through a series of coating cups (buffer coatings) and ultraviolet light curing ovens onto a tractor-controlled spool. The tractor mechanism slowly pulls the fiber from the heated preform blank and is precisely controlled by using a **laser micrometer** to measure the diameter of the fiber and feed the information back to the tractor mechanism. Fibers are pulled from the blank at a rate of 33 to 66 ft/s (10 to 20 m/s) and the finished product is wound onto the spool. It is not uncommon for spools to contain more than 1.4 miles (2.2 km) of optical fiber.

Testing the Finished Optical Fiber

The finished optical fiber is tested for the following:

- **Tensile strength** - Must withstand 100,000 lb/in^2 or more
- **Refractive index profile** - Determine numerical aperture as well as screen for optical defects

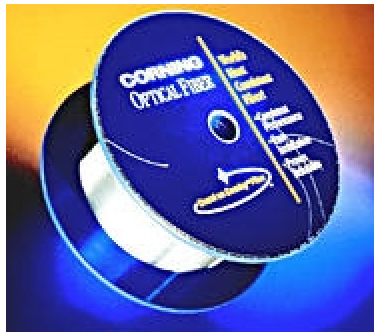
- 

Photo courtesy Corning

Finished spool of optical fiber

  Fiber geometry - Core diameter, cladding dimensions and coating diameter are uniform
- **Attenuation** - Determine the extent that light signals of various wavelengths degrade over distance
- **Information carrying capacity** (bandwidth) - Number of signals that can be carried at one time (multi-mode fibers)
- **Chromatic dispersion** - Spread of various wavelengths of light through the core (important for bandwidth)
- **Operating temperature/humidity range**
- **Temperature dependence of attenuation**
- **Ability to conduct light underwater** - Important for undersea cables

Once the fibers have passed the quality control, they are sold to telephone companies, cable companies and network providers. Many companies are currently replacing their old copper-wire-based systems with new fiber-optic-based systems to improve speed, capacity and clarity.