

## Optical fibers for Process Spectroscopy and other applications

**Optical fibers and waveguides** are used as a flexible radiation beam delivery. Applications include spectroscopy, laser power delivery, remote sensing, and many others. An optical fiber consists of three main components: the core, where the light is actually guided; the cladding, which maintains light confinement within the core through total internal reflection, and the coating (jacket or buffer), which protects the fiber from mechanical damage and environmental influences. Different types of optical fibers are selected depending on the operating wavelength range, transmission properties and environmental conditions of the specific application.

**Silica fibers (180 - 1200 & 400 - 2400 nm range)** are the most commonly used optical fibers. Their core is primarily made from high-purity silicon dioxide (SiO<sub>2</sub>), while cladding is typically composed of fluorine-doped SiO<sub>2</sub>. Low-OH silica fibers provide excellent transmission across the visible to near-infrared spectrum (400 nm to 2400 nm). High-OH silica fibers transmit the radiation from the ultraviolet to visible spectrum (180 nm to 1200 nm). Common protective coatings include acrylate which has an operating temperature range of -40°C to +85°C, and polyimide, which functions from -65°C to +300°C. For high temperature applications metal coating is used with temperature ranges from -270°C to +400°C for aluminum and to +600°C for copper in non-oxidizing atmospheres. In the case of fluorescence-sensitive applications metal coating is also a better option compared to polymer coating.

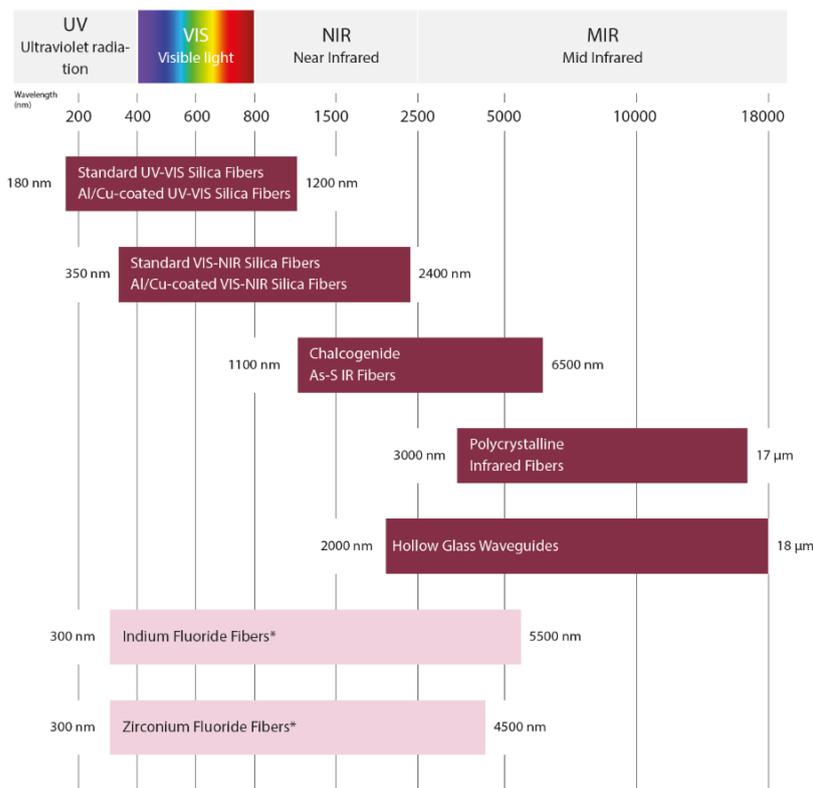
**Fluoride fibers (0.3 - 4.5 & 0.3 - 5.5 μm range)** work in mid-IR range with low optical loss: Zirconium fluoride ZrF<sub>4</sub> covers 0.3 to 4.5 μm, and Indium Fluoride InF<sub>3</sub> extends up to 5.5 μm. Fluoride fibers are recommended for applications beyond silica fiber range, but these fibers are more fragile and sensitive to moisture compared to silica fibers, necessitating careful handling. They are not recommended for high power laser applications. Operating temperature range is from -180°C to +150°C.

**Chalcogenide infrared fibers (1.1 - 6.5 μm range)**, known as CIR fibers, are made from As<sub>2</sub>S<sub>3</sub> glass and are ideal for Mid-IR applications, especially in 2.5 - 4 μm range, where silica cannot perform effectively. They are not recommended for high power laser applications. The operating temperature range for bare CIR fiber is -273°C to +90°C. CIR fiber has higher numerical aperture compared to fluoride fibers and it is recommended for spectroscopy applications.

**Polycrystalline infrared fibers (3 - 17 μm range)**, known as PIR, made from silver halide (AgClBr) offer exceptional transmission in the mid-IR range 3-17 μm. These fibers are non-hydroscopic, non-toxic and non-brittle. However, PIR fibers are sensitive to prolonged UV exposure and reactive to many metals and SO<sub>2</sub> containing compounds, which requires careful handling for long-term use. PIR fibers have no protective jacket and usually are used with a non-transparent protective tubing made of PEEK. They must be handled with care, and connectorization requires professional expertise. The operating temperature range (without cooling) is -273°C to +140°C. PIR fibers have a large numerical aperture and are widely used in mid-infrared ATR fiber optic probes for FTIR spectroscopy, thermosensing and CO<sub>2</sub> laser delivery.

**Hollow waveguides (3 - 17 μm range)**, known as HWG have a hollow core with a reflective inner coating to guide the light. Hollow Waveguides design is a perfect option to transmit a low divergent IR-light of Mid IR-spectrum from 3 to 17 μm. High performance HWG are produced with double polymer jacket to secure a superior mechanical strength and high flexibility. HWGs don't suffer from Fresnel reflection losses as solid core fibers but are more sensitive to beam coupling conditions and bending compared to PIR fibers. Operating temperature range is from -50°C to +90°C.

### Find fibers to match your application



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