The basic principle of light transport through an optical fiber is total internal reflection. This means that the light within the numerical aperture of a fiber (NA = input acceptance cone) will be reflected and transported through the fiber. The size of the numerical aperture depends on the materials used for core and cladding.

Two basic types of silica fibers can be distinguished; single-mode and multi-mode fibers, depending on the propagation state of the light, traveling down the fiber. For most spectroscopic applications multi-mode fibers are used. Multi-mode fibers can be divided into 2 subcategories, step-index and graded-index. A relatively large core and high NA allow light to be easily coupled into the fiber, which allows the use of relatively inexpensive termination techniques. Step-index fibers are mainly used in spectroscopic applications.

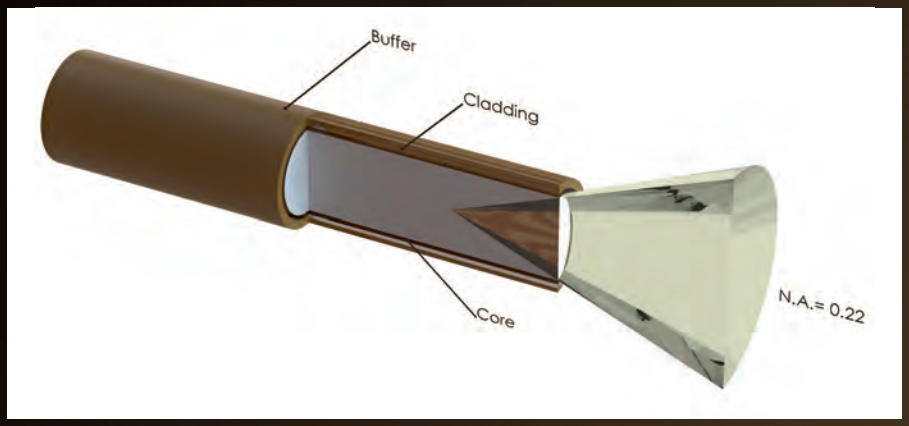
Graded-index multimode fibers have a refractive index gradually decreasing from the core out through the cladding. Since the light travels faster in material with lower refractive index, the modal dispersion (amount of pulse-spreading) will be less.
These graded-index fibers are mainly used in telecommunication application, where dispersion at long distance (2-15 km) plays an important role.

Product codes
For example FC-20UVIR200-3-BX
A product code is designed as follows:

Type of Product	Number of fibers	Wavelength	Fiber core diameter	Overall Length	Jacketing	Other options
FC = standard fiber cable FCB = bifurcated fiber FCR = fiber reflection probe FDP = fiber dip probe	almost any number possible	UV = 200-800 nm IR = 350-2500 nm UVIR = 200-2500 nm	8 µm* 50 µm** 100 µm*** 200 µm*** 400 µm*** 600 µm*** 800 µm** 1000 µm**	in meters	BX = stainless steel ME = chrome-plated brass MS = metall silicone	HT= high temperature on request: HTX= extreme high temperature PK= PEEK HY= Hastelloy®

* Only for IR fibers
** Only for UV or IR fibers
*** Only for UVIR fibers

FIBER-OPTIC DESIGN



Core

For spectroscopic applications, generally, multi-mode step index silica fibers are used. These range in core thickness from 50 to 1000 microns. The core is made out of pure silica. Other fiber cores with much higher absorption are made out of certain glass types or plastics. These are not offered in this catalog.

First a distinction is made between silica with high or low OH content. Silica fibers with high OH (600-1000 PPM) are used in the UV/VIS wavelength range because of the low absorption in the UV. They are referred to as UV/VIS fibers. For Deep-UV applications (below 230 nm) special solarization resistant fibers can be used.

The water content causes strong absorption peaks in the NIR wavelength range. In order to get good fibers for the NIR range, the "water" is removed from the silica. This results in low OH fibers (<2 PPM) with low absorption in the NIR. They are referred to as VIS/NIR fibers.

Best of both worlds are the so-called broadband fibers, which can be used for the UV-NIR range (200-2500 nm), the product code for these fibers is UVIR. Avantes has standardized on this broadband type of fiber.

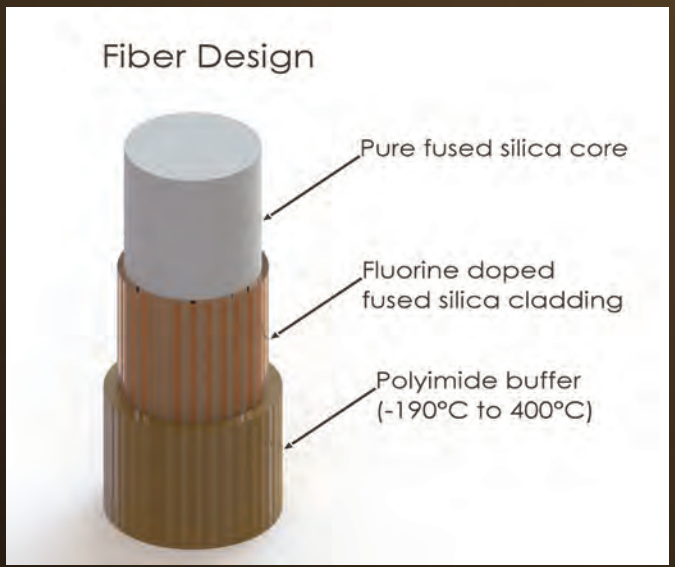
Cladding

In order to get the light guiding effect the core is cladded with a lower index of refraction material. For the highest quality fibers with the lowest absorption this is a fluorine-doped silica, the so-called silica-silica or all-silica fibers with a numerical aperture (NA) of 0.22.

Buffers

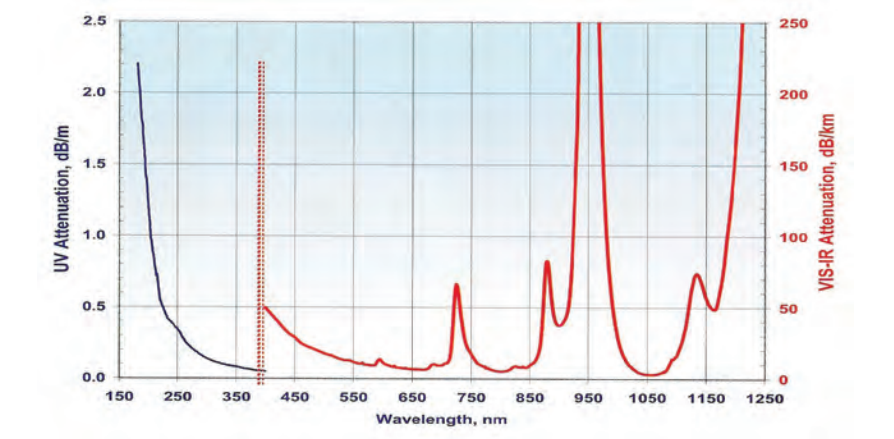
Without further protection fibers would easily break, because of small scratches or other irregularities on the surface. Therefore a next layer, the buffer, is added. This buffer also determines under what circumstances the fiber can be used. Temperature range, radiation, vacuum, chemical environment and bending are factors to be considered.

Polyimide buffers offer a wide temperature range (-190 to 400ºC) and superior solvent resistance. Also, this material is non-flammable. Drawbacks are sensitivity to micro bending and the difficulty to remove it.

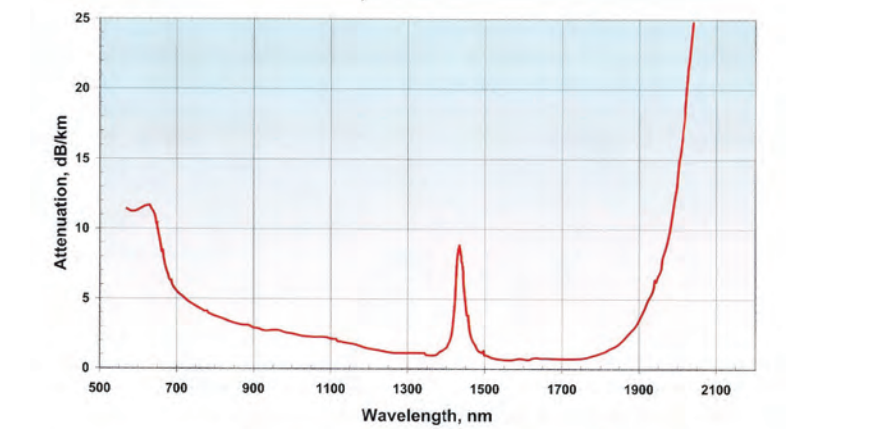


Technical Data

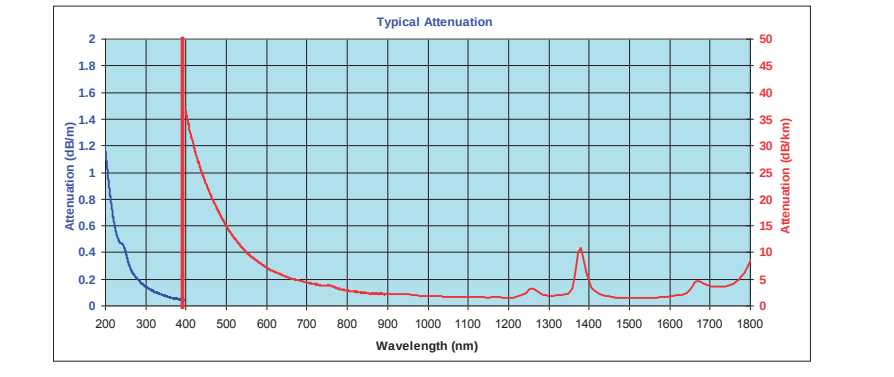
Fiber Materia	Standard
Temperature Range	-190 ºC to +400ºC
Fiber type	Step index Mutimode
Core Numerical Aperture	0.22 ± 0.02
Buffer	Polyimide
Available Diameters	50/100/200/400/600/800/1000 µm
Laser damage resistant core	1,3 kW/mm² CW at 1060 nm, up to 10 J, pulsed
Bend radius	momentary 100 x clad radius long term 600 x clad radius



Transmission UV/VIS fibers



Transmission VIS/NIR fibers



Transmission UV/VIS/NIR broadband

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