

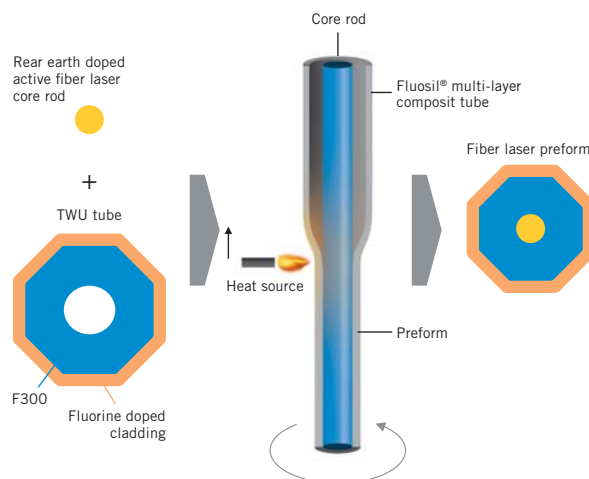
Highly Fluorine Doped Tubes

Fluosil® tubes are characterized by the unique high fluorine concentration, which leads to a depressed index of refraction up to -26×10^{-3} . Our Fluosil® tubes feature the highest fluorine content and therefore the lowest refractive index in the market. They can be manufactured as homogenous single layer as well as multiple layer composite tubes with a polygonal structure e.g. as pump cladding for fiber laser core rods.

Typical applications include:

- Structured composite tubes to create laser fiber pump claddings
- Down doped Fluosil® jacket tubes to overclad sensitive core materials
- Substrate tubes for chemical vapor deposition processes
- Fluorine doped capillaries, e.g., for optical and viscosity matching

Overcladding Process



Tube types

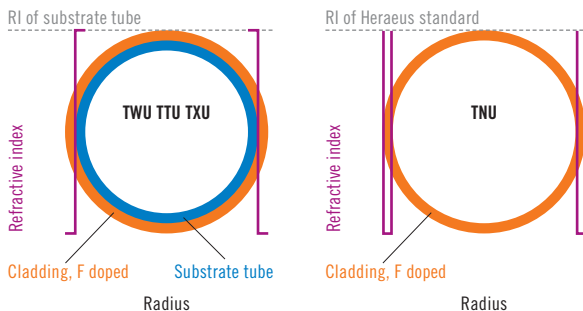
Two different types of Fluosil® tubes are available: Composite tubes with fluorine doped layers on a substrate tube or solely fluorine doped tubes.

| Available tubes | | | | |
|-----------------------|-------------------------|---------------------------------|---------------------------------|-------------------------------|
| | Composite tubes | | | Fluorine doped tubes |
| | TWU | TTU | TXU | TNU |
| Fluosil® layer | Refractive index* | | | 0 ... -26 x 10 ⁻³ |
| | OH [ppm] typical | | | 1 ... 30 |
| | F [ppm] | | | 0 ... 70,000 |
| Substrate tube | Substrate tube material | F300 | F320 | F110 |
| | Refractive index* | 0.35 ... 0.5 x 10 ⁻³ | -0.6 ... 1.2 x 10 ⁻³ | -0.1 ... 0 x 10 ⁻³ |
| | OH [ppm] typical | < 1 | < 1 | 500 ... 600 |
| | F [ppm] | - | 3,000 ... 4,000 | - |

*Difference to un-doped fused silica (Heraeus standard)

Uniformly fluorine doped Fluosil® tubes, referred to as U-types (TWU, TTU, TXU and TNU), are available. In addition, tubes are available with a double or multi step refractive index profile. These types are referred to as S-types (TWS, TTS, TXS and TNS). When using the soft fluorine doped tubes in MCVD or similar processes, stabilization of the tube can be achieved by adding an un-doped outer layer.

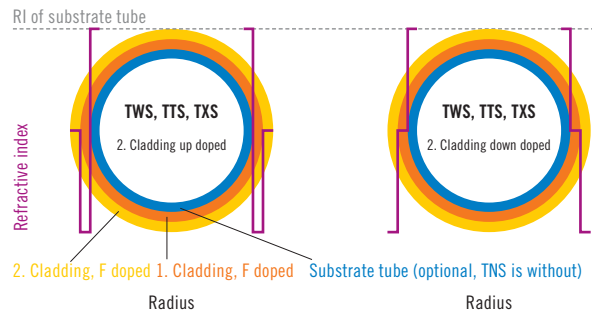
U-Types – Typical Cross Sections and Refractive Index Profiles



Germany
Heraeus Quarzglas GmbH & Co. KG
 Quarzstraße 8
 63450 Hanau
 Phone +49 (0) 6181.35-6324
 Fax +49 (0) 6181.35-6261
 fiber-optic-sales-de@heraeus.com
 www.heraeus-quarzglas.com

USA
Heraeus Tenevo LLC
 100 Heraeus Blvd.
 Buford, GA 30518
 Phone +1 678.804-1021
 Fax +1 678.804-1023
 fiber-optic-sales-us@heraeus.com
 www.heraeus-quarzglas.com

S-Types – Typical Cross Sections and Refractive Index Profiles



Typical geometries

- Outer tube diameter: 10 ... 40 mm
- Fluorine doped wall thicknesses: 2 ... 3 mm
- Lengths: Up to 1,300 mm
- Other custom geometries available on request

Special tube cross sections

Beyond the standard cylindrical tube geometry, we also offer Fluosil® tubes with polygonal cross sections such as rectangular, square or hexagonal. Rectangular Fluosil® tubes can have aspect ratios from 1:1 to as high as 1:6.

Physical Material Characteristics

| | Un-doped tube | F doped tube* |
|--|--|--|
| Refractive index @ 633 nm | 1.4571 | 1.440 |
| Refractive index @ 1,064 nm | 1.4498 | 1.433 |
| Transformation temperature | 1,050 °C | 750 °C |
| Fluorine content | 0 wt % | 5.0 wt % |
| Thermal expansion coefficient (20 to 400° C) | 6 x 10 ⁻⁷ K ⁻¹ | 2.5 x 10 ⁻⁷ K ⁻¹ |
| Density | 2.203 g/cm ³ | 2.180 g/cm ³ |
| Elastic modulus | 7.25 x 10 ¹⁰ N/m ² | n. d. |

*Tube with Δn 17.1 x 10⁻³ respectively un-doped fused silica

About us

Heraeus is the key global supplier of high purity synthetic fused silica products for optical fiber manufacturing. We have been a reliable partner in the world telecommunications industry since 1976.

We are certified for ISO 9001:2000 and our Total Quality Management system is based on the Business Excellence Model of the European Foundation for Quality Management (EFQM).