

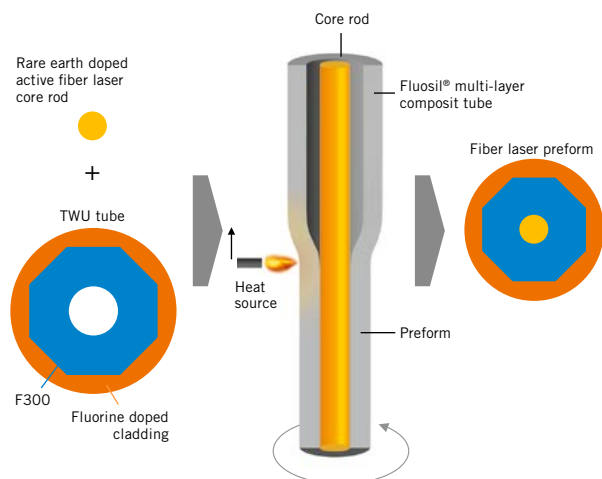
## Highly Fluorine Doped Tubes

Fluosil® tubes are characterized by the unique high fluorine concentration, which leads to a depressed index of refraction up to  $-26 \times 10^{-3}$ . Our Fluosil® tubes feature the highest fluorine content and therefore the lowest refractive index in the market. They can be manufactured 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
- Fluorine doped capillaries, e.g., for optical and viscosity matching

### Overcladding Process

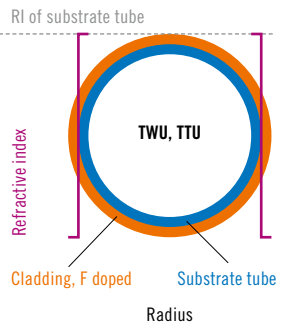


| Available tubes |                         |                            |                                       |
|-----------------|-------------------------|----------------------------|---------------------------------------|
|                 |                         | Composite tubes            |                                       |
|                 |                         | TWU                        | TTU                                   |
| Fluosil® layer  | Refractive index*       | 0 ... $-26 \times 10^{-3}$ |                                       |
|                 | OH [ppm] typical        | 1 ... 30                   |                                       |
|                 | F [ppm]                 | 0 ... 70,000               |                                       |
| Substrate tube  | Substrate tube material | F300                       | F320                                  |
|                 | Refractive index*       | 0.35 ... $10^{-3}$         | 0.5 x $-0.6 \dots 1.2 \times 10^{-3}$ |
|                 | OH [ppm] typical        | < 1                        | < 1                                   |
|                 | F [ppm]                 | -                          | 3,000 ... 4,000                       |

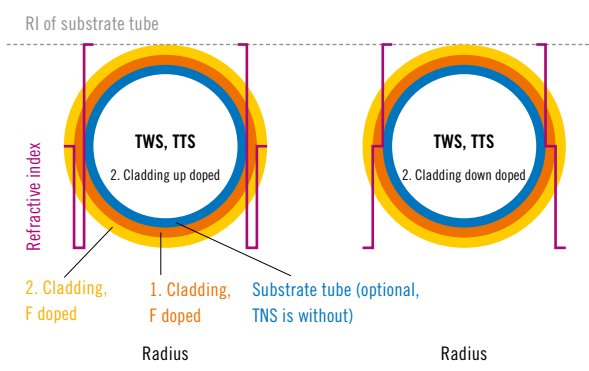
\* Difference to un-doped fused silica (Heraeus standard)

Uniformly fluorine doped Fluosil® tubes, referred to as U-types (TWU, TTU), 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).

**U-Types – Typical Cross Sections and Refractive Index Profiles**



**S-Types – Typical Cross Sections and Refractive Index Profiles**



**Typical geometries**

- Outer tube diameter: 10 ... 40 mm
- Fluorine doped wall thicknesses: 3 ... 15 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 multi layer Fluosil® tubes with polygonal interface sections such as rectangular, square, hexagonal or octagonal.

**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 %      |

\* Tube with  $\Delta n 17.1 \times 10^{-3}$  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.

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