SCHOTT® Shaped Fiber Rods

Precisely Shaped Illumination for Dental Handpieces

Examples of end configurations of shaped fiber rods

High transmission and high numerical aperture in combination with excellent forming properties enable SCHOTT's shaped fiber rods to be the first choice in dental handpiece illumination. The shaped fiber optic rods replace short length flexible fiber optic components due to their advantage of no fiber breakage and easy assembly into dental handpieces without complicated adjustments.

Consisting of a plurality of core/clad systems fused together to a multi core component, the Multi Core Rod type MCR-3 features excellent forming properties. Heating the raw rod up to the softening temperature makes it possible to shape complex 2D and 3D geometries according to customer specifications.

The shaping process utilizes a mold which ensures highly uniform manufacturing output while maintaining precisely specified dimensions and tolerances. Final quality inspection by an automated optical inspection system further supports the high level of quality of the delivered components.

Excellent mechanical as well as chemical stability facilitates a long lifetime and reliable functionality of the shaped fiber rod.

Technical Data	
Description	MCR-3 (FST-K3)
Core Type	Multi
Color of Outter Clad	Clear
Numerical Aperture	0.63
Eff. Acceptance Angle according to DIN 58 141 Part 3 Theoretical (□= 587. 6 mm)	78°
Lead-free	Yes
Biocompatibility According to DIN ISO 10993-5	Yes
Temperature • **Operational** (glass rod only) • **Storage/transport**	- 20°C/-4°F …+350°C/158°F - 20°C/-4°F …+ 70°C/662°F
Shelf Life According to IEC 60721 Part 3-1 (Class: 1K2, 1B1, 1C1, 1S2)	min. 2 years

Applications

- Dental handpieces
- Dental drillers
- Dental scalers
- Dental spray units

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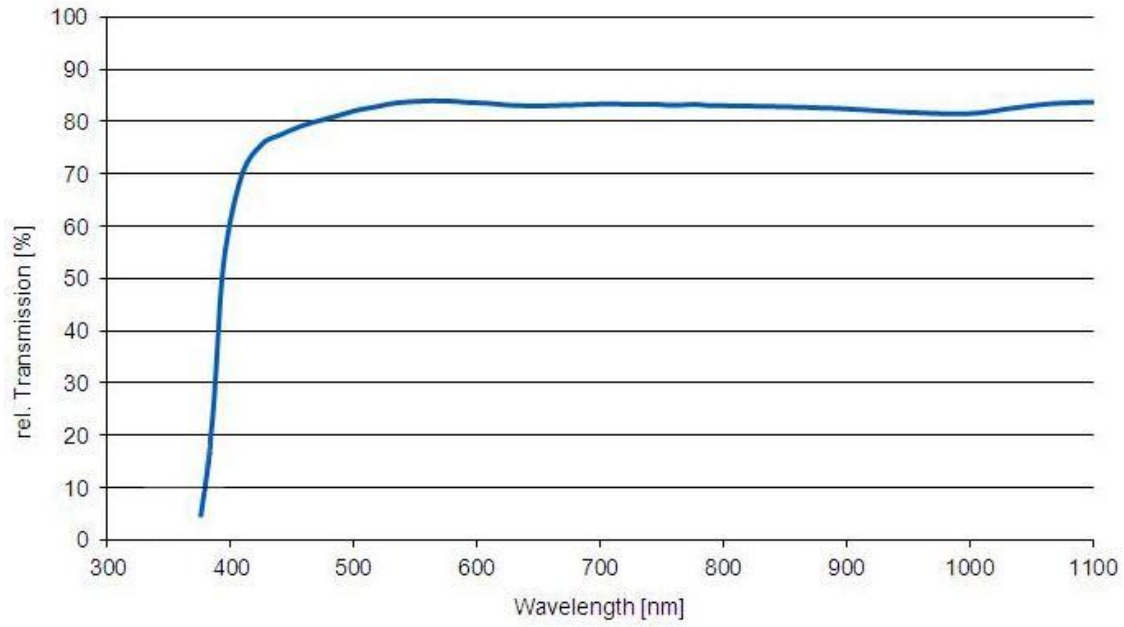
Typical Spectral Transmission MCR -3



Numerical Aperture

The numerical aperture or respectively the acceptance angle of the basic rod is calculated by the ratio of the refractive indices of core and cladding. For the MCR-3 material the theoretical numerical aperture is 0.63, which results in a full acceptance angle of 78°.

The numerical aperture of the shaped fiber rod is influenced by the design of the rod, in particular bends, angles, and transformations of the cross section will influence the final aperture of the rod. Due to plurality of different influences the aperture cannot be predetermined, but needs to be evaluated in the final shaped rod.

When further processed into the final shape the transmission may change, depending on the geometrical transformation. Further processing steps can be:

- cone shaping
- bending
- shaping into complex shapes
- end surface not perpendicular to axis of the rod

Transmission

The above displayed transmission curve represents SCHOTT's typical manufacturing level for MCR-3 rods. The transmission is controlled in the wavelength range between 460 and 660 nm.

The following conditions influence the transmission of a fiber optic component:

- Transmission of core glass
- Core/clad surface ratio (maximum for single core)
- Quality of end polish Length: negligible for rigid fiber optics, due to short application length
- Sharp bends (light leakage)

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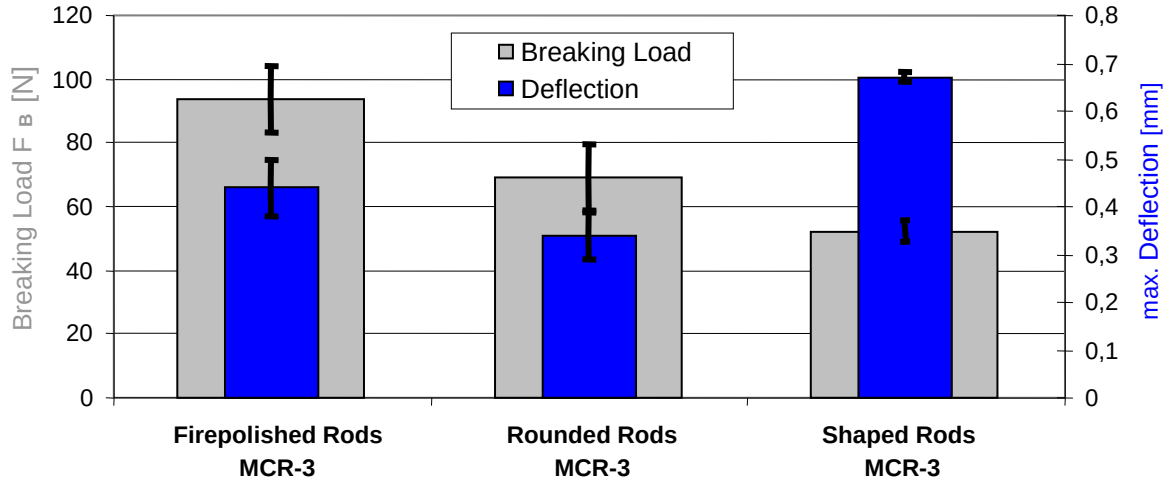
Mechanical Strength of Shaped Rods

Fire-polished MCR-3 rods have the original surface condition resulting from the initial rod drawing process. Diameter tolerances of the unprocessed rod are in the range of ± **0.03 mm**. This raw material tolerance will change during the shaping process. Fire-polished round rods feature the highest breaking resistance with slightly better deflection than rounded rods.

For higher requirements concerning mechanical tolerances the originally fire-polished MCR-3 rods can be **rounded**. These rods feature an improved diameter tolerance by mechanically grinding the outer diameter of the unprocessed rod to precise dimensions up to **+0/-0.02 mm**. This raw material tolerance will change during the shaping process. Since the common outer cladding is partially removed by the process, the breaking load resistance, as well as deflection, is lower in comparison to fire-polished rods.

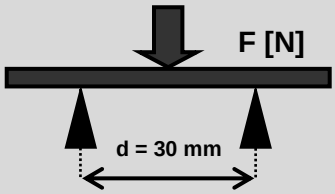
Shaped rods show different mechanical strength in comparison to the original round rods depending on the individual shapes and bends of the component. As an example the breaking load resistance of a kidney-shaped, straight rod is shown. The force has been applied to the concave side. The breaking load resistance is lower than for a round rod, but maximum deflection is significantly higher.

Mechanical Strength Measurements



Cross section: straight sample

Mechanical Strength of Shaped Rods	
Test Conditions:	**3 Point Bending Test**
Sample geometry	• 2.5 mm for round rods • 3.95 * 1.3 mm for kidney shape
No. of samples	• 10 … 20 per type
Starting force	• 5 N
Feed rate	• 2 mm/minute



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Design Guidelines for Shaped Rods

SCHOTT's shaping process enables a variety of different shapes and cross-sections to be realized.
The original circular shape of the basic rod can be transformed into flat, half-round or kidney-shaped designs. The straight rod can be angled in different shapes, realizing 2D as well as 3D configurations. Thus, the shape of the rod can be custom-tailored to the space requirements in the customer's application.

Quality Inspection

The precise dimensions of the shaped rods can be verified by an optical inspection system. Since all dimensions, except the overall length, are defined by the molding process, final process validation usually makes a 100% control of the finished fiber rods redundant.
Some dimensions, i. e. angles or bends cannot be measured on the final rod, since reference edges are not accessible. In this case check dimensions will be agreed upon (see check dimension "ZZ" in the design guidelines below).

Design Details

Some basic values of dimensions and tolerances are listed in the table, as well as in the principle sketches of a shaped rod below. The design guidelines can only give a brief overview about general tolerances and angles, which can be realized. A combination of different requirements may result in variations basic numbers in the table below, which need to be agreed upon by the SCHOTT engineering department

Design Details

Light Input End

The light input end usually maintains a round shape to gather as much light as possible from the light source, usually a small footprint halogen bulb or a light emitting diode - LED.
The maximum diameter of a shaped fiber rod is 3.0 mm. If the light path needs to be split into 2 arms, two half-round rods can be combined to a full circle.

Light Output End

The light output ends can have different shapes depending on the requirements. Round, flat or kidney-shapes are common, usually with a sharp bend right before the end surface

Diameter Tolerances

The tolerances of specified diameters depend on the shape of the component. In bent sections the outer diameters are slightly larger than the diameter of the basic rod, due to material bulging slightly sideways.

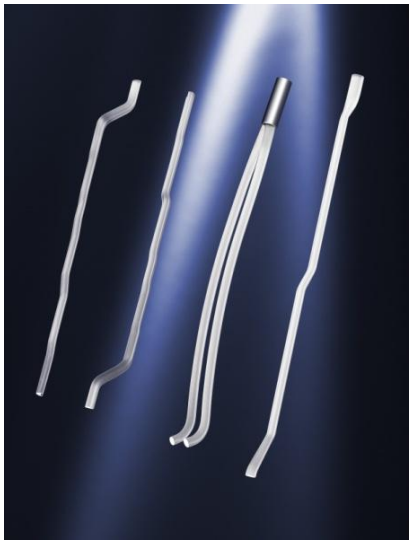
Angles

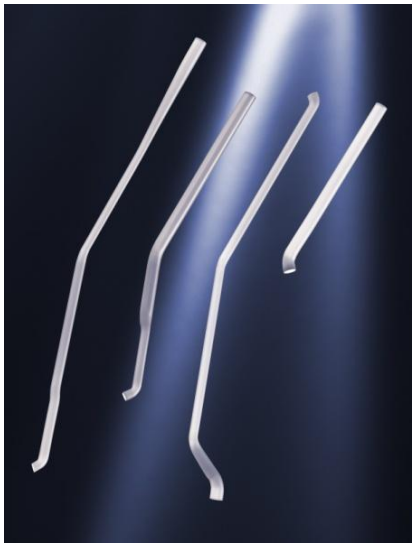
The shaping process allows the fiber rods to be bent in narrow bend radii. Standard values are
± 1°. Depending on the overall design smaller bend radii down to ± 0.5 mm are also possible.

Metal Ferrules

If required, metal ferrules can be attached to the final rod according to customer specifications.

Design examples





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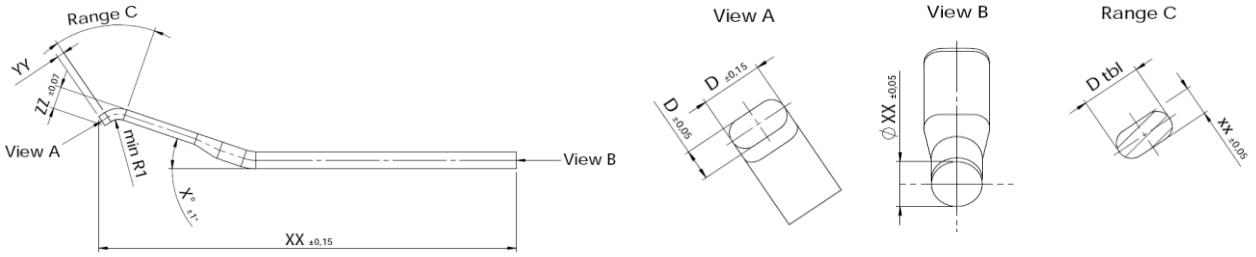
Design Guidelines for Shaped Fiber Rods		
Characteristics	**Recommendation**	**Comment**
Diameter of basic rod before shaping	1.0 …3.0 mm	Reference view “B“
Diameter tolerance of shaped rod in round section	Fire-polished: ± 0.05 mm Rounded: ± 0.03 mm	Reference view “B“
Diameter tolerance of shaped rod in bent sections	Width: approx. 0.2 mm larger than maximum nominal diameter Height ≥ ± 0.05 mm	Reference range “C“
Minimum bending radii	**Standard: ≥ 2.0mm** Optional: ≥ 1.0mm	Informal dimension only
Bending angle tolerance	**Standard: ≥ ± 1°** Optional: ≥ ± 0.5°	Informal dimension only
Installation height bend to light output tolerance	± 0.07 mm	Reference length “ZZ“ **Length ZZ is check dimension**
Straight length between bend and light output area	Length ≥ 1.0 mm	Reference length “YY“
Cross-sectional shape at light output	**Standard: round, half-round, oval/flat** Optional: kidney shape	See picture above for reference
Cross-section at light output	Should be perpendicular to the axis of the rod	Non-perpendicular cross-sections bear a high risk of chipped edges. In addition, the NA of the rod changes.
Tolerances at light output	Width ≥ ± 0.15 mm Height ≥ ± 0.05 mm	Reference view “A“
Overall length of shaped rod	30 mm … 150 mm	Reference length XX
Overall length tolerance	± 0.15 mm	Reference length XX



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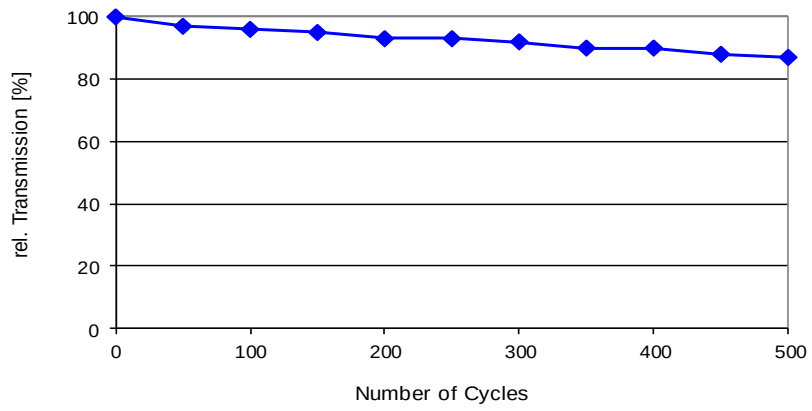
Chemical Resistance of Shaped Rods

MCR-3 rods feature excellent chemical resistance. Core and cladding glasses have high chemical resistance classes, which ensure long-term stability over their lifetime under repeated reprocessing cycles.

Resistance validated by optical measurement of relative transmission

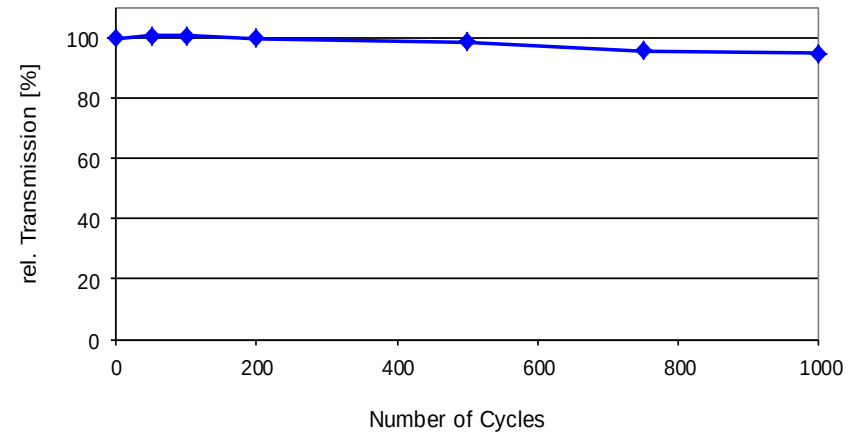
- Measured in accordance with DIN 58 141 Part 2
- Aperture of light beam: 0.1
- Measurement wavelength: λ = 535 nm
- Prior to optical measurement cleaning of end surface with cloth and ethanol
- Autoclaving tests performed with un-mounted glass rods

Thermal Disinfection Resistance MCR-3



Thermal Disinfection Resistance	
Test Conditions	
Unit	Miele Disinfector Automatic G7735
Cleaning program	Simulation Standard program Sesin 95°C-10
Detergent	Neodisher MA Dental, 30 ml dil. in 10 L Water
Regeneration	Neodisher Mielclear

Autoclave Durability MCR-3



Autoclave Durability	
Test Conditions	
Autoclave	Standard laboratory autoclave
Autoclaving program	134 °C, 10 min. sterilization time, 40 min. cycle time

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