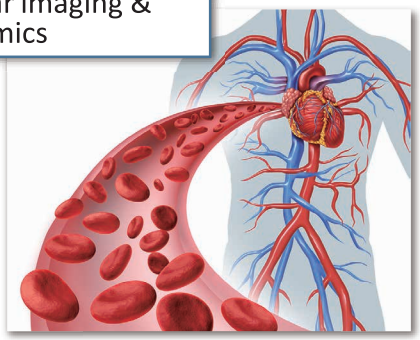

SILICAGRIN®
Gradient Index Micro Lens
Thinner, Wider, and Longer
Control your light
inside the human body
TOYO GLASS CO.,LTD.

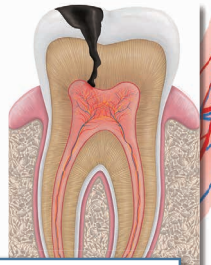
SILICAGRIN

A new standard for medical fibers.

For precise beam control, fiber catheter and probe tips are joined to SILICAGRIN.

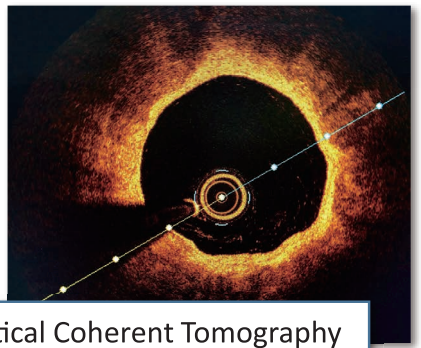
Cardiovascular imaging & dynamics



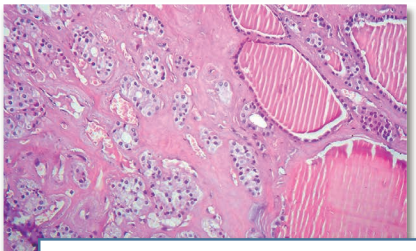


Optical diagnosis

for Diagnosis Field

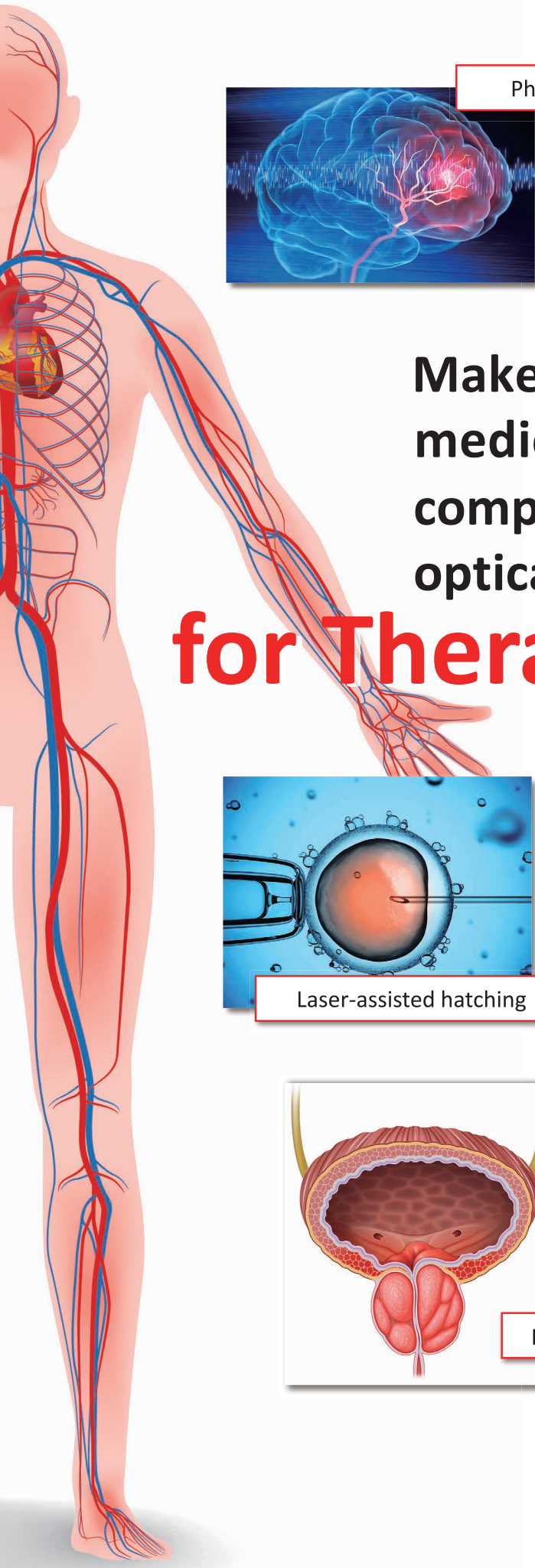


Optical Coherent Tomography



in vivo microscopy imaging

The applications listed in this catalog are only ideas from Toyo Glass Co., Ltd., and we cannot guarantee the effectiveness of an application for actual medical devices, diagnostics, or treatments.



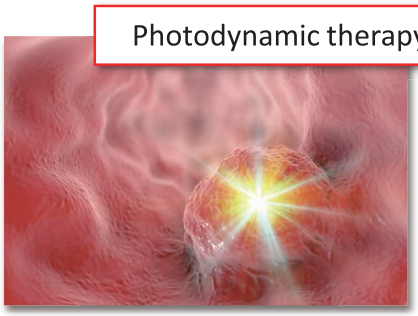
Photothermal therapy

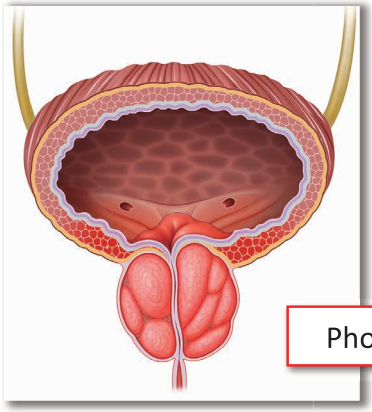
Make your genuine selective medical device development complete with our outstanding optical properties.

for Therapeutics Field

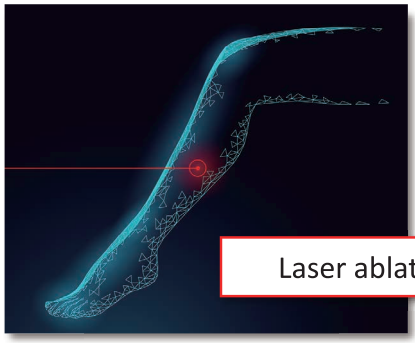
Laser-assisted hatching

Photodynamic therapy





Photoselective vaporization



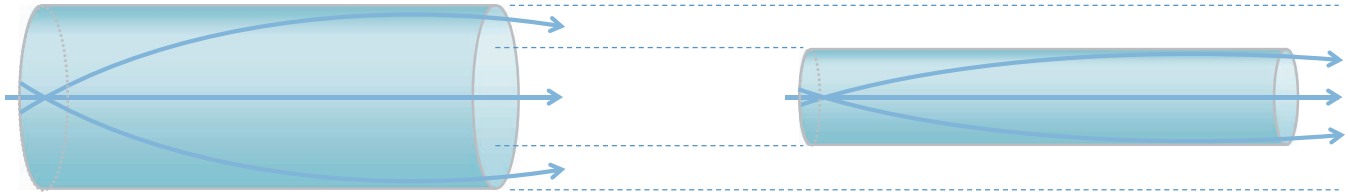
Laser ablation

SILICAGRIN

What is "SILICAGRIN"?

With SILICAGRIN, you no longer need complicated lenses at the end of your optical fiber. SILICAGRIN is an extremely minute silica rod lens (grin lens) with a diameter of 125µm. SILICAGRIN is fusion-spliced onto the tip of an optical fiber to control the diameter, focus, and spread of the light beam as desired by the application engineer.
Grin lens is a common optical device that already exists, but Toyo Glass's SILICAGRIN, made using a unique manufacturing method, achieves the following performance that was not possible with a conventional grin lens. Their performance is overwhelmingly effective for fiber probes and fiber catheters for biomedical applications.

Conventional GRIN Lens **SILICAGRIN**



Multi-component glass	**Material**	**Silica glass**
Ion exchange method	**Manufacturing method**	Proprietary method
Large effective lens diameter	**Lens diameter**	Compact (ϕ125-250 µm)
Generally High NA	**Numerical Aperture**	Can offer a low NA
Sensitive to moisture	**Chemical properties**	Excellent chemical durability
Adhesive connection	**Fiber connection**	Fusion-splice

Various Excellent Features of SILICAGRIN

- The refractive index profile is a clear squared distribution
- Excellent heat resistance (-270/+1000°C)
- Excellent power resistance (at 1060 nm, CW 20 W, 1000 hrs.)
- Radiation resistant
- Can be used at wavelengths from 370 to 1700 nm
- NA: 0.11 - 0.38

Biomedical!

The Many Disadvantages & Dangers of Conventional GRIN Lens

- Unsuitable for minute body organs such as blood vessels
- A large NA and difficult to get high resolution
- Difficult to use for medical applications due to sensitivity to moisture
- The adhesion method causes accidents...and more

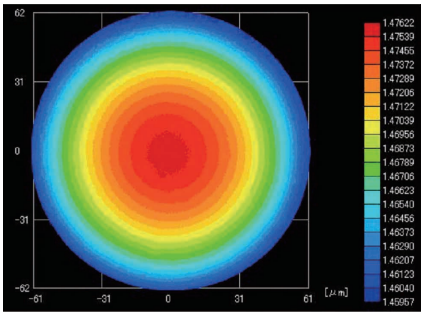
SILICAGRIN

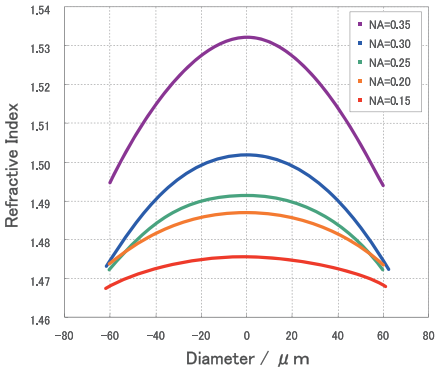
What only SILICAGRIN can do

Pure single mode beam

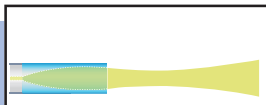
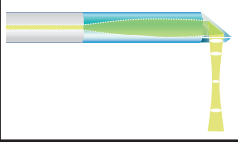
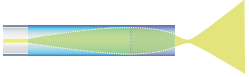
Silica-made single mode GRIN lens. This is the most important feature of SILICAGRIN, which is rare in the world. There are other 125µm quartz GRIN lenses on the market, but they are all made by adjusting the NA (Numerical Aperture) of Graded Index fiber (GI) for optical telecommunication and are using the same manufacturing method as telecomm fibers such as MCVD (Modified Chemical Vapor Deposition). The same manufacturing method results in a refractive index called "Central Dip", distortion of the output beam, and instability.

Please refer to the graph on the right. SILICAGRIN's profile is a perfect Gaussian distribution with no distortion. A laser beam propagated in a single mode for diagnosis and therapeutics is expanded, focalized, and collimated as it is in a pure single mode. That is SILICAGRIN's mission.





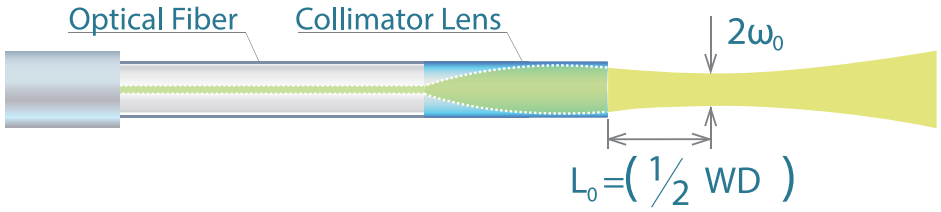
Now, let's open the door of SILICAGRIN!

Beam Shape		Product Name	Page
Thin and Long		SILLCAGRIN Collimator	p5
Thin, Long, and Lateral		SILICAGRIN LEC (Lateral Emitting Collimator)	p6
Short Focalized and Wider		SILICAGRIN Condenser	p7
Beam Expansion		SILICAGRIN BEX (Beam Expander)	p8

SILICAGRIN Collimator

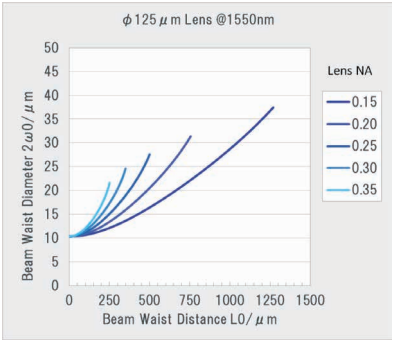
Beam Shape — Thin and Long

Fusion-Splice to an Optical Fiber with Alignment



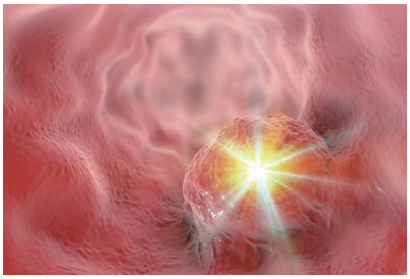
Features

- Beam diameter and beam waist distance can be selected with a wide variety of NA options (graph on the right).
- Suitable for visible to near-infrared wavelengths
- Custom design available
    - Fiber: SMF, PMF, MMF and MCF
    - Zirconia/metal ferrule processing, etc.
    - AR coating, fiber metallization processing



Beam waist diameter by beam waist distance setting value and NAs

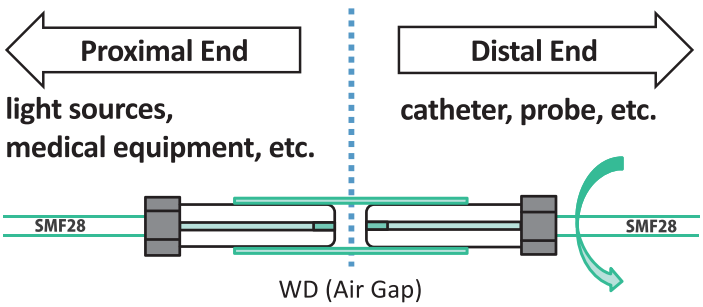
Applications



Fiber probes for selective ablation, vaporization, and other treatments.

Typical Beam Shape	
Beam-Waist Distance (mm)	Beam-Waist Diameter (μm)
1.5	50
1.0	36
0.5	20

Lens Diameter: 125 μm, Wavelength: 1550nm,
Optical Fiber: SMF (MFD: 10.4 μm)



Typical Coupling Performance	
Insertion Loss (Ave.)	≤ 0.5 dB
Return Loss (Ave.)	≥ 35 dB

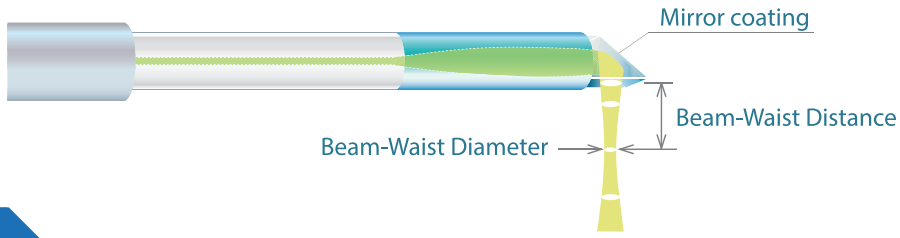
Average value of every 90 degree rotation (See left)
WD=1.0mm, Wavelength: 1550nm,
PC Polished with AR coating

For non-physical contact connection applications in DIRTY/CLEAN areas of medical optical fiber catheters

SILICAGRIN LEC (Lateral Emitting Collimator)

Beam Shape Thin, Long, and Lateral

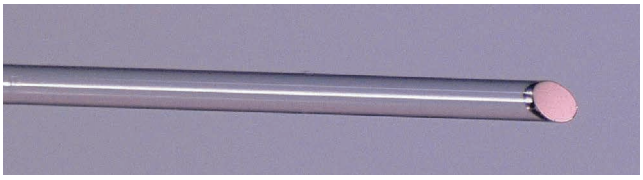
Fusion-Splice to an Optical Fiber and Angled Tip with Alignment



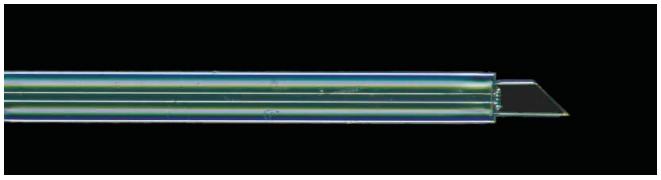
Features

- A light beam with a calculated beam diameter and beam waist distance is emitted from the side of the lens. Incidence and collection of light from the side is also possible.
- In comparison with other side-emitting technologies such as ball lenses, it is significantly smaller and can be mass-produced.
- Suitable for visible to near-infrared wavelengths
- Custom design available
    - Fiber: SMF and MMF
    - Metal coating on reflective surface, AR coating on output surface

Two types of LECs



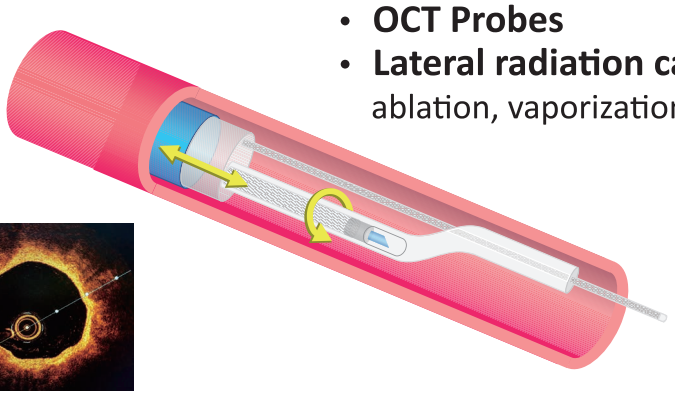
Direct Polishing LEC
Thin, compact and simple

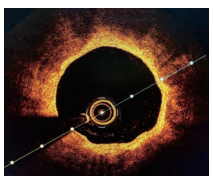


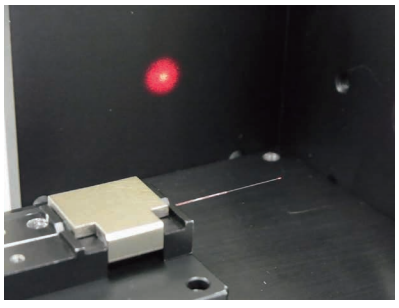
Prism Fused LEC
Accurate circular beams are possible

Applications

- **OCT Probes**
- **Lateral radiation catheters** in ablation, vaporization treatments





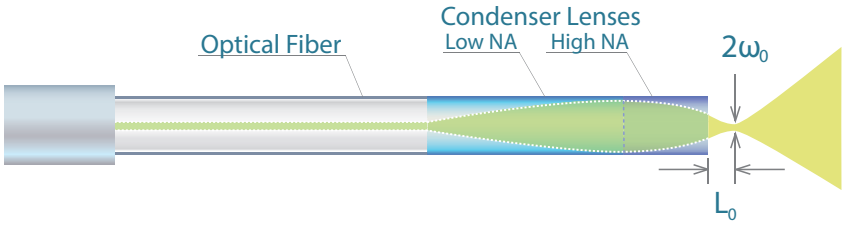


Emission experiment
using Prism Fused LEC

SILICAGRIN Condenser

Beam Shape Short Focalized and Wider

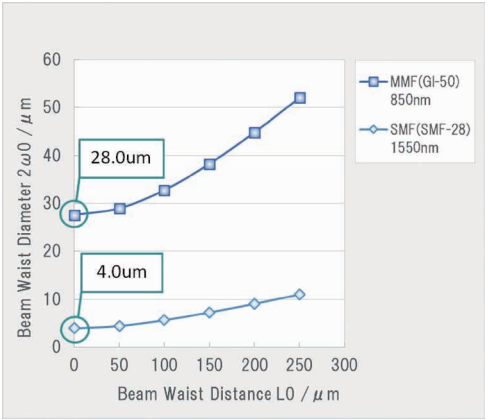
Two Lenses Fusion-Splice to an Optical Fiber with Alignment



Features

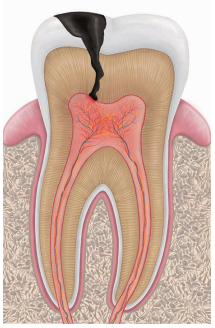
- A serial connection of Low NA and High NA lenses emits a beam with a small focus and a large divergence.
- The reduced focus also makes it suitable for coupling and observations of micro-optical systems.
- Minimum spot size 4.0µm (@1550nm).
- Custom design available
  - Fiber: SMF, PMF, MMF
  - Zirconia/metal ferrule processing, etc.
  - AR coating, fiber metallization processing

Typical Optical Characteristics (SMF)	
Insertion Loss at fused point	≤ 0.1 dB
Beam Waist Size ($2\omega_0$)	4.0 µm
Beam Waist Distance (L_0)	0 - 50 µm

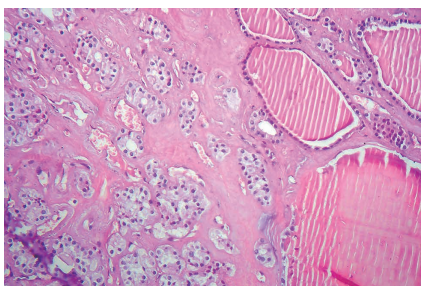


Beam waist diameter
by beam waist distance setting value

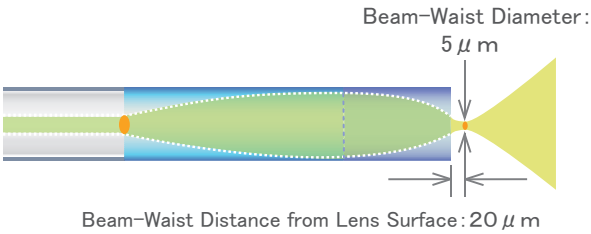
Applications



Optical diagnosis



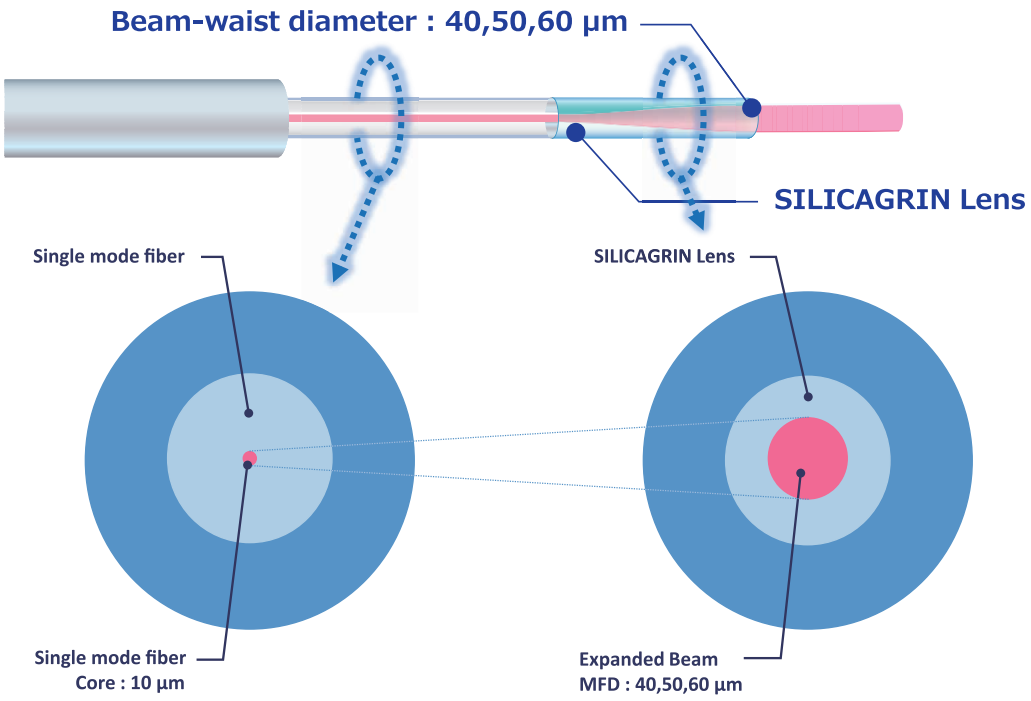
***in vivo* microscopy imaging**



An example of beam shape
with SMF and Condenser
(@1550nm)

SILICAGRIN BEX (Beam Expander)

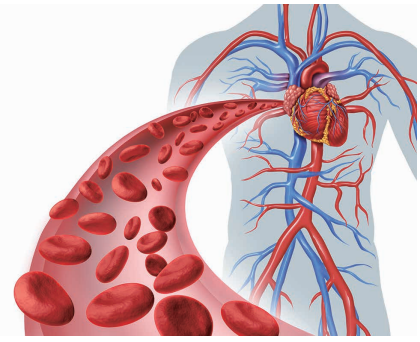
Beam Shape — Beam Expansion



Features

- Expands the beam of a single mode fiber from 40 to 60μm without changing the profile.
- Eliminates excessive energy density of high power laser output and coupling.
- Reduces connection loss when connecting in contaminated areas.

Applications



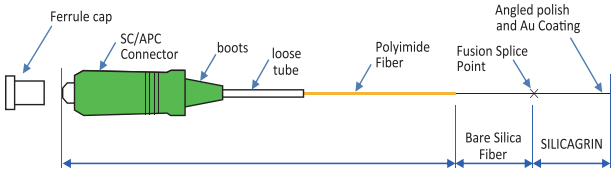
Cardiovascular dynamics

Typical Optical Characteristics	
Maximum Optical Power	6 W
Expanded Beam Diameter	40, 50, 60 μm

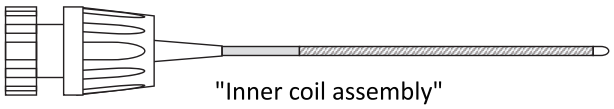
SILICAGRIN

Fiber Catheters & Probes

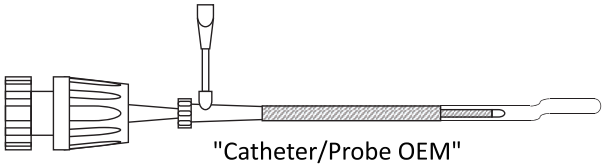
ODMs & OEMs with SILICAGRIN



"Optical fiber pigtail"



"Inner coil assembly"



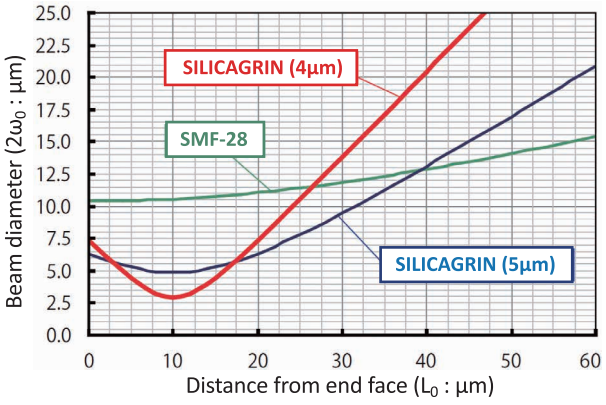
"Catheter/Probe OEM"

There are three shipping configurations for SILICAGRIN, **"Optical fiber pigtail"**, **"Inner coil assembly"**, and **"Catheter/Probe OEM"**. Inner coils and catheters require optical and mechanical designs that are compatible with the customer's equipment, and Toyo Glass, as professionals in optical fiber devices, undertakes these tasks as well. Toyo Glass's Fiber Catheters & Proves ODM service. Of course, it is also possible to manufacture and sell on an OEM basis according to customer drawings and specifications. We also accept inquiries regarding compliance with FDA, MDR, NMPA, etc.

Technical Note

Why? SILICAGRIN

Selective treatment has become a global trend and theme in the medical world. Prioritize the patient's QOL and provide accurate treatment to the appropriate area. In the field of laser therapy using optical fibers, this is achieved through precise and minute control of the laser beam.



The graph above shows the beam spread of a simply cut SMF-28 fiber and SILICAGRIN condensers with 2ω0=4μm and 5μm (wavelength: 1550nm). A simply cut SMF-28 fiber spreads out from the MFD diameter of the cut surface and has no focal point. On the other hand, SILICAGRIN Condensers have extremely small focal points around 10μm from the end face. This focus enables selective treatment.

In the fields of diagnosis and observation, this minute focus will also have implications for in vivo microscopy. Use SILICAGRIN to create cutting-edge medical fiber devices that were not possible with conventional single-mode fibers.

SILICAGRIN FAQ

Q1: Can SILICAGRIN be customized?

A1: Yes. We can do everything meets your needs, such as those elating to NA, pitch, tip processing (angled polishing), coating, etc.

Q2: Is SILICAGRIN already used in medical fiber catheters?

A2: Yes. SILICAGRIN is already used in certified OCT fiber probes and has proven track record of many successful deliveries and clinical use.

Q3: What shapes do you sell SILICAGRIN in?

A3: SILICAGRIN is sold as a pigtail with a connector on one end, with an inner coil or catheter. While the pigtail is also manufactured by us, we also fuse it to products supplied by our customers.

Q4: Do you sell SILICAGRIN fiber lenses on their own?

A4: We do not sell SILICAGRIN fiber lenses on their own. SILICAGRIN is sold in an SMF-fused state only.

Q5: Do you offer prototypes and mass production?

A5: Yes. We offer everything from small-lot prototypes for evaluation experiments to the mass production of 60,000 pieces per year.

Company name : Toyo Glass Co., Ltd.
Established : Apr. 1888 / Nov. 1942
Capital : JP Yen 960 million
Head Office : 2-18-1 Higashi-Gotanda, Shinagawa-ku, Tokyo 141-0022, Japan
Number of employees : 802 (Number of employees of the entire Toyo Seikan Group: 19,758)

Company History :

1888: Production of glass tableware begins at the Shimada Glass Factory in Osaka
1917: Toyo Seikan Co., Ltd. was established. Established the head office and Osaka factory in Osaka City
1953: Became part of Toyo Seikan Group, a comprehensive container manufacturer
2003: Started development of SILICAGRIN at Toyo Glass
2005: Exhibited SILICAGRIN for the first time at an exhibition event in Japan (InterOpto 2005)
2009: Exhibited SILICAGRIN for the first time at an exhibition event overseas (ECOC 2009, Vienna, Austria)
2013: Changed to holding company system Changed trade name to Toyo Seikan Group Holdings, Ltd.
2019: Started mass production of medical use SILICAGRIN (60 k annual production possible)
2023: SILICAGRIN business returns to Toyo Glass

TOYO SEIKAN GROUP

Specifications

Product Name	SILLCAGRIN Collimator	SILICAGRIN LEC	SILICAGRIN Condenser	SILICAGRIN BEX	Unit
Beam Shape	Thin and Long	Thin, Long, and Lateral	Short Focalized and Wider	Beam Expansion	
Outer Diameter	125	125	125	125	μm
Beam waist distance (L_0)*	0.2 - 2.0	0.2 - 2.0**	< 0.25	-	mm
Beam waist diameter ($2_{\omega 0}$)*	20 - 40	20 - 40**	≥ 4	-	μm
Beam diameter	-	-	-	40 - 60	μm
Wavelength	370 - 1700				nm

*Measurement with SMF at 1550nm
**Before angled polishing

The information reflected in this datasheet is subject to change and the product described herein may be modified or discontinued without notice.
The applications listed in this catalog are only ideas from Toyo Glass Co., Ltd., and we cannot guarantee the effectiveness of an application for actual medical devices, diagnostics, or treatments.

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