GRINTECH

Gradient Index Optics

GRIN Assemblies for Imaging

www.grintech.de

Precision for every application

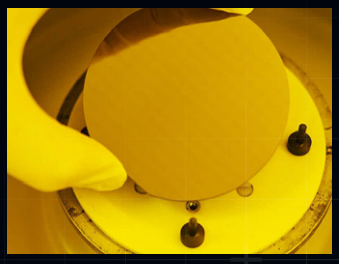
Endoscopic assemblies often consist of biocompatible GRIN objective lenses and other micro-optical components such as GRIN relay lenses, image-guiding fiber bundles, prisms and beam splitters.

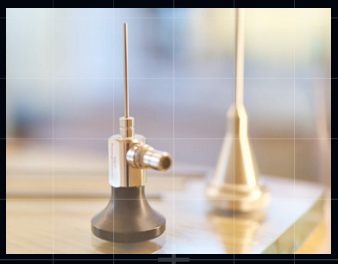
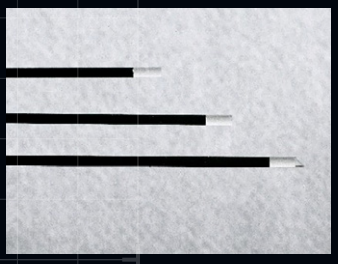
- GRIN objective lenses are made of non-toxic glass material (biocompatibility according to EN ISO 10993-1). With standard diameters between 0.25 and 2.0 mm, they have plane optical end faces. GRIN objective lenses with viewing angles of +/- 30° are mainly used for endoscopic applications
- In endoscopic assemblies, GRIN objective lenses produce a reduced intermediate image in the size of the lens diameter, which is transmitted over longer distances with relay lenses. Optical design files (ZEMAX) are available on request.
- We offer customer-specific assemblies made of GRIN lenses with image-guiding fiber bundles

Customizable at the customer's request

On request, the following are possible:

- Working distance and lens length changes
- Design wavelength change
- Photolithographically generated apertures on GRIN end faces

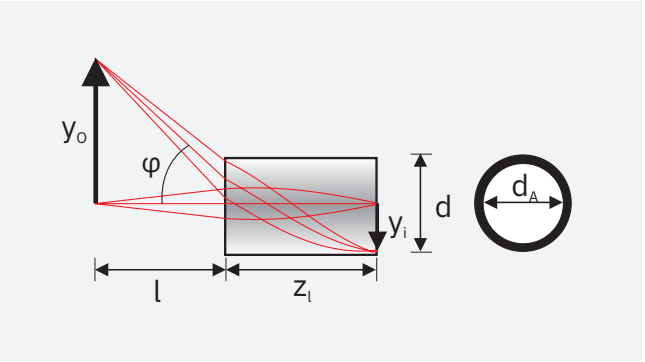


GRIN Objective Lenses for Endoscopy

Gradient index lenses for endoscopic imaging optics

- Non-toxic silver-based glass material
- View angle φ +/- 30° (numerical aperture 0.5)
- Plane surfaces, low chromatic aberration
- Combination with prisms and beam splitter cubes on request
- Aperture and field stops (black chromium coating ring on lens surface generated by photolithography) are available on request
- Certification: Biological safety – toxicology (EN ISO 10993-1)
- Design wavelength: 570 nm



Diameter d (mm)	**Working distance** s (mm)	**Lens length** z_l (mm)	**Parax. Magnification** $M = y_o/y_i$	**Refractive index at the center of the profile** n_0	**Product code**
2.0	Infinity	4.86	–	1.635	GT-IFRL-200-inf-50-NC
	20	5.14	-10.56	1.635	GT-IFRL-200-020-50-NC
	10	5.42	-5.35	1.635	GT-IFRL-200-010-50-NC
	5	5.94	-2.81	1.635	GT-IFRL-200-005-50-NC
1.8	Infinity	4.29	–	1.635	GT-IFRL-180-inf-50-NC
	20	4.51	-11.94	1.635	GT-IFRL-180-020-50-NC
	10	4.72	-6.04	1.635	GT-IFRL-180-010-50-NC
	5	5.14	-3.14	1.635	GT-IFRL-180-005-50-NC
1.0	Infinity	2.23	–	1.635	GT-IFRL-100-inf-50-NC
	20	2.29	-22.85	1.635	GT-IFRL-100-020-50-NC
	10	2.35	-11.46	1.635	GT-IFRL-100-010-50-NC
	5	2.47	-5.80	1.635	GT-IFRL-100-005-50-NC
0.85	Infinity	1.89	–	1.635	GT-IFRL-085-inf-50-NC
	10	1.96	-13.61	1.635	GT-IFRL-085-010-50-NC
	5	2.05	-6.86	1.635	GT-IFRL-085-005-50-NC
0.6	Infinity	1.31	–	1.635	GT-IFRL-060-inf-50-NC
	10	1.35	-19.47	1.635	GT-IFRL-060-010-50-NC
	5	1.39	-9.77	1.635	GT-IFRL-060-005-50-NC
0.5	Infinity	1.09	–	1.635	GT-IFRL-050-inf-50-NC
	10	1.12	-23.47	1.635	GT-IFRL-050-010-50-NC
	5	1.14	-11.77	1.635	GT-IFRL-050-005-50-NC
0.35	5	0.80	-16.67	1.635	GT-IFRL-035-005-50-NC
0.25	5	0.56	-23.16	1.635	GT-IFRL-025-005-50-NC

General Information & Customization

- Working distance and lens length deviating from these standards are available on request
- ZEMAX files can be downloaded from our website
- As standard, GRIN rod lenses are provided without antireflection (AR) coatings. However, AR coatings can be offered as described at the end of this brochure. Please find here also further important information on tolerances, handling, and cleaning.

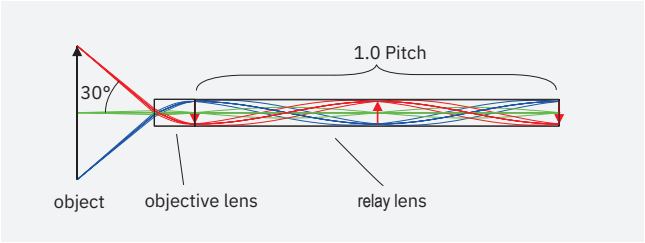
GRIN Endoscopic Rod Lens Systems

GRIN endoscopic systems consist of a GRIN objective lens, a GRIN relay lens and a GRIN eyepiece. Combining the system with a prism enables the change of the direction of view. Standard diameters are 0.35, 0.5, 1.0 und 2.0 mm. We offer the systems in two different principle design options.

Design A

The objective lens creates a reduced intermediate image at the exit surface of the objective lens, which will be imaged by the relay lens 1:1 (if the lens length of the relay lens is a multiple of the period) or -1:1 (if the lens length of the relay lens is an odd multiple of the half period) to the exit surface of the relay lens.

- possible standard working distances: for 0.35 mm diameter: 5 mm, for 0.5 to 2.0 mm diameter: 5 mm, 10 mm and infinity. Other working distances on request.



Schematic view design A

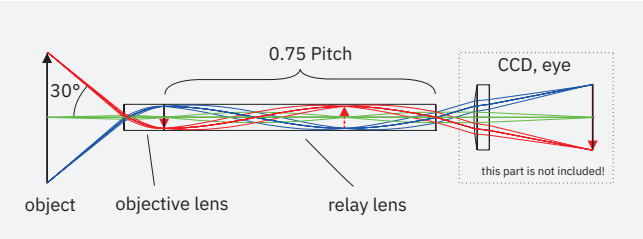
Possible Pitch Lengths:

Diameter d (mm)	Relay pitch	System length (mm)	Image orientation
0.35	0.5	approx. 8.2	inverted to design A
	1.0	approx. 15.7	like design A
	1.5	approx. 23.1	inverted to design A
0.50	0.5	approx. 16.3	inverted to design A
	1.0	approx. 31.4	like design A
	1.5	approx. 46.5	inverted to design A
1.00	0.5	approx. 24.7	inverted to design A
	1.0	approx. 47.0	like design A
	1.5	approx. 69.4	inverted to design A
2.00	0.5	approx. 55.5	inverted to design A
	1.0	approx. 105.8	like design A
	1.5	approx. 156.0	inverted to design A

Design B

The objective lens creates a reduced intermediate image at the exit surface of the objective lens, which will be imaged by the relay lens at infinity. Such a lens system is a complete endoscopic imaging system. It allows the direct observation with the human eye or the use of a conventional camera system (including camera lens): camera and camera lens are not provided by GRINTECH.

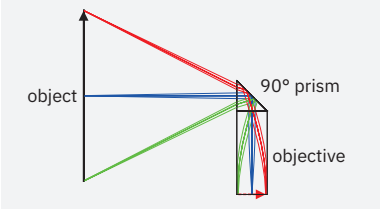
- possible standard working distances: for 0.35 mm diameter: 5 mm, for 0.5 to 2.0 mm diameter: 5 mm, 10 mm and infinity. Other working distances on request.



Schematic view design B

Possible Pitch Lengths:

Diameter d (mm)	Relay pitch	System length (mm)	Image orientation
0.35	0.75	approx. 12.0	like design B
	1.25	approx. 19.4	inverted to design B
	1.75	approx. 26.9	like design B
0.50	0.75	approx. 23.8	like design B
	1.25	approx. 38.9	inverted to design B
	1.75	approx. 54.0	like design B
1.00	0.75	approx. 35.9	like design B
	1.25	approx. 58.2	inverted to design B
	1.75	approx. 80.6	like design B
2.00	0.75	approx. 80.7	like design B
	1.25	approx. 130.9	inverted to design B



90° Change of view

Both versions are available with a 90° change of view by attaching a prism to the objective.

Customization – GRIN Biophotonic Probes – Imaging Probes

In addition to our standard products, GRINTECH offers imaging fiber bundle assemblies with imaging micro-optics according to customer specifications. Please ask us and let us know your requirements as detailed as possible (the closer we know your specifications the better we can advise you).

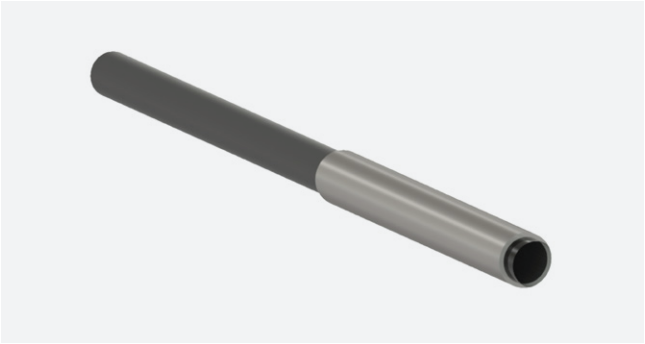
Applications

- Imaging Probes
- Confocal endoscopy
- Microscopic endoscopy
- Endoscopy
- Multimodal endomicroscopy

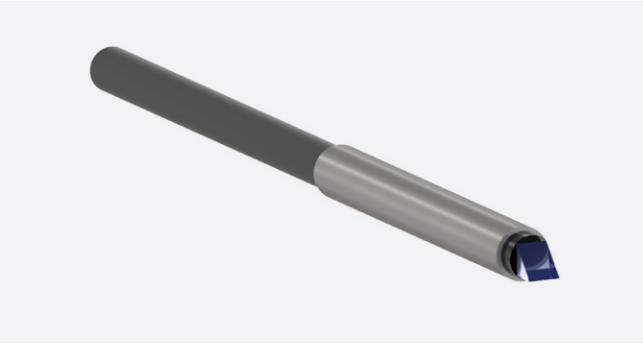
For the optical and mechanical design and the quotation we need at least the following information:

- Fiber bundle type (Fujikura): FIGH-10-350S, FIGH-10-500N, FIGH-30-850N, other
- Fiber bundle length
- Connector: none or FC/PC
- Working distance
- Diameter of the optical components: 0.5 or 1.0 mm
- Further information or specification: For example: prism for side firing, or other.
- Quantity

Typical Configurations:



GRIN-lens assembly in stainless steel tube with imaging fiber bundle



GRIN-lens prism assembly in stainless steel tube with imaging fiber bundle

Development of Customized GRIN Systems

In addition to our standard products and customized systems, GRINTECH offers more sophisticated solutions as customized developments.

Please ask us and let us know your requirements as detailed as possible. The closer we know your specifications the better we can advise you.

The following examples show some customer inspired systems and may illustrate the possibilities.

Our development services include:

- Zemax design studies
- Adaption of the refractive index profile: NA, higher order correction
- Coatings: special AR coatings, beam splitting coatings, reflectivity coatings, etc.
- Stops: aperture and field stops
- Chromatic corrections

Example Configurations:

GRIN lens assemblies with beam splitter cubes, GRIN diameters: 1.0, 1.8 and 2.0 mm in these examples.

Coating Options

GRIN rod lenses are produced without antireflection coatings as standard. Antireflection coatings (for incidence angles of 0° – 30° corresponding to measurements on a reference substrate) can be offered for several GRIN lens geometries, except on GRIN relay lenses

Coating Code:

NC: no coating (reflection loss approx. 12%) – standard

C1: λ = 400 ... 700 nm, R < 1.0%

C2: λ = 800 ... 1000 nm, R < 0.5%

C5: λ = 1310 ... 1550 nm, R < 0.5%

One-sided coatings are available on request. Variations due to modifications of the production process are possible. It is the user's responsibility to determine suitability for the user's purpose.

Please note our partnership with Inscopix as our exclusive distributor for the field of neuroscience applications in non-humans. If you wish to order GRIN lenses of this brochure for these applications, please visit www.inscopix.com or contact order.inscopix@bruker.com.

Tolerances and Handling Instructions

For our singlet lenses we have the following fabrication tolerances and quality criteria:

Tolerances

- Lens length z_i: ± 5% due to variations of the gradient constant
- Working distance s: ± 0.02 mm (only LFRL- and CFRL lens series)
- Diameter d: +0 / -0.01 mm
- Tighter diameter tolerances on request

Surface quality

- 5 / 3 × 0.025; L 3 × 0.005; E 0 (defined by DIN ISO 10110-7:2000-02).
- The surface quality is defined within 90% of the lens diameter. Outside of this area defects are allowed.

Storage

GRIN lenses and lens systems should be stored in a dry environment. For short term storage, the plastic box or foam packing in which the lenses are shipped will provide adequate storage. Recommended storage temperature: -20 °C – 80 °C.

Storage boxes should ensure that the lenses do not touch each other to prevent chipping and scratches. Best is to use the original box.

Handling

Lenses should be carefully handled with plastic tweezers, preferably those with a tapered end. Lenses should be picked up out of their individual compartments by firmly holding each on its side cylinder surface (not the polished ends). Especially small sized lenses may stick to the lens box material and can be lost during removal.

Cleaning

If it is necessary to clean the lens surfaces due some dust or other contaminant which may impair the optical performance. GRINTECH generally recommends the use of ethyl alcohol as a cleaning solvent, maybe combined with some smooth lintfree lens cleaning tissue.

Acetone may also be used, but it should be pure enough, otherwise it might leave some residue on the lens surface.

GRINTECH

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