FISBA's Fast Axis Collimators Improve Diode Laser System Performance

Diode lasers are efficient, compact, and robust laser sources. Their size, weight, and power usage advantages are driving innovation, and that innovation in turn enables new applications. But the output beams from diode lasers are divergent, and the divergence itself is asymmetric. For diode lasers to reach their full potential, the output beams must be shaped to optimize their optical quality.

Over the past decade, the industry standard solution for creating high-quality diode output beams has become the Fast Axis Collimator (FAC). FACs fabricated of high refractive index glass with acylindrical surface profiles have high numerical apertures and create beams with low residual divergence. FISBA's wide portfolio of FACs with different focal lengths is designed to provide superior performance for both single emitters and diode laser bars.

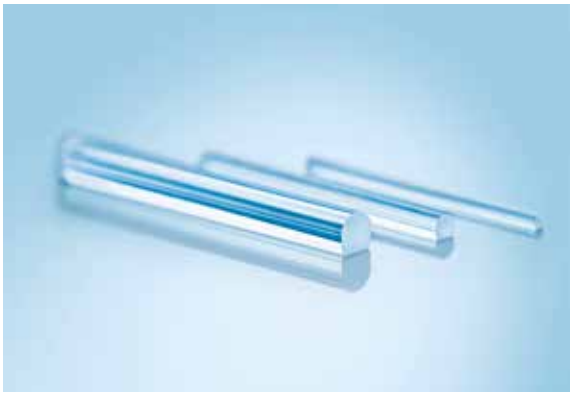

Fig. 1. FISBA Fast Axis Collimator Lenses

Although FACs have become the industry standard for optimizing diode laser beam quality, FISBA continues to innovate. For example, a range of FACs are now available for wavelengths shorter than the near-infrared. In addition, advances in packaging make it easy to support automated high-volume assembly.

The Right FAC for the Diode—and the Application

Laser diodes are extremely reliable and very efficient, which makes them ideal sources for many biomedical and materials processing applications. Laser diodes become the optical source of choice for even more applications when many of them are combined, opening up new possibilities, such as keyhole welding, optoacoustic imaging, and high-power fiber laser pumping. Combining multiple beams levies even higher requirements on the beam quality from each individual laser diode source — whether single sources or diode laser bars.

FISBA's wide portfolio of FACs with different focal lengths is introduced in *Figure 2*.
The standard formats and focal lengths are available in different physical lengths. FISBA's design and production engineers can deliver customized lengths in a short period of time. Customized coatings are also possible. Even needs for customized focal lengths can be met with reasonable NRE costs and turnaround

times. FISBA production processes also ensure that even a new FAC type can be scaled up to large volume production in a relatively short time.

Parameters	Wavelength range nm	Numerical aperture –	Focal length EFL @ 940 nm µm	Back focal length BFL @ 940 nm µm	Dimension (height × thickness) mm
FAC 150	790 – 990	0.8	150	30	0.23 × 0.20
FAC 200	790 – 990 750 – 850	0.8	200	55	0.33 × 0.27
FAC 300	660 – 700 790 – 990 750 – 850	0.8	300	70	0.50 × 0.43
FAC 360	790 – 990	0.8	360	70	0.60 × 0.53
FAC 360	1450 – 1550	0.8	360	70	0.60 × 0.53
FAC 450	790 – 990	0.8	450	100	0.75 × 0.64
FAC 510	790 – 990 780 – 940	0.8	510	130	0.91 × 0.70
FAC 510	800 – 1100	0.8	510	130	0.91 × 0.70
FAC 600	790 – 990	0.8	600	140	1.00 × 0.82
FAC 600	790 – 990	0.5	600	150	0.80 × 0.82
FAC 600	430 – 470	0.8	600	140	1.00 × 0.83
FAC 740	790 – 990	0.8	740	70	1.20 × 1.22
FAC 900	790 – 990	0.8	900	90	1.60 × 1.49
FAC 900	790 – 990	0.8	900	178	1.50 × 1.34
FAC 1100	790 – 990	0.7	1100	110	1.50 × 1.77
FAC 1100	790 – 990	0.45	1100	152	1.10 × 1.72
FAC 1300	790 – 990	0.7	1300	130	1.80 × 2.12
FAC 1500	790 – 990	0.5	1500	90	1.65 × 2.58
FAC 1500	790 – 990	0.7	1500	90	2.00 × 2.57
FAC 1700	430 – 470	0.6	1700	1200	2.20 × 1.05
All FAC	Transmission: ≥ 98 %, Length: Variable to match your requirements				

Fig. 2. Table of FISBA FACs

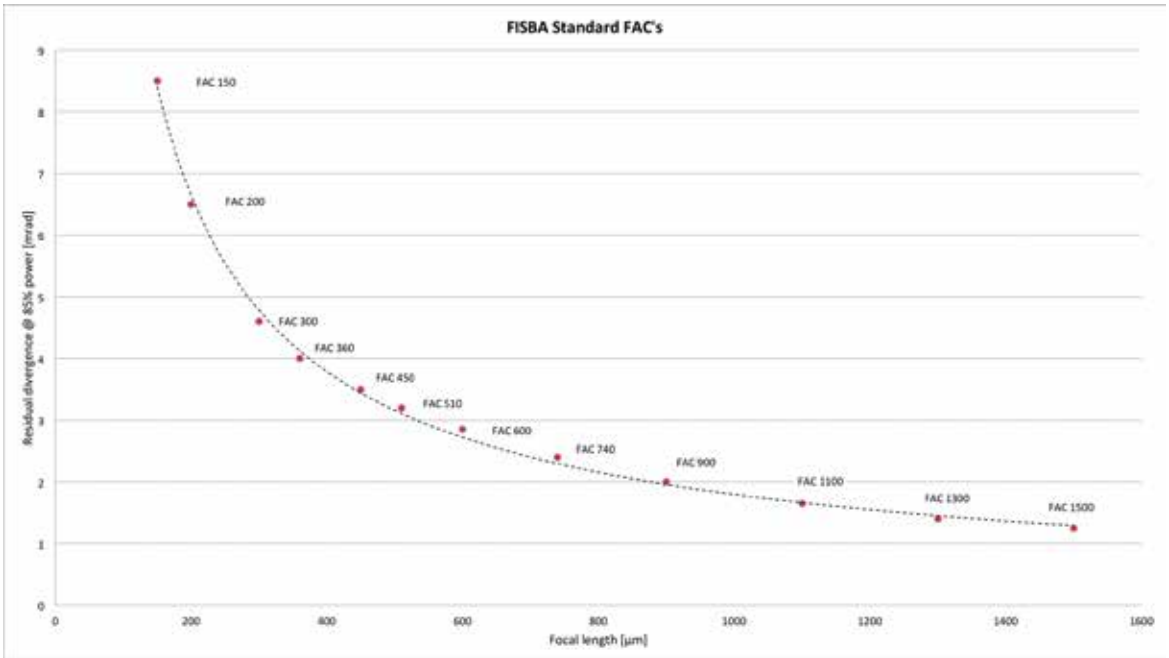

Fig. 3. Residual divergence of the FISBA standard FACs

As shown in *Figure 3*, FISBA FACs can control beam divergence across the full range of focal lengths. In addition, there has been increasing demand for FACs at shorter wavelengths. In recent years, customers have been requesting modifications for applications using blue diode lasers.

For example, FISBA developed a FAC lens for the collimation of a diode laser bar with a wavelength of 450 nm. This wavelength range is important for medical applications and in materials processing. By using a specially optimized glass FISBA engineers minimized absorption within the lens and consequently reduced lens heating. That makes this FAC lens particularly suitable for very high laser output. The lens is fabricated with an acylindrical shape, guaranteeing the usual excellent performance. Owing to FISBA's particularly flexible manufacturing process, this new blue-wavelength FAC was very quickly developed and fabricated to meet evolving market demands (See *Figure 4*).

In addition to the unique requirements driven by wavelength, customers using blue diodes in TO-cans have another requirement: they don't want to open the diode packages and lose the lifetime component warranty. FISBA's solution was to develop FACs with unusually long back focal lengths, allowing the lens to be assembled in front of the TO-can and still maintain acceptable optical performance.

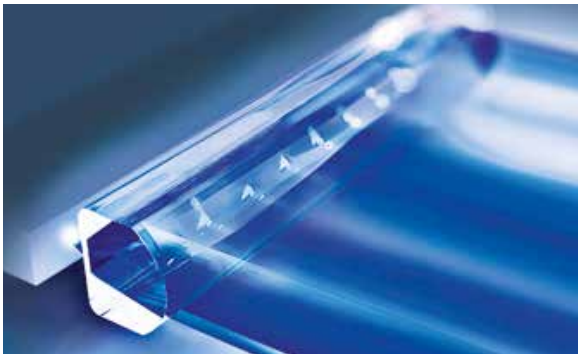

Fig. 4. FAC600 for diode laser with wavelengths from 430 to 470 nm

Ready-to-use Packaging

The materials processing market is growing rapidly, taking advantage of the superior qualities of fiber lasers, and their dropping costs. That's driving a big increase in demand, as large numbers of laser systems are produced with automated or semi-automated processes, driving an equivalent shift in an aspect of lens production that might not be immediately obvious: packaging for delivery.

In the early days of laser diode systems, packaging played a minor role. At that time the micro-optics were expensive, so as long as the optical components were not damaged during transport, the packaging was sufficient. Today packaging is acknowledged as a significant factor in optimizing the supply chain and minimizing both fabrication cost and production time.

FISBA invested in automated packaging of FACs into Gelpacks, which keeps down the handling costs. It also opens up the possibility of very dense packaging, which reduces material costs. These packaging improvements also enable automated assembly processes on the customer side. The accuracy of the gel-pack packaging process is the only way to position the lenses precisely enough to support automated assembly.

A FAC Never Stands Alone

As mentioned earlier, the output beams from laser diodes are asymmetric, with one axis diverging several times faster than the other. FACs collimate the beam in that fast axis, but to fully collimate the diode output beam FACs should be combined with other micro-optical components. FISBA also produces acylindrical Slow Axis Collimators (SACs) for single emitters, SAC arrays for multi-emitters, and twister arrays. Twister arrays are available as a preassembled component, containing a Tab with a FAC and the twister array, well known as the FISBA BeamTwister™.

In addition to these standard products designed to help customers get optimum performance out of their laser diodes, FISBA is prepared to assist in meeting novel system requirements as well. FISBA's depth of knowledge and history of innovation in optical design make us the right company to develop a micro-optic design for very specific requirements. FISBA engineers can identify the right standard components and, if required, design customized components, helping customers get the best out of their diode laser systems.

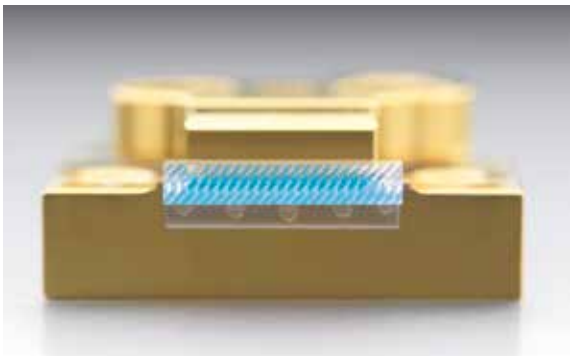

Fig. 5. FISBA Beam Twister™ in front of a diode laser bar with several emitters on one chip (CS mount)

Fig. 6. Diode laser with one individual emitter (C mount)