

# Datasheet 3D-Printed Freeform-Optics

## 1. Compatible components

1. Laser (DFB and other)
2. PIC: SOI, SiN, InP, LiNb and more
3. SMF, PMF and MMF fiber arrays
4. PIN and APD diodes

## 2. Standard 3D-printed optics:

1. Focal length up 0.5 cm and mode-field diameters<sup>1,2</sup> of 1.2...80  $\mu\text{m}$ ,
2. With mode-field converter
3. Total-internal-reflection mirrors
4. Angled facets

## 3. Coupling<sup>3</sup>, depending on laser and chip

1. Laser and PIC interface: 0.7 to 2.5 dB
2. Back-reflection: below -30 dB

## 4. Alignment tolerances<sup>4</sup>:

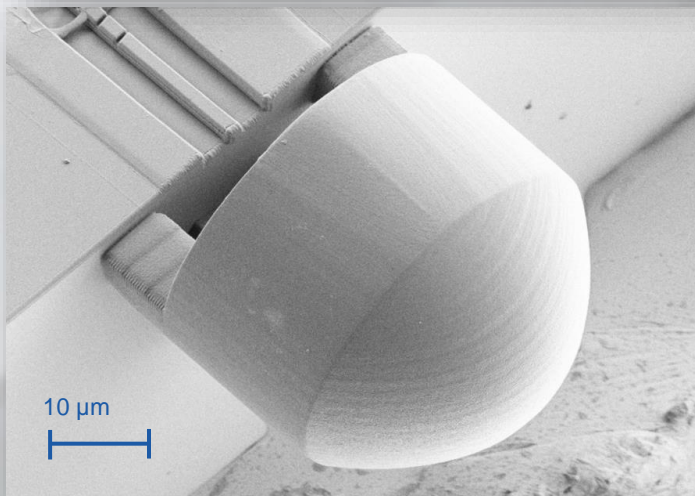
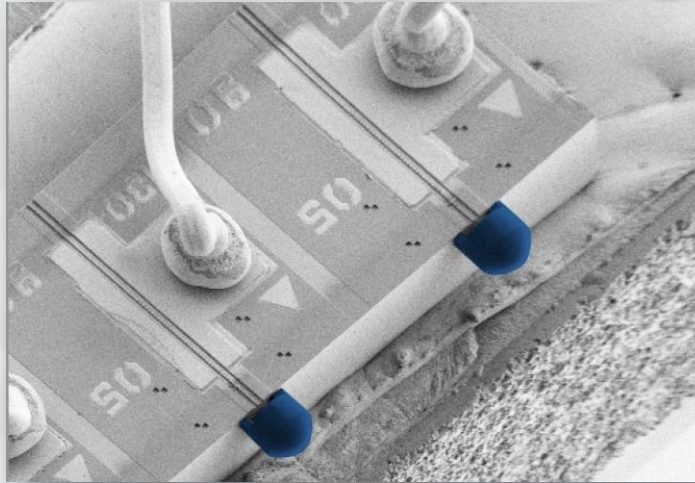
- $\pm 1.5 \mu\text{m}$  (single lens on one component) to  
 $\pm 20 \mu\text{m}$  (beam expander)

## 5. Operation range

530 nm to 1650 nm

## 6. Fabrication time

<60s, depending on model<sup>6</sup>



## 7. Reproducibility

1. Below  $\sigma = 0.2 \mu\text{m}$  MFD variation
2. Below 10% mode-field and focus length variation/deviation

## 8. Accuracy

1. Below  $3\sigma = 50 \text{ nm}$  detection accuracy
2. Below  $\pm 100 \text{ nm}$  shape accuracy<sup>5</sup>
3. Less than 10 nm RMS-roughness<sup>5</sup>

## 9. Environmental testing

1. > 4000 h 85°C/85% rel. hum
2. > 250 cycles -40°C to 85°C
3. Reflow soldering, 3 cycles, 270°C
4. AuSn 310°C
5. Acceleration 500 g and more
6. Vibration, 20g, all axis

## 10. High power operation

- >1 W @ 1550 nm  
4000h@100mW on DFB facet

## 11. Cryogenic operation

- > 10 cycles 4K to room temperature

<sup>1</sup> Measured at  $1/e^2$  intensity

<sup>2</sup>  $\text{MFD}_{\text{min}} = 2\lambda$

<sup>3</sup> Typical, reproducible values

<sup>4</sup> Measured at 1 dB coupling penalty

<sup>5</sup> Measured with white-light interferometer

<sup>6</sup> Lens printed on DFB laser to create 10  $\mu\text{m}$  MFD