

Lensed single-mode fiber arrays

What are lensed fiber arrays?

Efficient coupling light from photonic integrated chips (PICs) e.g. based on SiN, Si or InP technology requires a single-mode fiber (SMF) with a mode-field diameters (MFD) matched to the PIC. However typical SMFs have MFDs of around 10 μm while most PICs require MFDs in the range of few micrometers or below. To achieve mode matching, lensed-fibers or tapered fibers are used. These are SMF with either a lens or a taper melted or etched to the SMF. By this method neither length nor pitch of several SMF can be precisely matched to form an array of lensed SMFs. To overcome this challenge we use V-Groove arrays, that have a well-defined facet and pitch. We fabricate lenses onto this facet with 3D-microprinting based on two-photon polymerization. We are able to fabricate **aspheric freeform lenses** with highest reproducibility, also available as lensed SMF-arrays.

What performance can lensed fiber arrays deliver?

It has been demonstrated that individual lensed fibers can couple InP lasers with losses of down to 0.6 dB into SMFs [1]. Losses to SOI chips are highly dependent on the taper. For standard 200 nm taper we expect losses of 3 dB with a penalty of approximately 2 dB if several lenses are to be coupled in parallel.

What specification can I order?

Our lensed fiber arrays can be either purchased on a 127 μm pitch SMF-array or a 250 μm SMF-array. We can supply lens fiber arrays with MFD from 1.5 μm to 25 μm for a wavelength of 1310 nm or 1550 nm.

Can I order custom optics on SMF-arrays?

Yes we can provide larger MFDs up to 25 μm as well as larger working distances, different wavelength or custom optics/fiber arrays, multi-core fibers and custom fibers and optics.

What power can the lenses withstand?

We could couple with powers of up to 3 W (35 dBm) at a wavelength of 1550 nm. Please note that this is close to destruction threshold, typical operation should be below 30 dBm at 1550 nm.

Further informations

[1] P.-I. Dietrich et al. "Lenses for Low-Loss Chip-to-Fiber and Fiber-to-Fiber Coupling Fabricated by 3D Direct-Write Lithography," in *CLEO'16*, OSA, 2016, SM1G.4.

[2] S. Schneider et al. "Optical coherence tomography system mass-producible on a silicon photonic chip," *Opt. Express* **24**, 1573–1586 (2016).

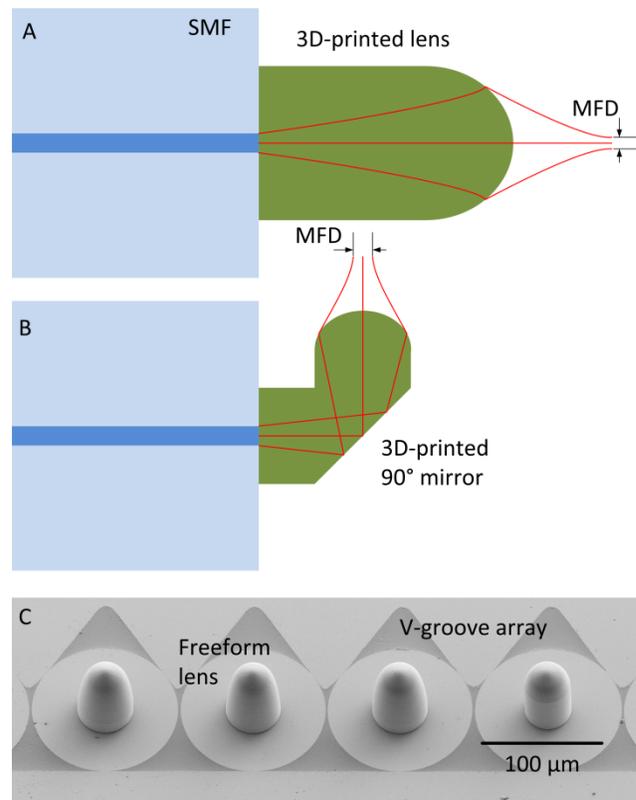


Figure 1: Lensed fiber array with different 3D-printed lenses. The lenses can be printed with standard and custom specifications. (A) Lens with freeform surface. (B) Lens-90°-mirror comprising total internal reflection. (C) Electron microscopy image of different lenses on a V-groove array.

How can I order the lensed SMF-arrays?

Please mail at sales@vanguard-photonics.com and specify the product number, see table below. Please ask for customized optics.

Direction [deg]	MFD@1/e ² [μm]	Wavelength [nm]	Pitch [μm]	# SMFs
0	1.5	650	127	4
90	2	1310	250	8
	2.5	1550		12
	3			
	3.5			
	4			
	5			
	10			
	25			
"0-3-1550-250-8" is a lens with 3 μm MFD for 1550nm, 8x250 μm				
"90-5-1310-127-4" is a 90°-mirror with 10 μm MFD for 1310nm, 4x127 μm				