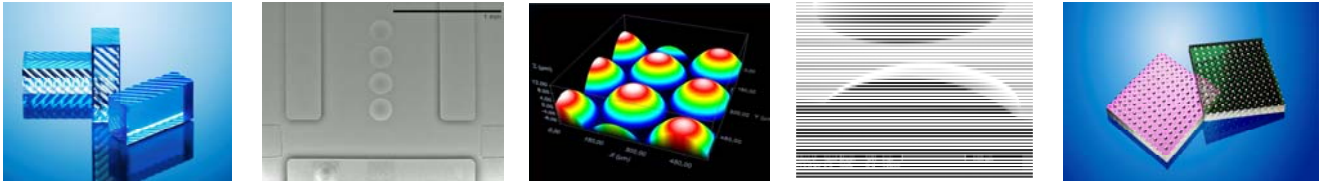


SMO TECHINFO SHEET 08 - INTRODUCTION TO MICROLENSES



Microlenses at a glance

Microlens arrays for fiber coupling and optical switching

Microlenses for collimation of laser diodes and VCSELs

Microlens arrays for imaging and sensor systems

Beam homogenizers for high-power lasers and illumination

Array optics with precise lens positioning

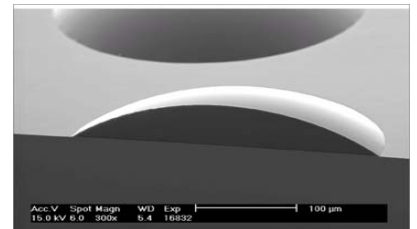
High-class lens quality (spherical and aspherical lens profiles)

Significant reduction of degrees of freedom in the assembly

Introduction

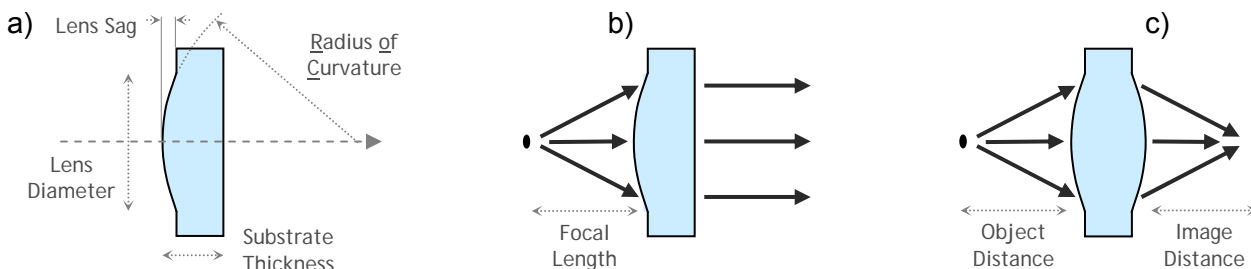
Refractive microlenses cover a range of 10 μm to 2 mm lens diameters. Refractive microlenses are an interesting alternative for all applications where miniaturization and reduction of alignment and packaging costs are necessary. A refractive microlens refracts the incident light according to Snell's law, similar as large-scale glass lenses do.

Refractive microlenses are manufactured in Fused Silica or Silicon using standard semiconductor technologies like photolithography, resist processing and reactive ion etching. These wafer-based manufacturing technologies allow a very accurate shaping of the lens profile and a precise positioning of the lenses within an array. SUSS MicroOptics is manufacturing in 200 mm (8") wafer technology in cleanroom environment.



Optical Properties

The basic optical properties of a microlens are the lens diameter $\varnothing = 2a$ and the effective focal length f_E .



Additional parameters are the sag at the lens vertex h , the refractive index n_1 of the bulk material, the radius of curvature R_C , the conic constant k and the numerical aperture NA .

For spherical lens profiles the conic constant k is 0, k is -1 for parabolic profiles and $k = -(n_1)^2$ for hyperbolic profiles.

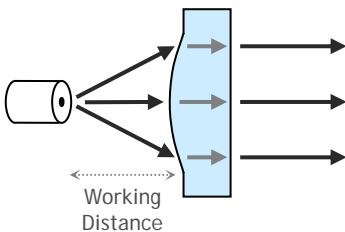
$$f_E = \frac{R_C}{n_1 - 1} \quad NA \approx \frac{a}{f_E} \quad h = R_C - \sqrt{R_C^2 - a^2} \quad R_C = \frac{a^2}{2h} + \frac{(k+1)}{2} h$$

Microlenses are usually manufactured in Fused Silica (refractive index $n_{589\text{nm}} = 1.458$) and Silicon ($n_{1.5\mu\text{m}} = 3.478$). Microlenses in Fused Silica are well suited for the full wavelength spectra from the DUV to the IR (wavelength range: 150 nm to 4 μm). Microlenses in Silicon are suitable for the infrared wavelength range (wavelength range 1.2 μm to 15 μm).

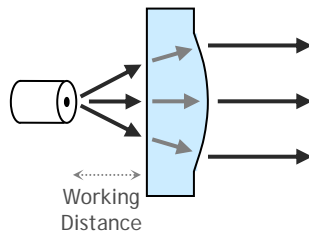
Applications

Microlenses are used for the collimation, focusing or imaging of light. For example, a microlens images the light from a bundle of single mode optical fibers onto an optical switching device and back in another fiber bundle. The high precision of the lateral array dimensions (better than $\pm 0.25 \mu\text{m}$) allows a very accurate fiber-to-lens positioning in one step. The high-class lens quality and the exceptional lens-to-lens uniformity ensure optimum coupling efficiencies for all optical channels in parallel. Aspherical lens profiles are used to minimize the spherical aberrations for different optical configurations.

a) Lens on Front-Side



b) Lens on Back-Side



The choice of the optimum parameters of a microlens array depends very much on the actual design and requirements of your optical system.

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