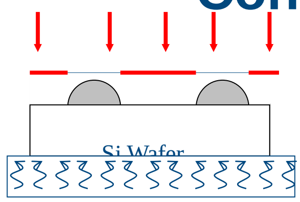
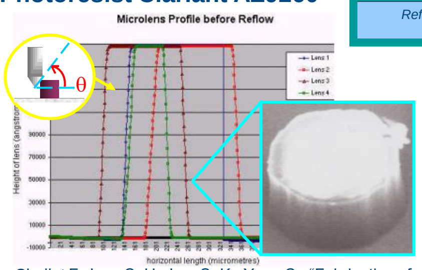
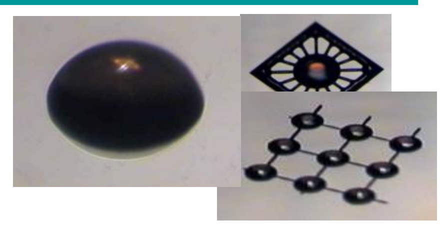
Convex lens - fabrication



Photoresist Clariant AZ9260

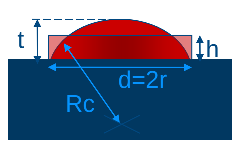
Process	Speed (rpm)	Temp (°C)	UV Irr. (mW/cm²)	Duration (s)
Spin-coat	1000	/	/	60
Pre-bake	/	100	/	300
Exposure	/	/	10	200
Development	/	/	/	600
Reflow	/	115	/	900





Chollet F., Low C. H., Lee S. K., Yang C., "Fabrication of concave and convex micro-optical elements with polymer for free-space micro-optical bench", Int. J. of Computation. Eng. Sci., vol. 4, n. 3 (2003) : 443-446

Convex lens - model



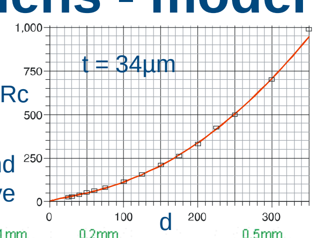
$768\pi V R_c^3 - 12\pi^2 d^4 R_c^2 -$
$576V^2 - \pi^2 d^6 = 0$

$V = h\,\pi(d/2)^2$

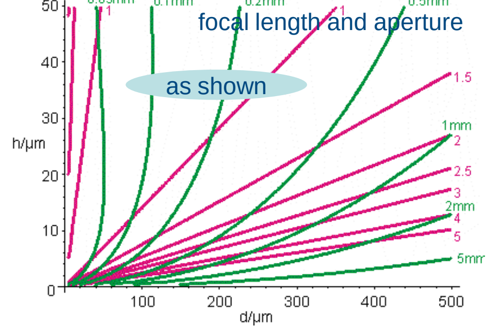
$f = R_c * (n\text{-}1)$ – lens maker's equation

$\# = f/d$ – relative aperture

Experimental and theoretical curve



focal length and aperture

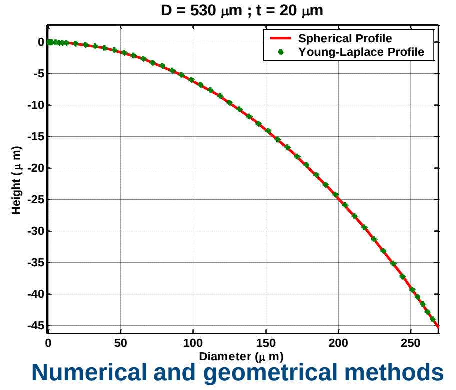


- **The model assumes that:**
  - ➔ the diameter *d* does not change on reflow
  - ➔ the reflow creates a spherical profile

Convex lens - model

- The profile can also be obtained as a solution of Young-Laplace equation
- The equation can be solved numerically with the ability to see the effect of other parameter like gravity (g), density of molten polymer (ρ_L), surface tension of molten polymer (γ)…
- Even this solution is not complete as it does not take into account the dynamic of melting and solidification

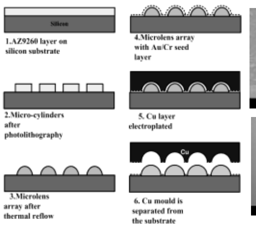
$$\frac{d^2y/dx^2}{\sqrt{(1+\frac{dy}{dx}^2)^3}}+\frac{dy/dx}{x\sqrt{1+\frac{dy}{dx}^2}}=\frac{(\rho_L-\rho_V)gy}{\gamma}+\frac{2}{R_0}$$

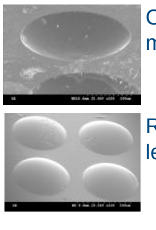


Numerical and geometrical methods

Microlens - application

- Production of copper lens insert for molding of fiber coupling array

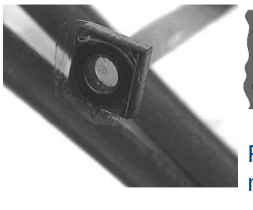


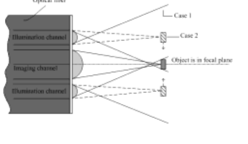


Copper mold

Replicated lens

- Imaging/illumination fiber for endoscopic application





Fiber bundle with multi-lensed tip

Ashraf M., Chollet F., Murukeshan VM., Yang C., "Fabrication of polymer-based reflowed microlenses on optical fibre with control of focal length using differential coating technique", Sadhana, doi:10.1007/s12046-009-0038-5, Vol. 34, No. 4, (2009) : 607–613