

Inkjet Printing of Micro-Lens Arrays on large, lithographic structured Substrates

EPIC ONLINE TECHNOLOGY MEETING ON 3D PRINTING

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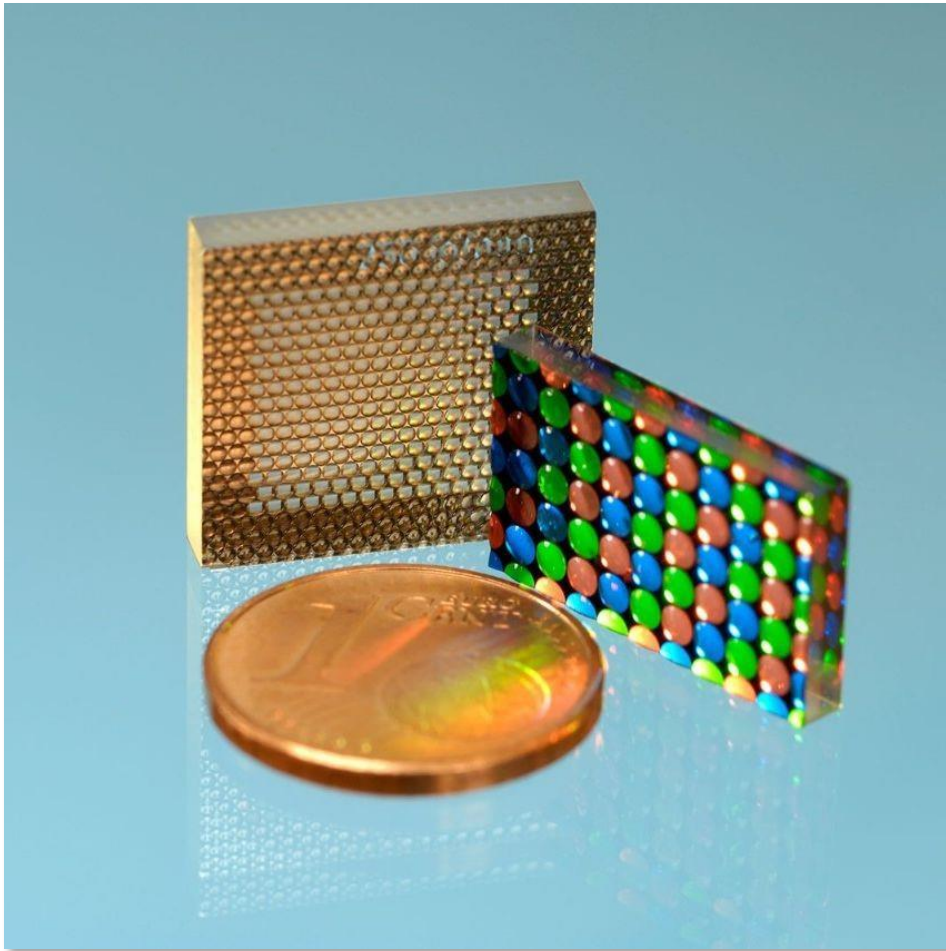
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Motivation

Large Area Micro Optics



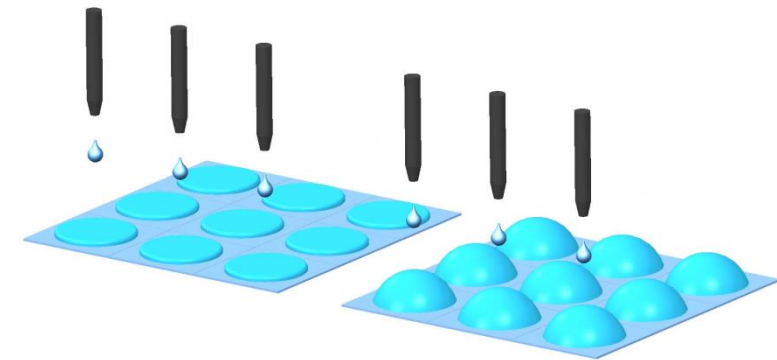
Application examples

- Flat illumination system
 - Homogenizer
 - Multi-apertur pattern projectors
 - Artificial sun/ daylight projectors
 - Flat imaging systems
 - Cluster eye multi-aperture cameras
 - Microscopes etc.
- Increasing demand for large area μ -optics

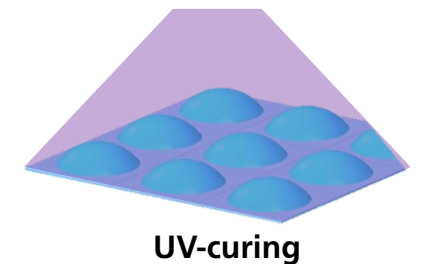
Manufacturing Process

Micro-Lens Inkjet Printing

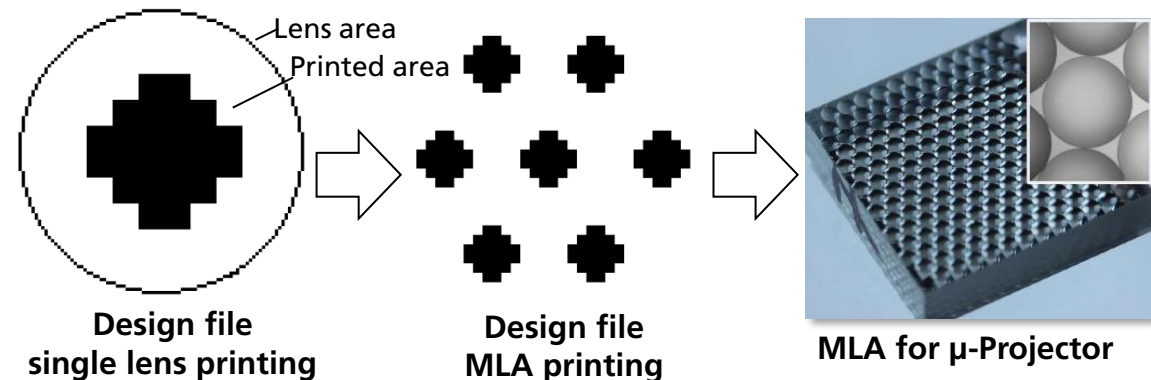
- Material: Ormocer (micro resist GmbH)
 - UV-cross-linking hybrid polymer
 - Inkjet-printable solution
 - 30% - 50% solid content
- Print, dry and UV-cure
 - Wetting structures made using photolithography → fluorsilane evaporation
 - Lens area: “Fill up” with ink
--> Several 100 Nozzles in parallel possible
 - Print lens volume in several printing runs
 - (Drying: solvent evaporation at RT)
 - Curing by UV-LED array and halogen lamp



MLA manufacturing using multi-nozzle-printing



UV-curing



Manufacturing Process

Inkjet Printing – Equipment for Large Areas



Industrial inkjet printing system e.g. for solder masks

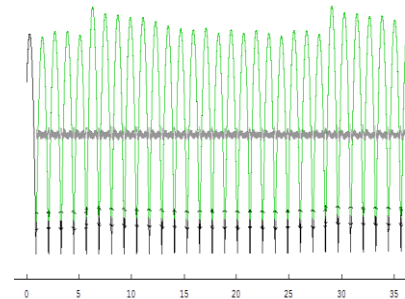
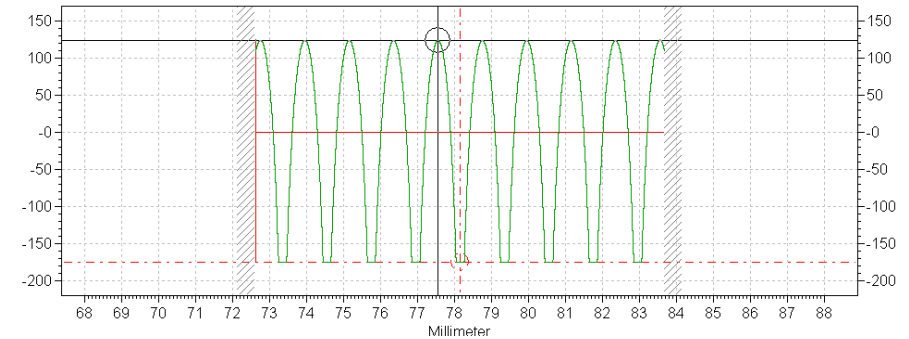
- Maximum print size 610 mm x 610 mm (24" x 24")
- Minimum feature size 80 μm
- Minimum opening 30 μm
- Print speed 24"x18" – 37 s

Image and data courtesy of Notion Systems GmbH, Germany

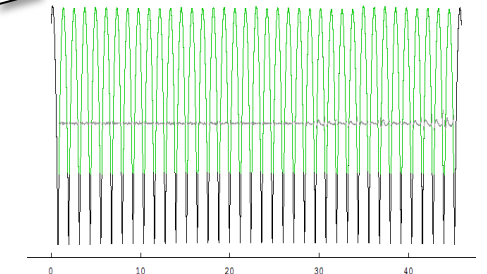
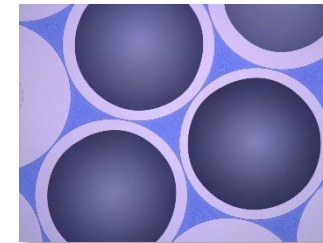
Results

Inkjet Printing Performance – Lens Shape Deviation on 300 mm Wafer

- Optimization of Inkjet Printing Process
 - Droplet Volume Homogenization, Curing
- 800 droplets
 - Height: $113.25 \pm 0.28 \mu\text{m}$ → Deviation < **0.25%**
 - Calculated Droplet Volume: 80 pl
- 2300 droplets
 - Height: $299.31 \pm 0,1 \mu\text{m}$ → Deviation < **0.03%**
 - Calculated Droplet Volume: 80 pl
- 3500 droplets
 - Height: $379.79 \pm 1.4 \mu\text{m}$ → Deviation < **0.38%**
 - Calculated Droplet Volume: 70 pl



Lens Type	Pad \varnothing [μm]	ROC [μm]	Height [μm]
Bottom Lens	1190	1797	102
Top Lens	300	930	12
Top Spacer	970	860	150
Aperture Type		Aperture \varnothing [μm]	
Bottom		400	
Top		50	



A circular frame containing a square mesh structure. The mesh has a color gradient from blue at the bottom to green at the top. The text "Thank you for your Attention!" is centered over the mesh.

Thank you for your Attention!