

## Technologies



Photo from EVG

# Fabrication of Nanoimprint Lithography Masters for Photonic Applications

## Fast Facts

- 8" Si wafers
- Grating material Si, SiO<sub>2</sub>, ...
- 10 mm<sup>2</sup> single dies
- Active area of 9 mm x 9 mm filled with 400 nm lines and spaces – nano grating
- Local chip alignment structures
- Global 6" and 8" alignment structures for high accuracy alignment

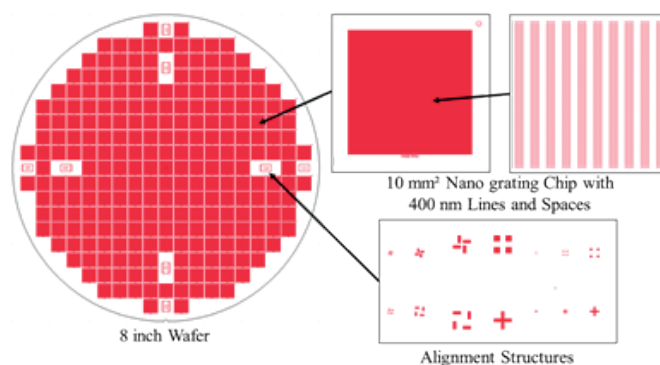


Figure 1: 8" wafer layout with 10 mm<sup>2</sup> single chip, the 400 nm L/S and alignment structures.

- Cross section of the nano grating with its 400 nm lines L and spaces S
- Resulting period P
- Different etch depths are investigated to achieve high aspect ratio of the 400 nm L/S grating
- Homogeneity over the wafer (residual resist layer)

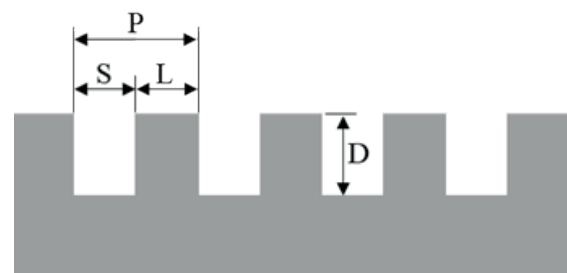


Figure 2: 8" wafer layout with 10 mm<sup>2</sup> single chip, the 400 nm L/S and alignment structures.

## Structure Depth and Aspect Ratios

Structure Depth (nm)	200	400	500	1000	2000
Aspect Ratio (Depth:Width)	0.5:1	1:1	1.25:1	2.5:1	5:1

## Fabrication – Lithography

- i-line wafer stepper NIKON NSR 2205i11D CD 350 nm
- High throughput 50W/h ↔ research and high flexibility, ...
- 22 x 22 mm<sup>2</sup> field view, ...
- 6" and 8" wafers, 250 µm to 1 mm thickness, ...
- Thin and thick resist, spray resist (MEMS), ...

## Fabrication – Reactive Ion Etching (RIE)

- Centura 5200 etching tool from Applied Materials with an eMXP+ chamber
- RIE of 6" and 8", silicon, isolators and metals

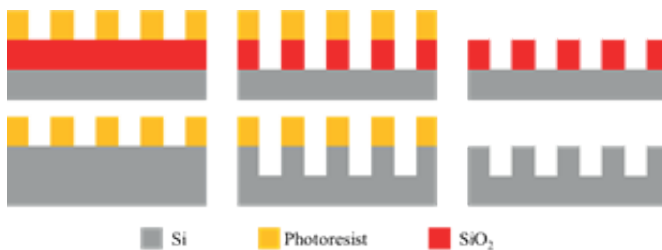


Figure 3: Scheme of the Si and SiO<sub>2</sub> approach for the pattern transfer of the photoresist into the Si or SiO<sub>2</sub>.

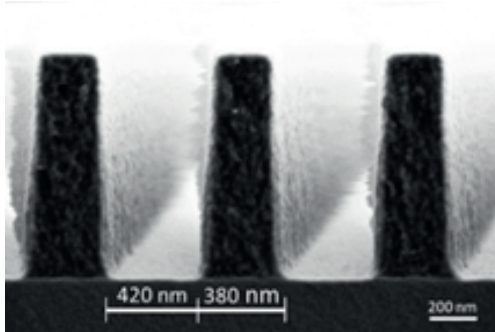


Figure 4: SEM cross view of a nano grating with 380 nm lines L and 420 nm spaces S in 950 nm OiR674/9 photoresist after lithography.

## Characterization – SEM

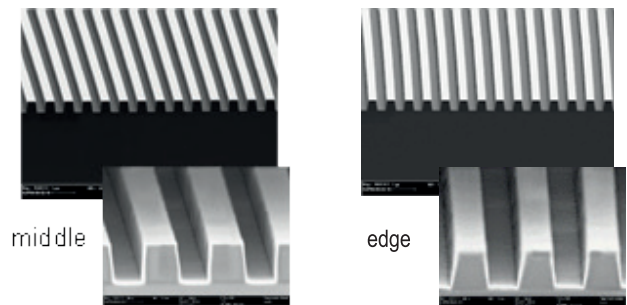
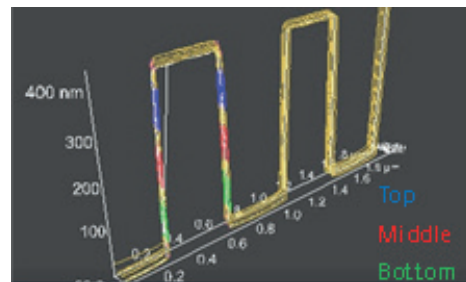


Figure 5: SEM cross views of the patterning transfer in SiO<sub>2</sub> layers with 500 nm depth at the middle and edge of the wafer.

## Characterization – CD-AFM

- Bruker's InSight CAP automated AFM
- Measure the depth and CD within one single die
- AFM tip CDR120 "critical dimension tip"
- Analysis of top, middle and bottom CD of grating
- Eight single scans within every die of a 8" wafer
- With 200 nm and 400 nm SiO<sub>2</sub> deep etching



Etch Depth [nm]	Nano Grating Linewidth [nm]			Sidewall Angle [°]
	Top	Middle	Bottom	
212±2	364±10	374±10	380±10	87
425±5	351±10	368±10	378±10	86

Figure 6: AFM characterization of the eight single scans within one die at the middle of the wafer with 200 nm SiO<sub>2</sub> deep etching.

## In cooperation with



Fraunhofer ENAS is part of



## Contact

Dr. Christian Helke  
Phone +49 371 45001-450  
christian.helke@enas.fraunhofer.de

Fraunhofer ENAS  
Technologie-Campus 3  
09126 Chemnitz | Germany

[www.enas.fraunhofer.de](http://www.enas.fraunhofer.de)

Photo acknowledgments:  
Fraunhofer ENAS  
All information contained in this datasheet is preliminary and subject to change. Furthermore, the described system is not a commercial product.