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Combination of direct laser writing and soft lithography molds for combined nano- and microfabrication

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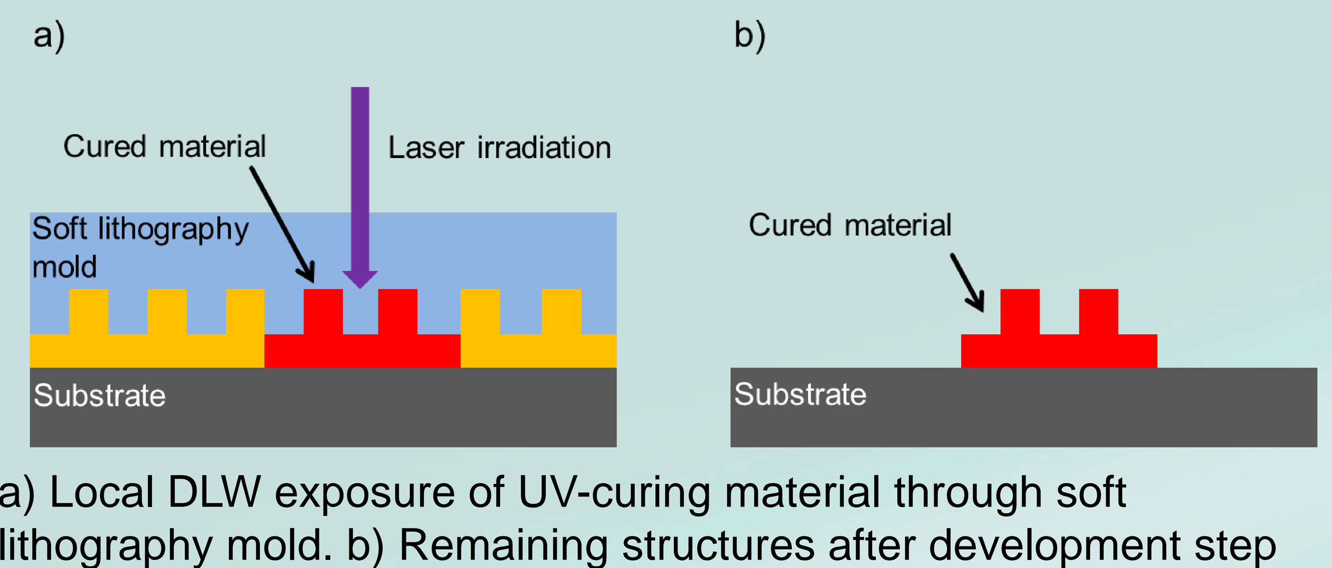
Introduction and process scheme

- The fabrication of combined nano- and micropatterns is of interest for different application fields (e.g. photonics, microfluidics) [1,2].
- We present a novel approach based on the combination of direct laser writing (DLW) and soft lithography molds.
- Results concerning the fabrication of hierarchical structures and local structure transfer into imprint resists ("local" imprinting) are presented.



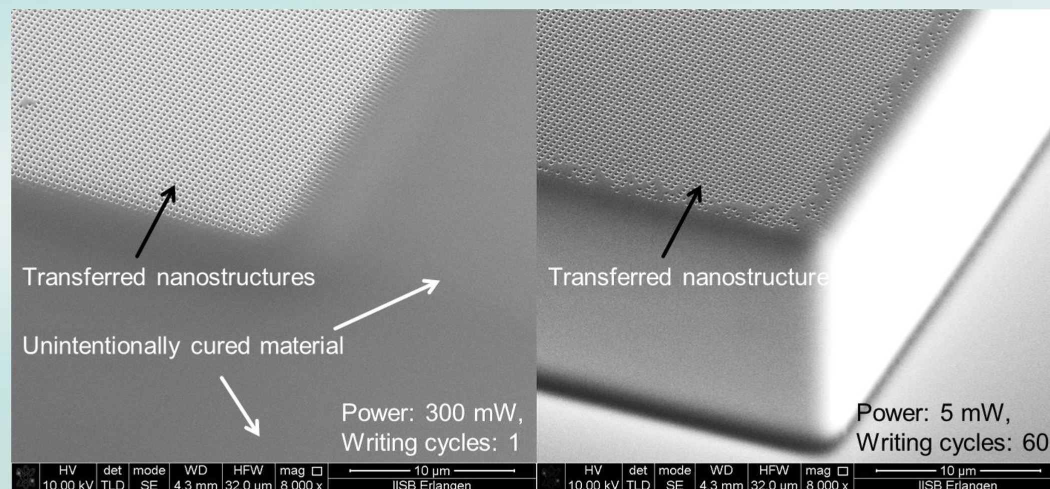
a) Local DLW exposure of UV-curing material through soft lithography mold. b) Remaining structures after development step

Fabrication of hierarchical structures

Experiments on silicon

Impact of exposure parameters

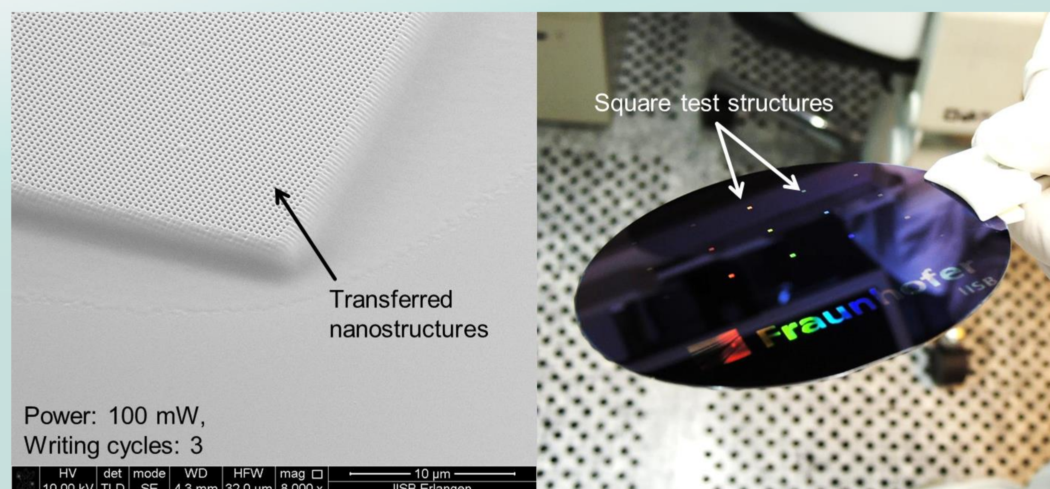
- Crucial impact of laser power on sidewall formation
- Uncontrollable curing outside irradiated area for high exposure power
- Multi-cycle exposure renders nearly vertical sidewalls



SEM images of OrmoComp® structures exposed with different process settings

Use of diluted OrmoComp®

- Dilution of OrmoComp® with PGMEA (ratio 1:1)
- Unwanted curing reduced, UV-sensitivity decreased?
- Enables reduction of process time

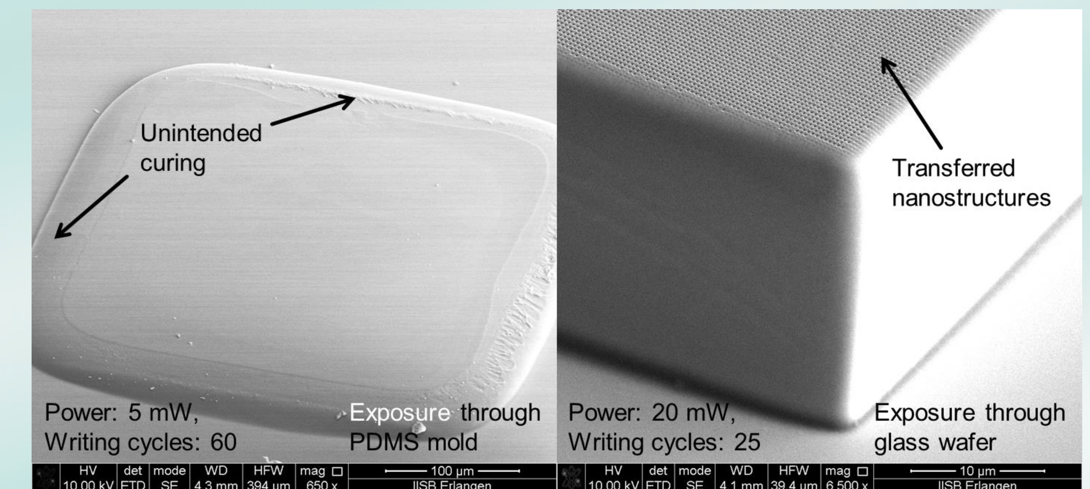


SEM image and photograph of structure written into diluted OrmoComp®

Experiments on glass

Influence of mold-structures

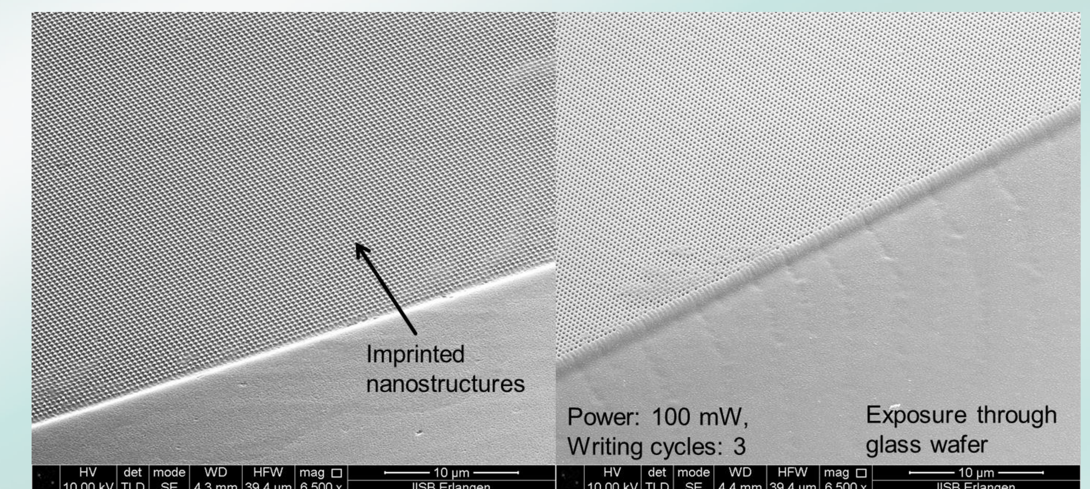
- No 1:1 transfer of parameters from Si-process possible
- Coupling of laser light into glass wafer due to diffraction effects?
- Exposure through glass wafer excludes influence of mold structures



SEM images of OrmoComp® structures exposed through PDMS mold or glass wafer, respectively

Hierarchical structure as UV-NIL mold

- Manual test imprint using hierarchical structure fabricated by DLW through PDMS mold
- Successful replication of nanostructures

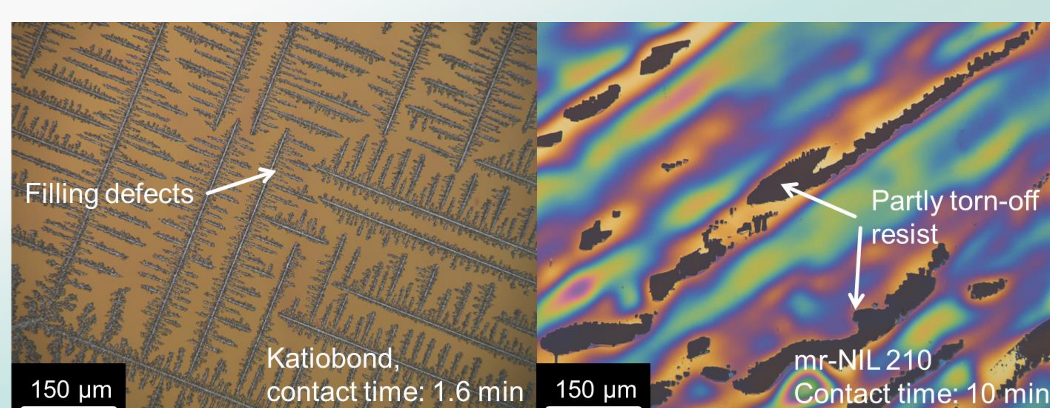


SEM image of manual test imprint and corresponding hierarchical structure used as mold

"Local" imprinting

Resist diffusion into PDMS

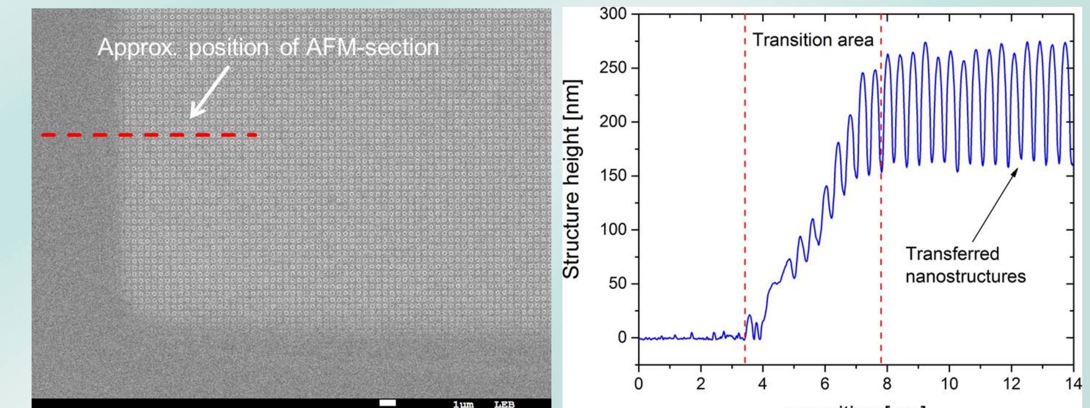
- Evaluation of diffusion behavior of Katiobond 110707 and mr-NIL210 [3,4]
- No stable condition for both resists → PDMS mold unusable
- Use of "hybrid" PDMS/OrmoComp®-molds



Optical microscope images of defects caused by resist diffusion into PDMS mold

Exposure through „hybrid" mold

- Successful local transfer of nanostructures into mr-NIL210
- Formation of transition area with incomplete resist removal
- Further process optimization necessary



SEM image of structure written into mr-NIL210 and AFM-section of edge area

Conclusions

- A novel approach for the combined fabrication of nano- and microstructures is presented.
- Fabrication of hierarchical structures and "local" imprinting successfully demonstrated

Outlook

- Optimization of exposure parameters for "local" imprinting (reduction of transition area and residual layer thickness)
- Combination of nanostructures from different molds on one substrate

[1] Liao, Y. et al., Lab Chip 12, 746-9 (2012).
[2] Warren-Smith, S. C., Opt. Express 24, 378-87 (2016).
[3] Fader, R. et al., Microelectron. Eng. 98, 238-41 (2012).
[4] Schlachter, F. et al., Microelectron. Eng. 155, 118-21 (2016).

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