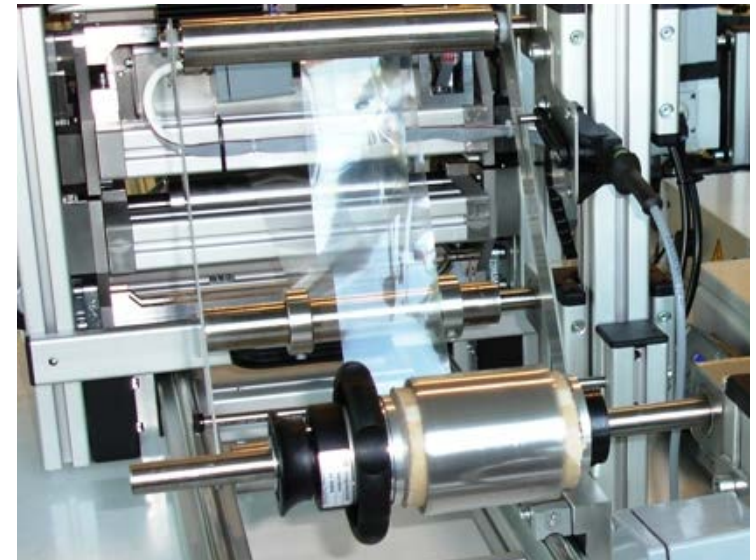
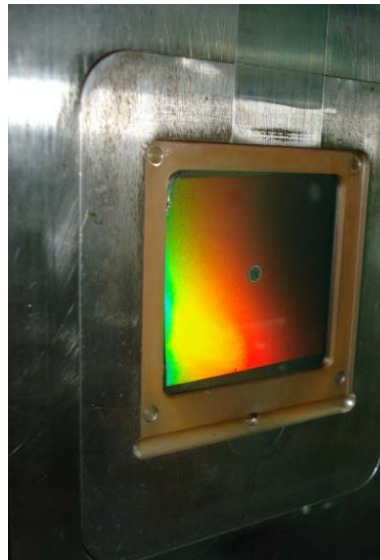
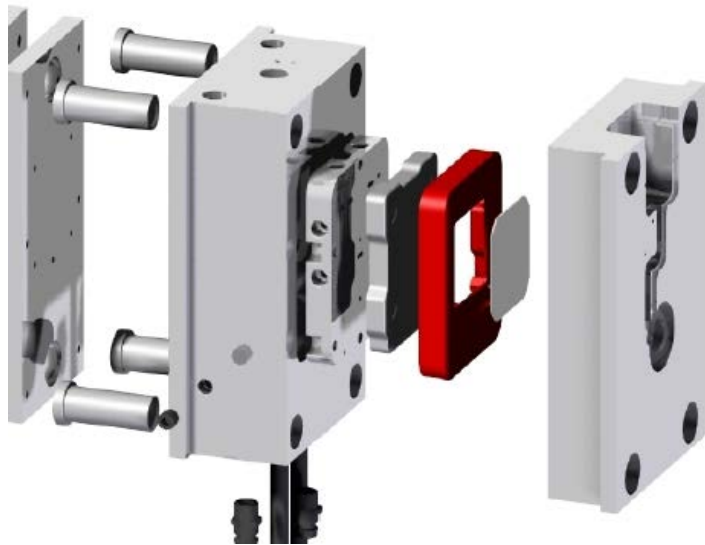


Funktionalisierung von Kunststoffoberflächen durch Mikro-/Nanostrukturen

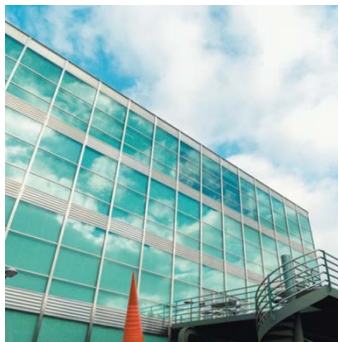
Forschungsbeispiele aus dem INKA

Swiss MNT Network: Trends in Micro Nano, Luzern/Horw, 5. 12. 2013

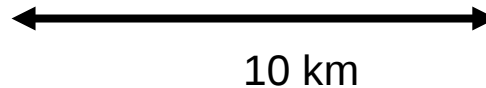


Jens Gobrecht (PSI und FHNW) und Per Magnus Kristiansen (FHNW-INKA)

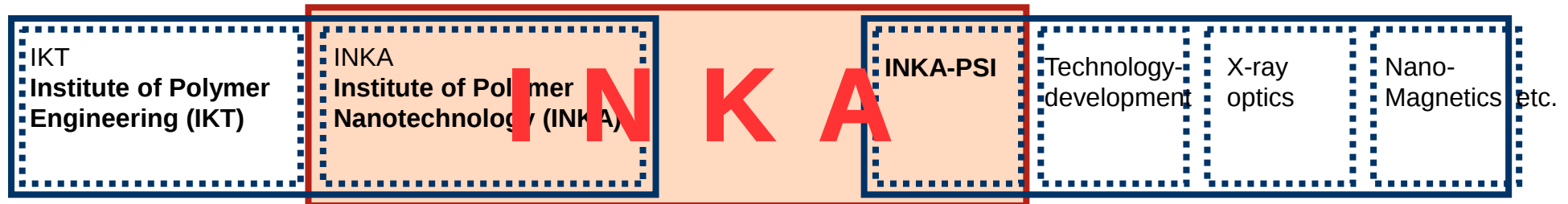
Institut für nanotechnische Kunststoff-Anwendungen INKA – a „joint venture“ between FHNW & PSI



FHNW - IKT & INKA



LMN – Laboratory for Micro- und Nanotechnology



Advantages / USPs of INKA

- Full access to infrastructure of PSI and FHNW (inkl. KATZ)
- Access to knowhow on «both sides»
- „Pooling“ of personal resources INKA/IKT und INKA/LMN

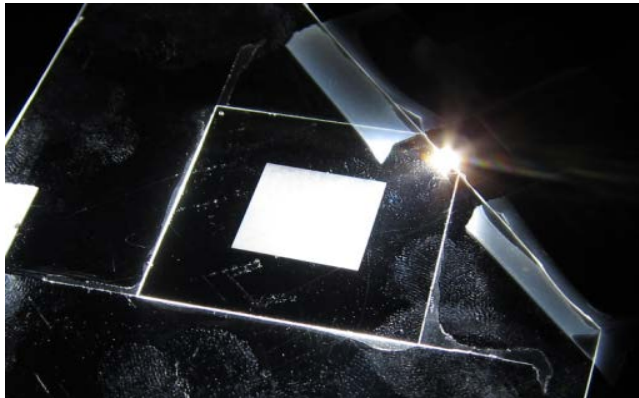
The complete coverage of the entire value chain makes INKA quite unique!

Focus of research at INKA:

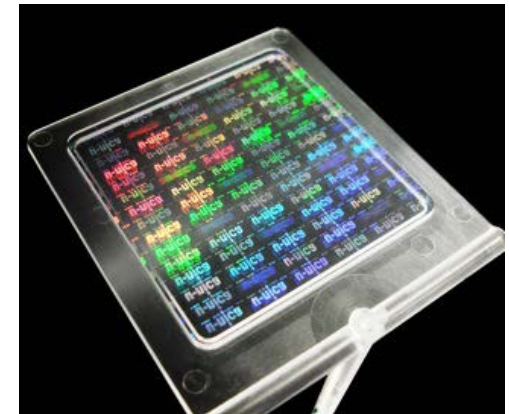
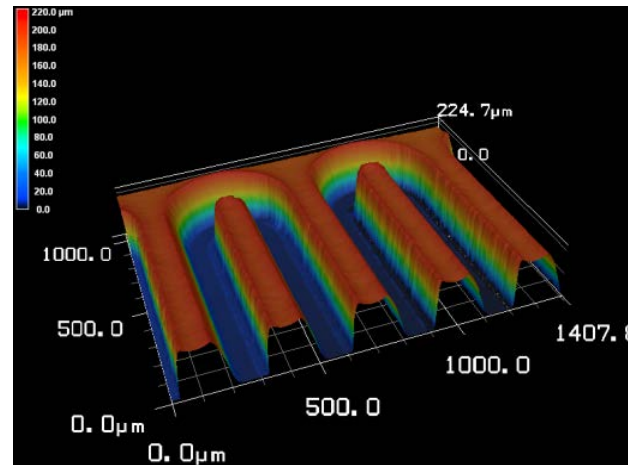
Functional Micro- and Nanopatterns on Polymer Surfaces

For applications in:

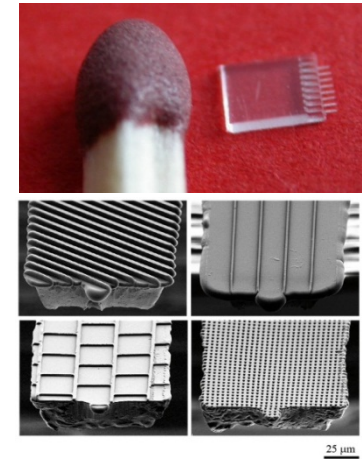
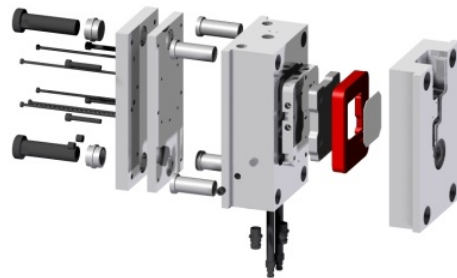
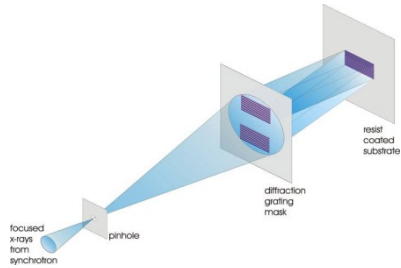
- Medical and bioanalytics, medical research
- Security and brand protection
- Microoptics



Homogeneous backlight on 16x16mm²



The complete value chain of micro- & nanostructured polymer devices in one hand at INKA!

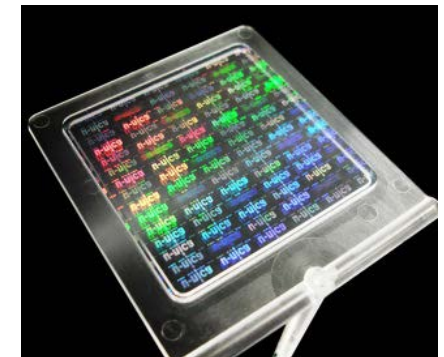
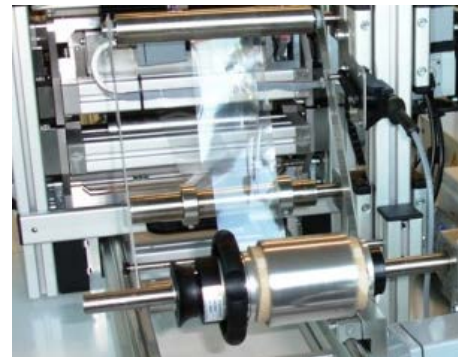
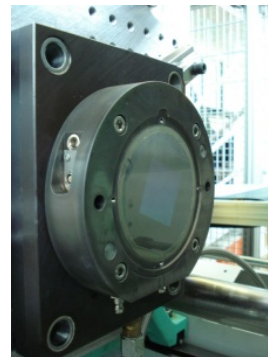
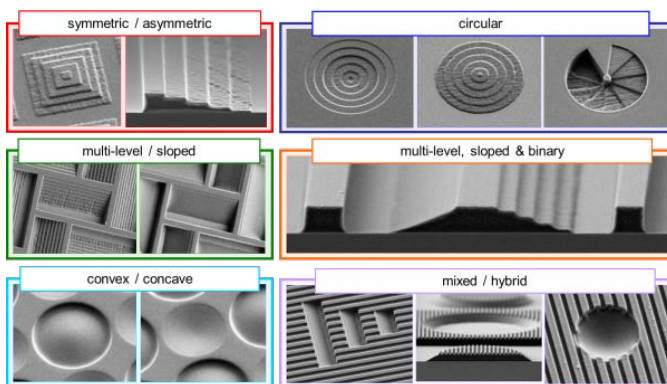


**Master structure
generation**

**Tooling design,
construction and
manufacturing**

**Replication
technologies**

Applications



Application example: Microoptics

Nanopatterning based on Nanoimprinting Lithography

The project targeted scalable nano-manufacturing processes for arbitrary 3-dimensional surfaces

WP on development of processes
→ lead with Dr. Helmut Schift at PSI

Industrial Demonstrators

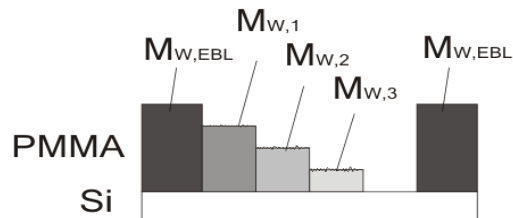
- Planar Diffractive Optical Element (PDOE)
- Emissive Head-Up Display (eHUD)
- Light Directional Elements (LDIR)



Thermal post-processing of 3-D resist pattern

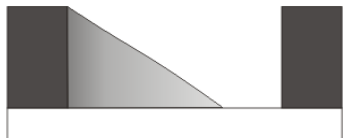
PMMA resist layer (500 nm high) after development

resist pattern /
molecular weights

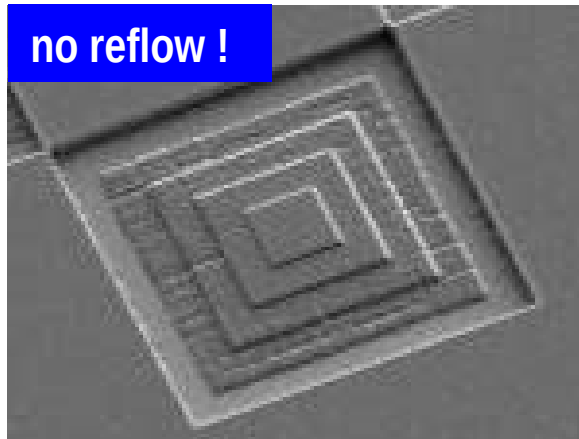


$$M_{W,EBL} \gg M_{W,1-3}$$

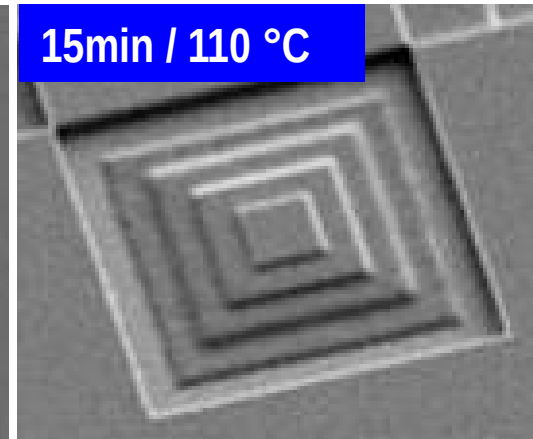
reflow



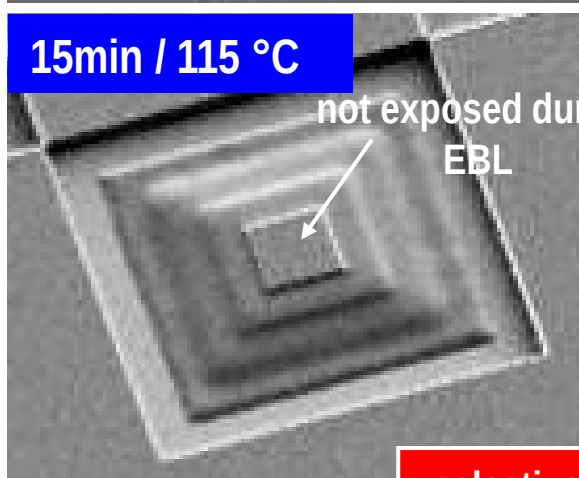
no reflow !



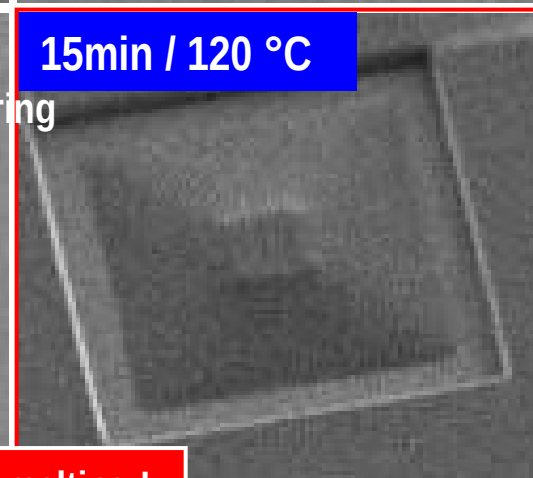
15min / 110 °C



15min / 115 °C



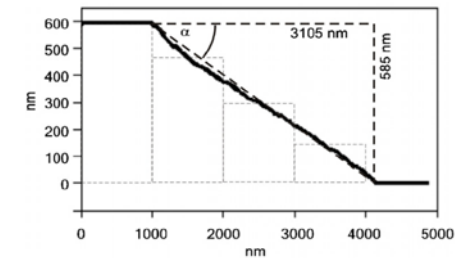
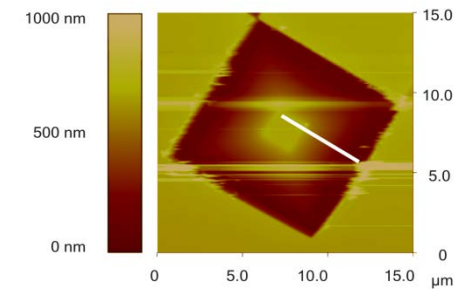
15min / 120 °C



selective melting !

2 μm

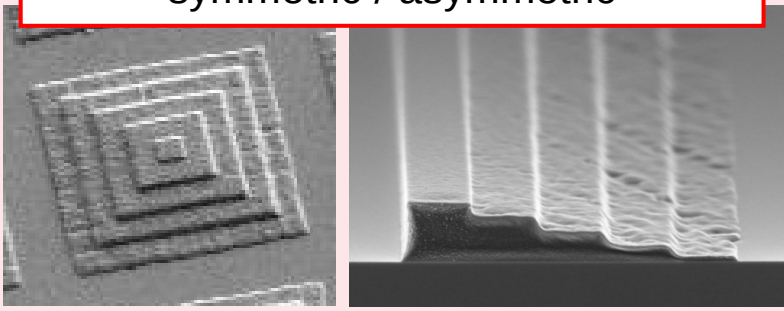
AFM analysis



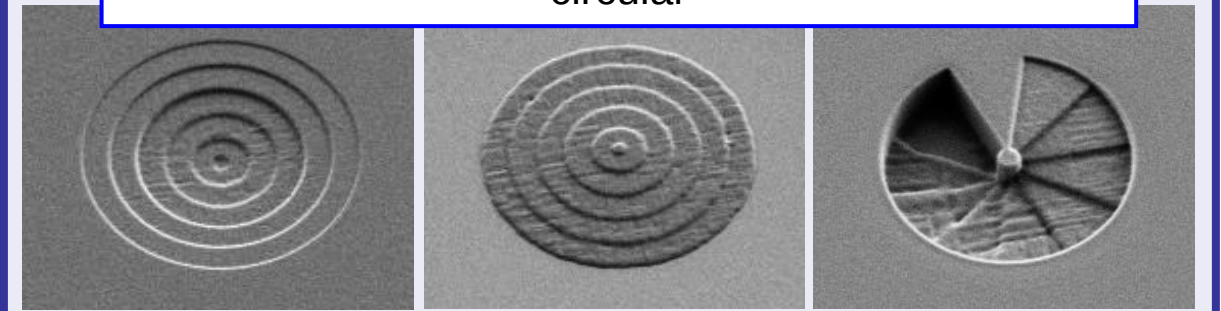
slope inclination
~ 11 °

3-D structures by hybrid nanomanufacturing processes

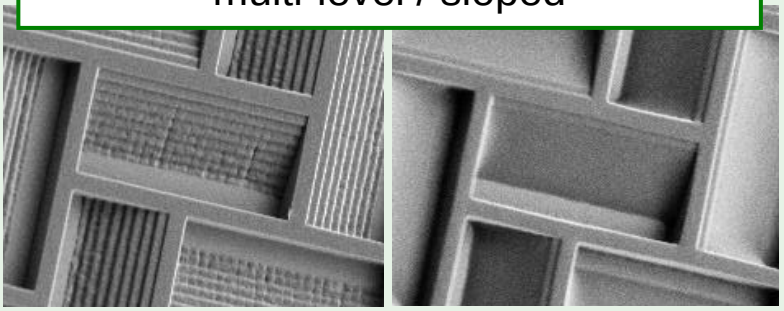
symmetric / asymmetric



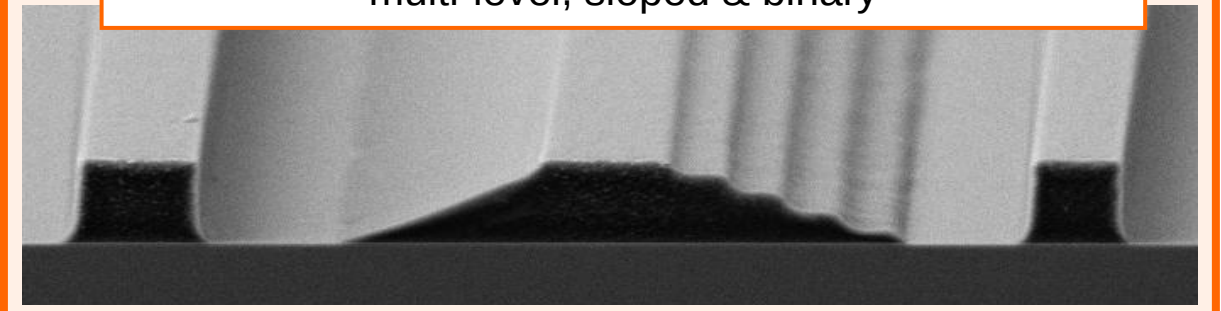
circular



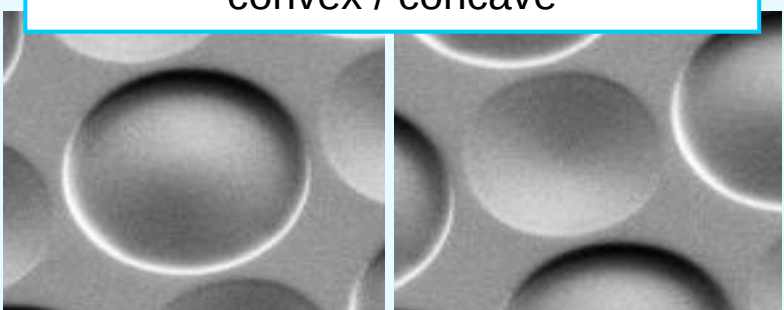
multi-level / sloped



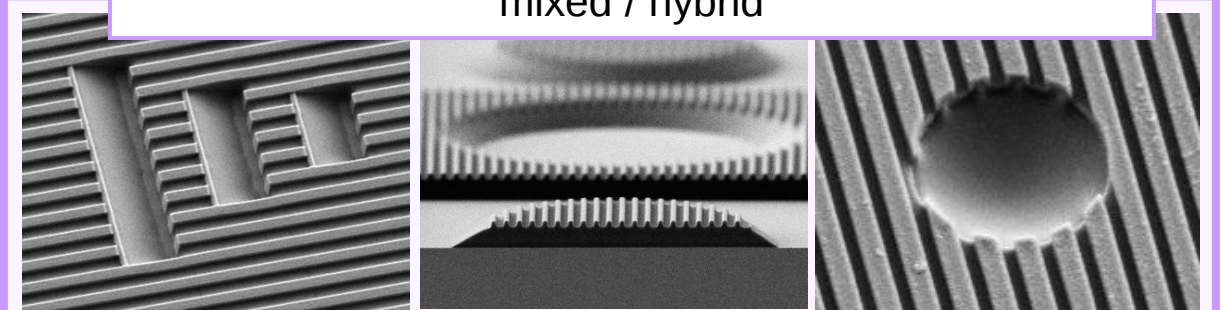
multi-level, sloped & binary



convex / concave

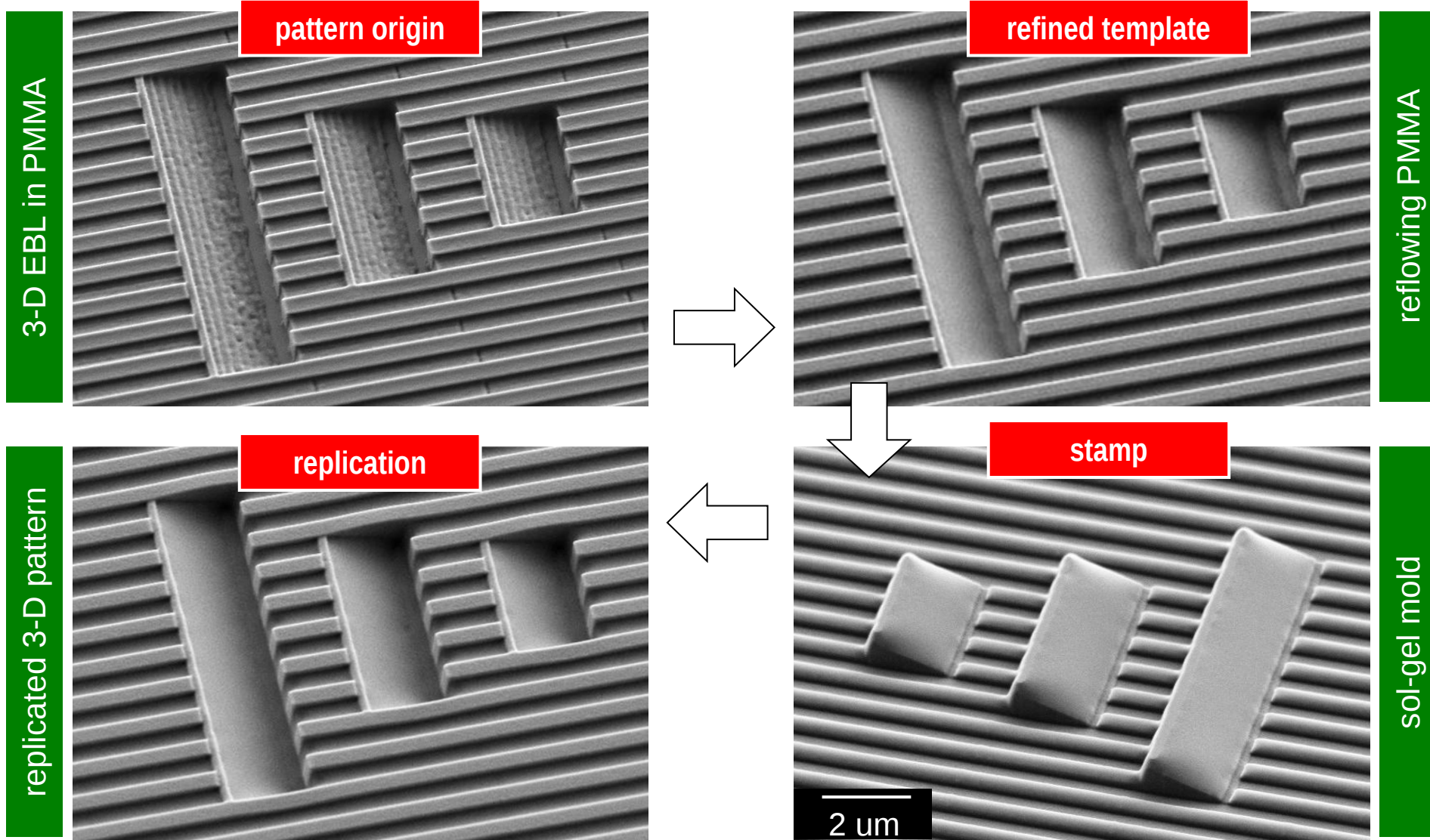


mixed / hybrid



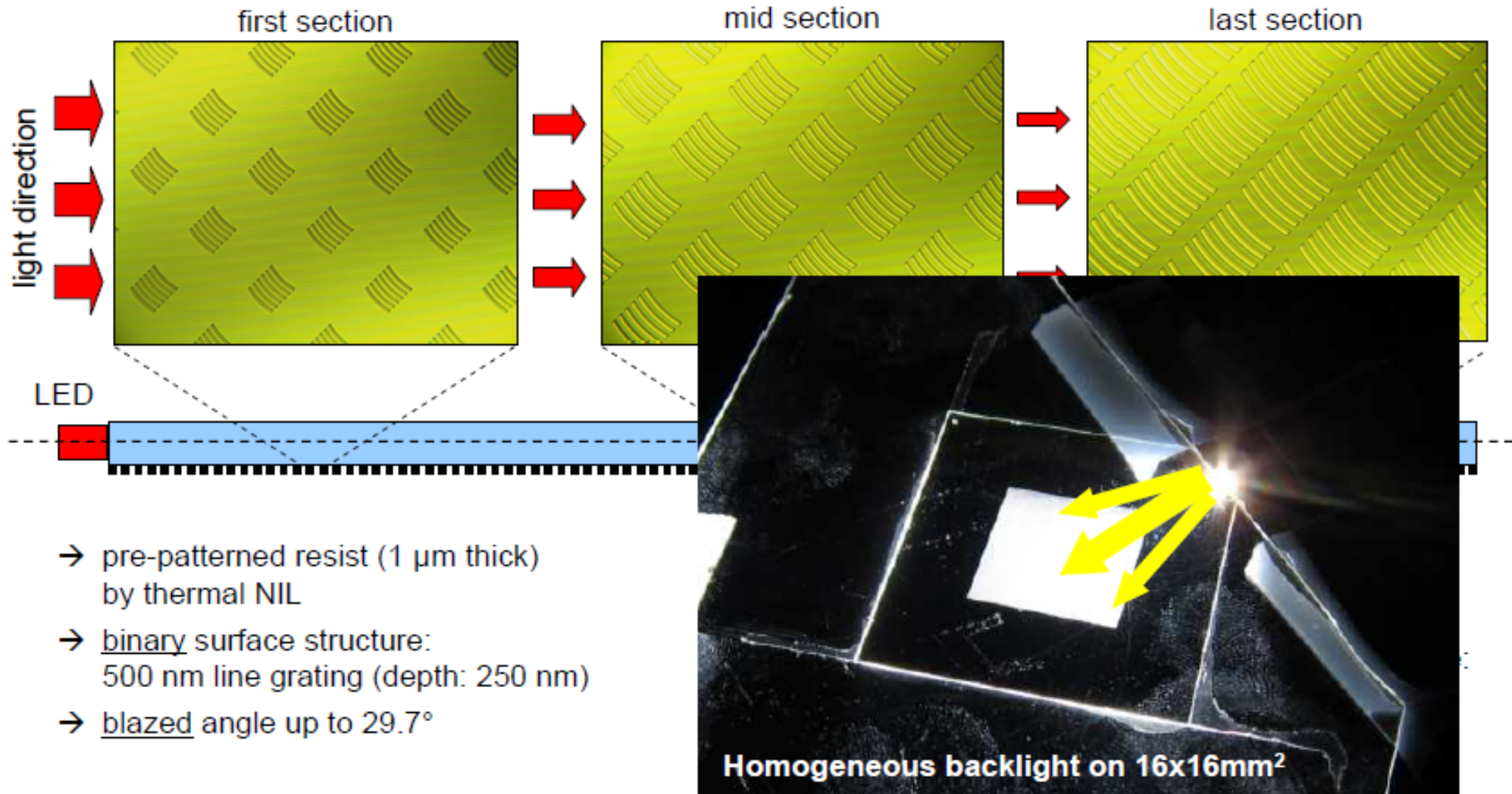
Mass replication using nanoimprint lithography (NIL)

Pattern are copied into a sol-gel material and repeatedly replicated into a polymer



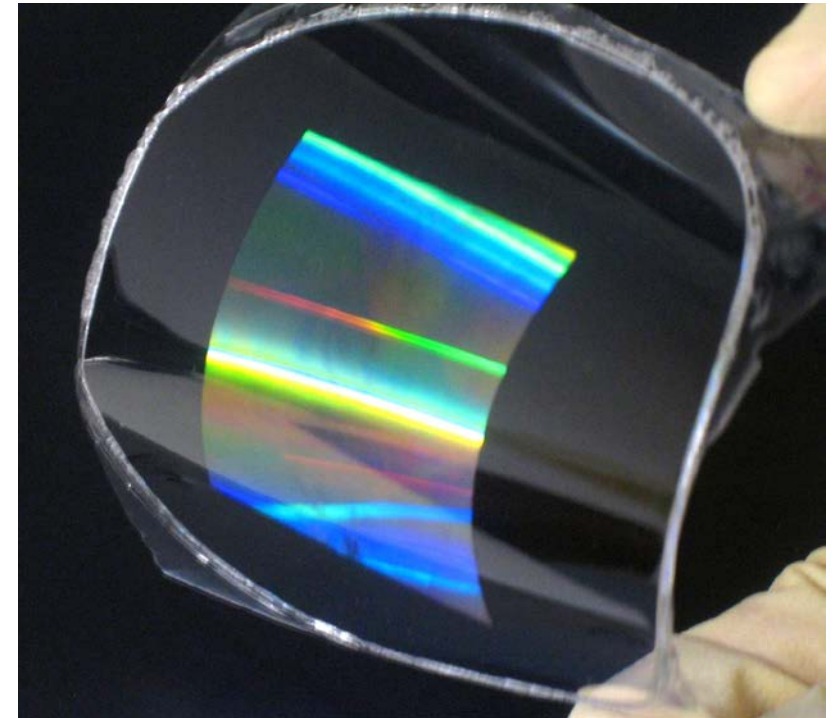
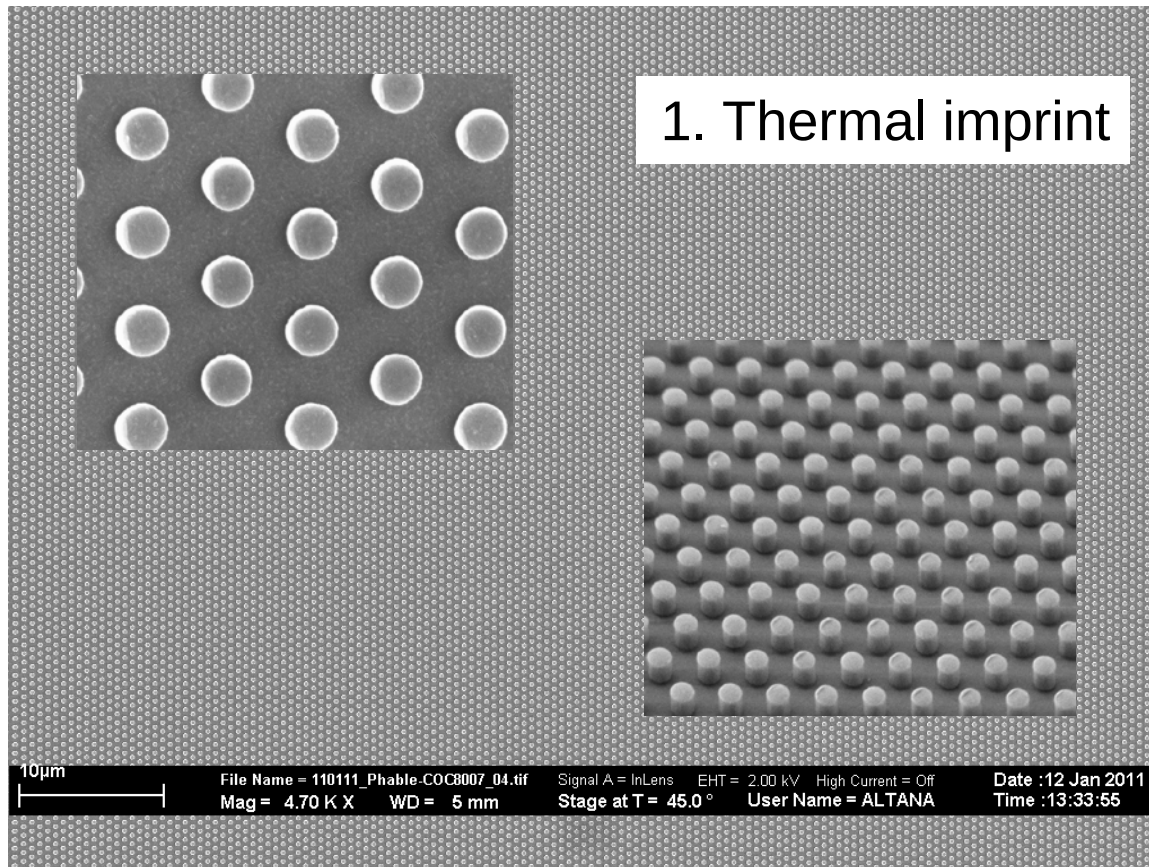
Fabrication of hybrid gratings by selective thermal reflow

Pixelized lightguide surface for backlighting devices: outcoupling elements and anti reflective pattern



Test pattern for large area surface replication: Phable

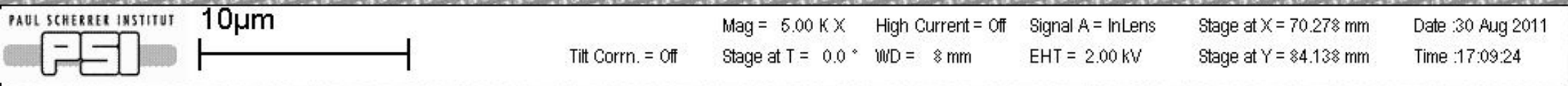
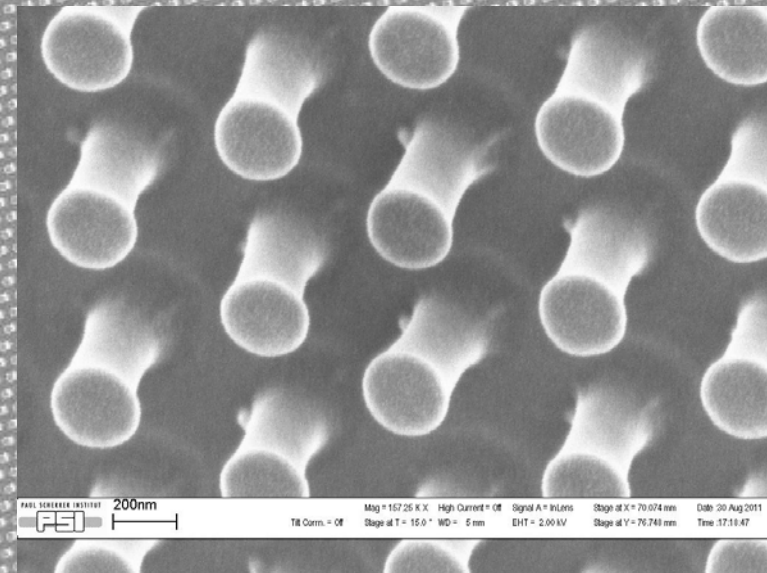
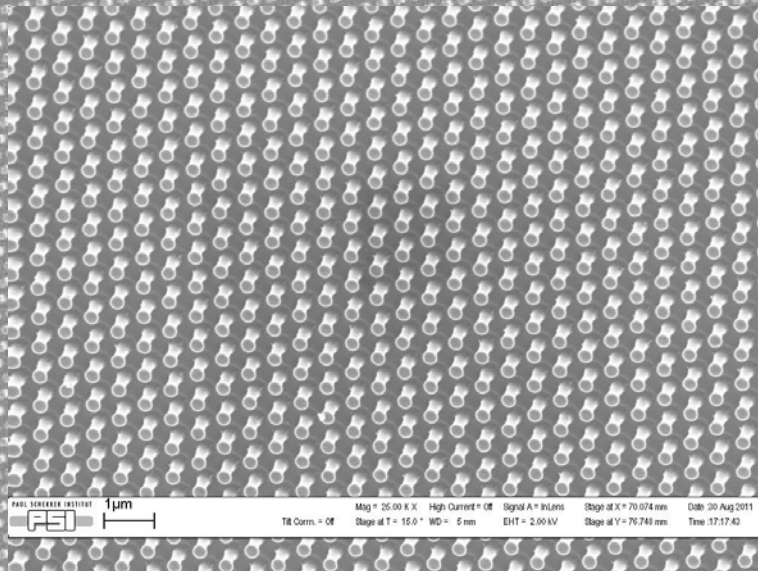
Courtesy of H. Solak, Eulitha AG



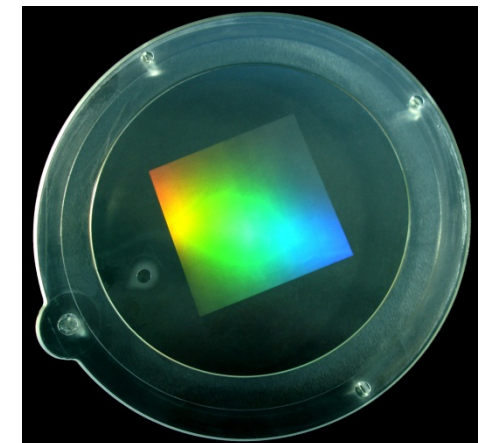
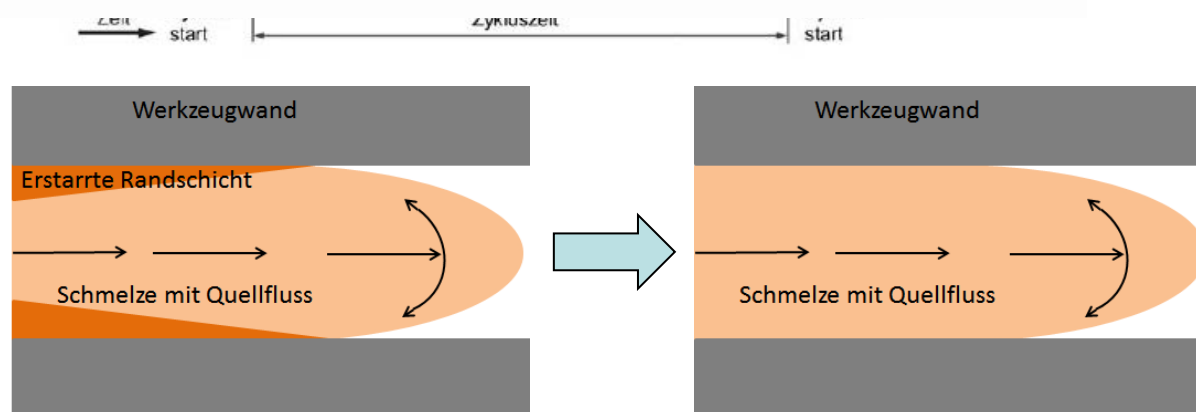
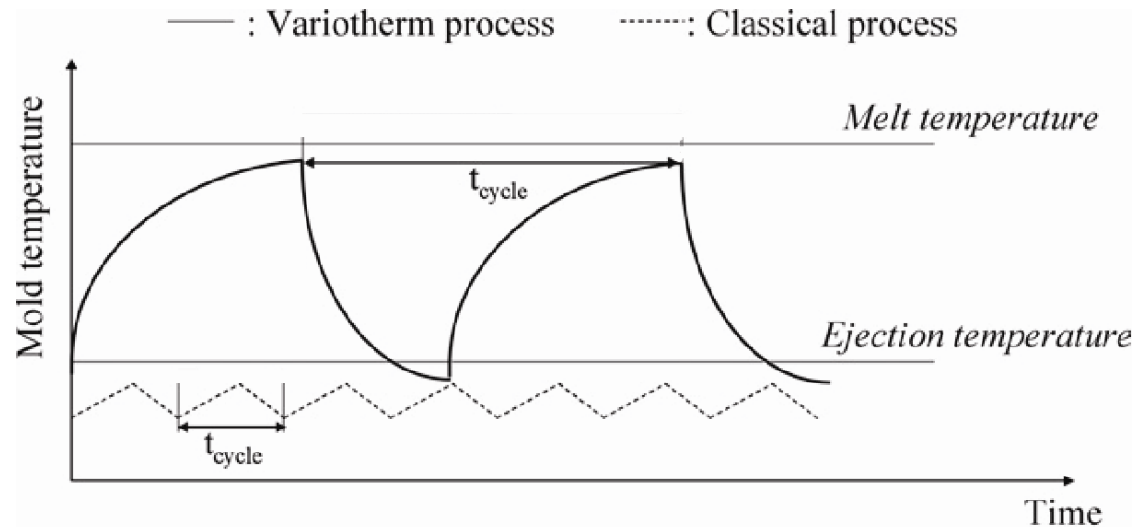
Pattern: 600nm period hexagonal array
(all images from polymer replica)

Nanoimprint tests made by M. Altana, INKA Institute

2. Injection molding

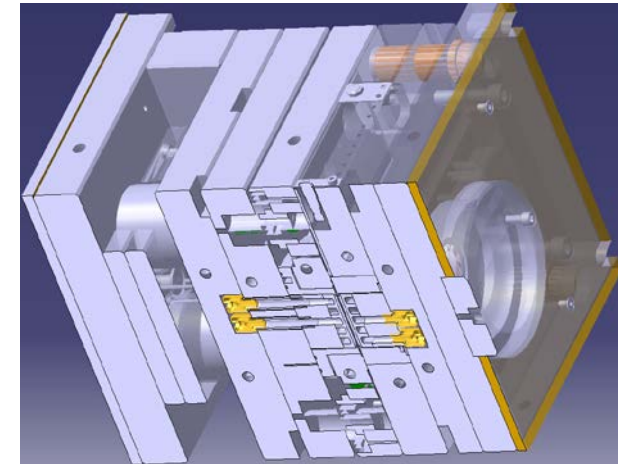


Large-area nanostructure replication by variothermal injection molding



Ref: *NaPANIL Library of Processes*, Ed. H. Schiff, published by the NaPANIL-consortium represented by J. Ahopelto, 2nd Edition (2012), p. 85-86, ISBN Nr. 987-00-038372-4; URL: <http://www.NaPANIL.org>

Variothermes Spritzprägewerkzeug mit Heiss-/Kaltwasser



3D Werkzeugkonstruktion



PC-Replikat
unter polarisiertem Licht

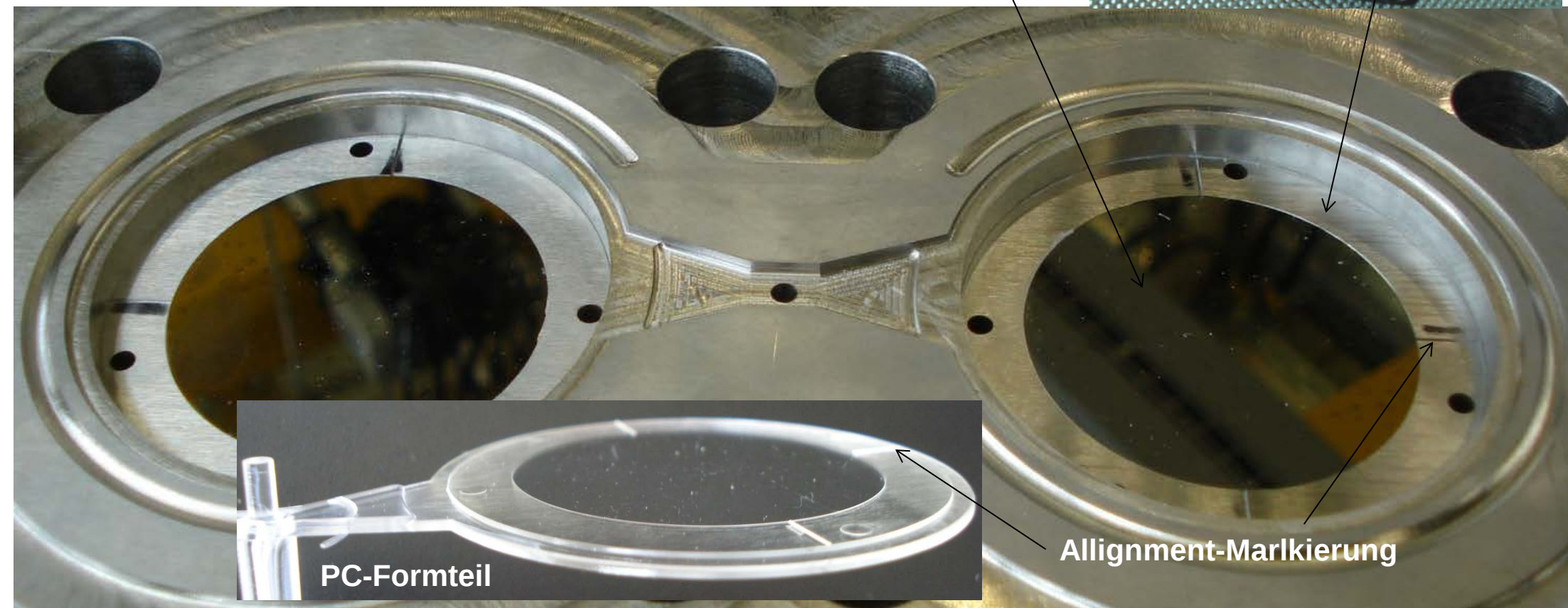
2 Kavitäten
→ Auswerferseite



Insert (2mm Wandstärke, D=45mm)



Insertaufnahme von hinten



PC-Formteil

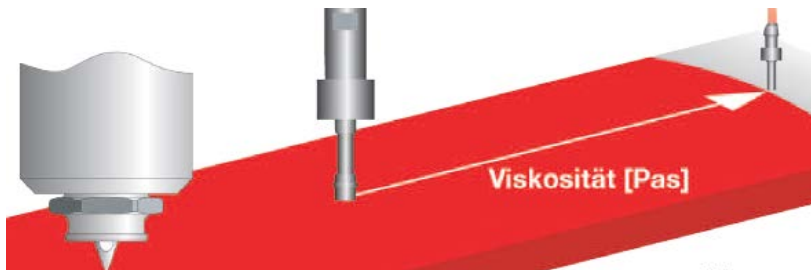
Alignment-Markierung

Sensoren von Priamus

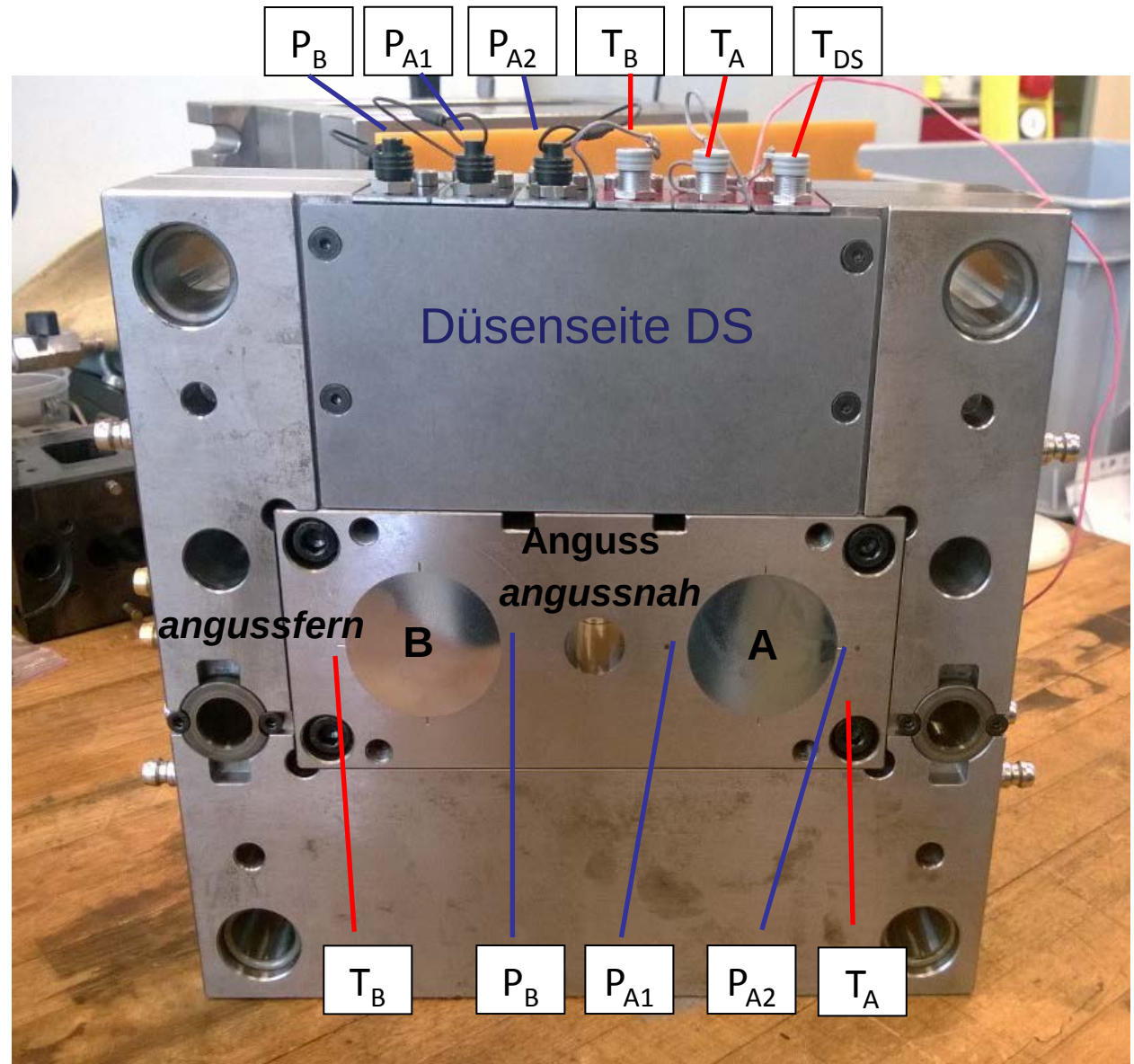
4 Temperatursensoren
3 Drucksensoren

Messung von:

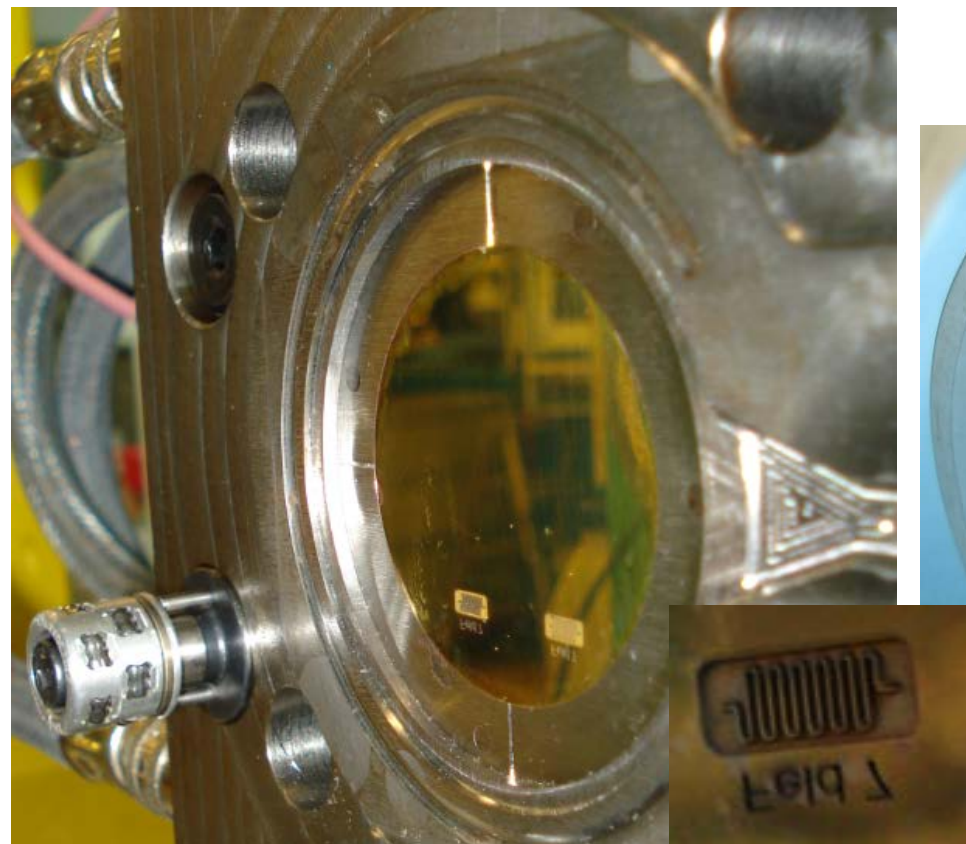
- Füllsymmetrie Kavität A und B
- Druckhomogenität Spritzrängen
- Druckabfall Spritzgiessen
- Viskositätsbestimmung
über P und T Sensor



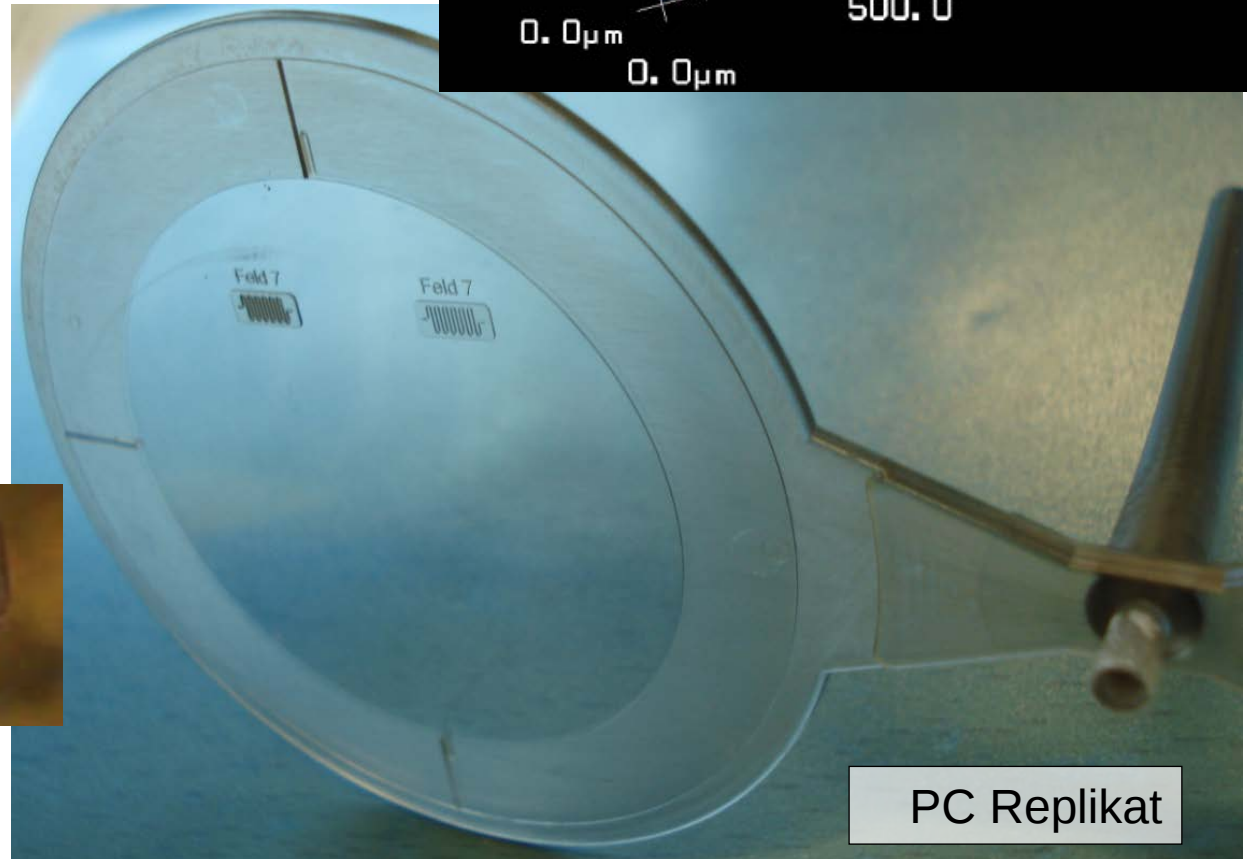
Priamus



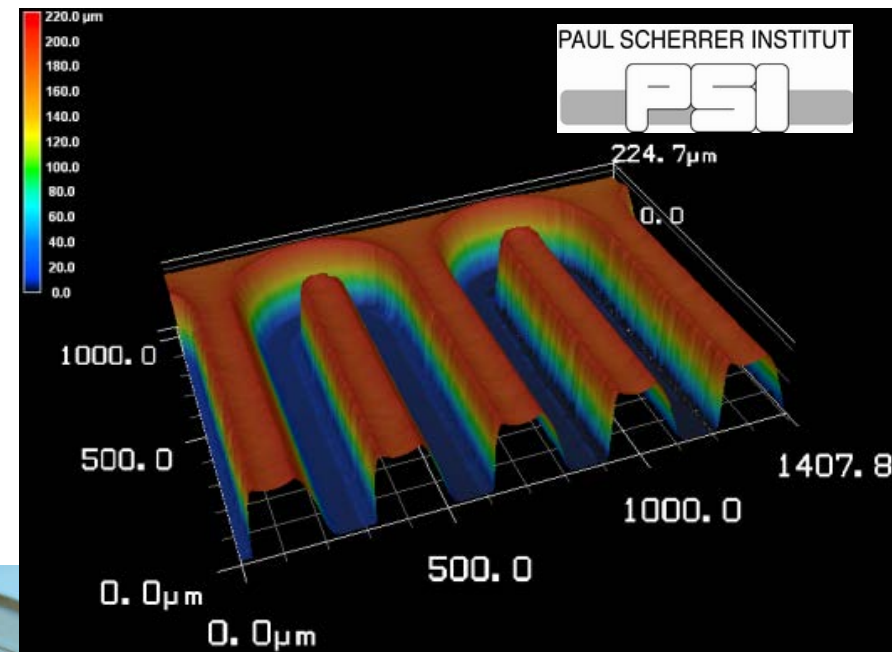
Gelaserte Mikrostrukturen in Messing Anwendungsbeispiel: Mikrofluidik-Mäander



Messing Insert
mit gelaserten Mikrostrukturen



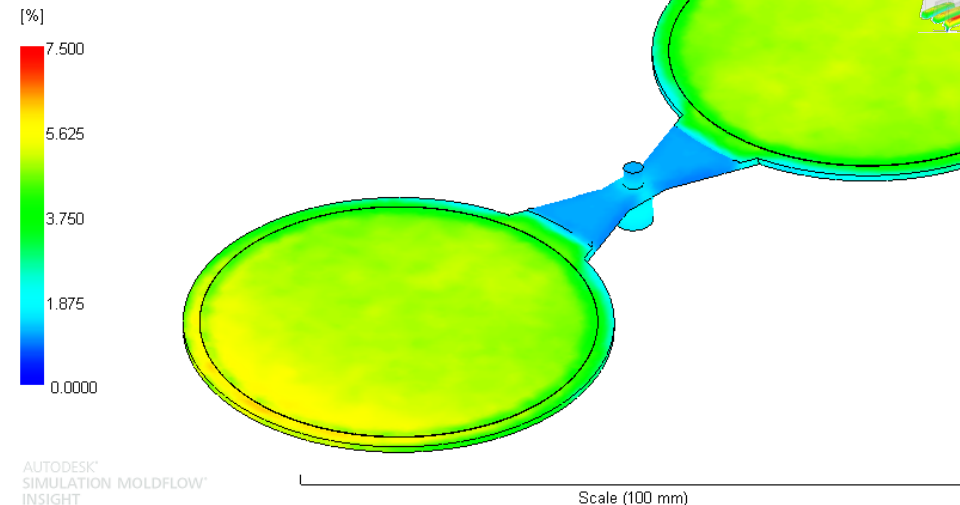
PC Replikat



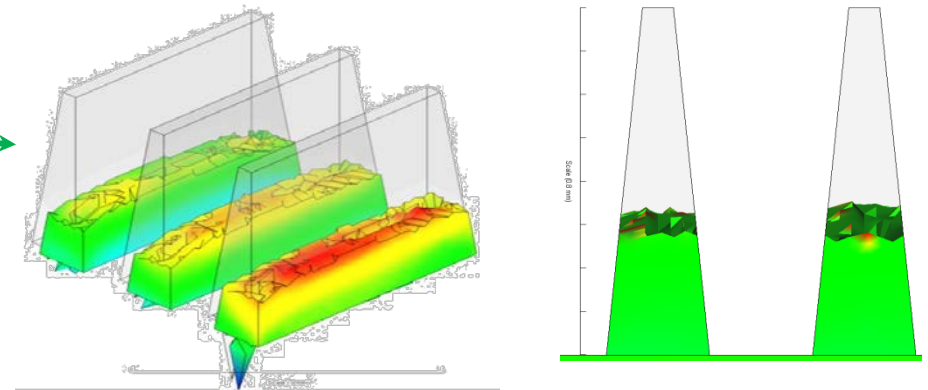
Simulation des Spritz- oder Prägevorgangs in Autodesk Moldflow

Durchschnittlicher Schwund [%]

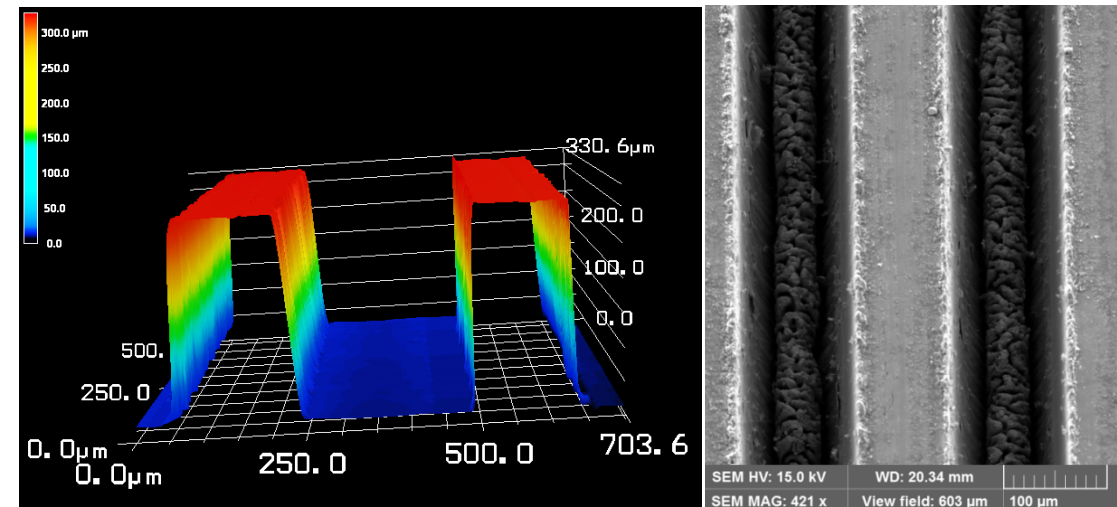
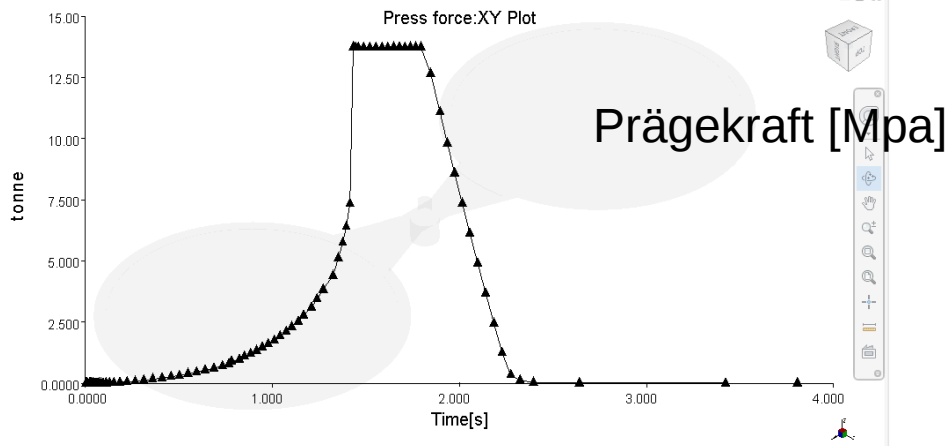
Average volumetric shrinkage
Time = 30.78[s]



Abformung von Mikro- und Nanostrukturen



Simulierte Mikrostruktur

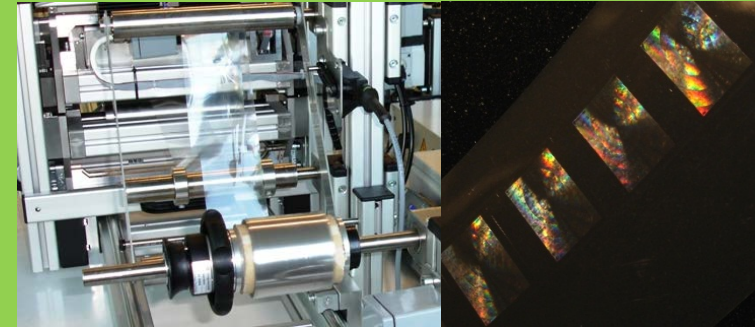


CLSM und REM Aufnahmen der Mikrostruktur

Hot embossing / UV NIL

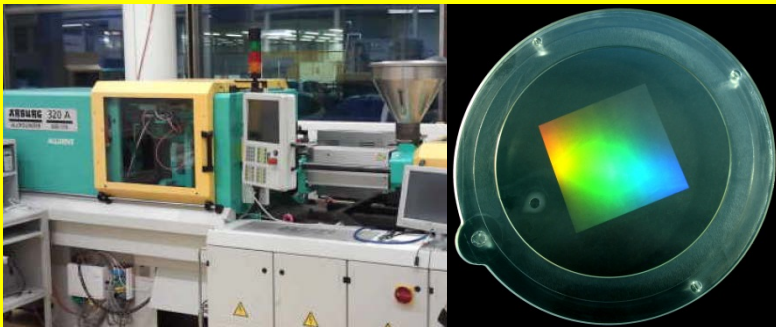


R2R thermal embossing

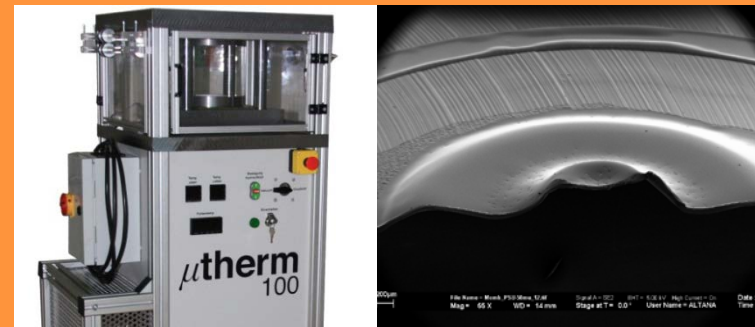


Replication technology toolbox

Injection molding



Microthermoforming



Spezieller Dank geht an:

@ PSI: Dr. H. Schiff, Dr. A. Schleunitz, K. Vogelsang

@FHNW: Ch. Rytka, U. Bruggisser, S. Aubry

THANK YOU !!

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Institute of Polymer Engineering (IKT)

Paul Scherrer Institut

Laboratory for Micro- and Nanotechnology (LMN)

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