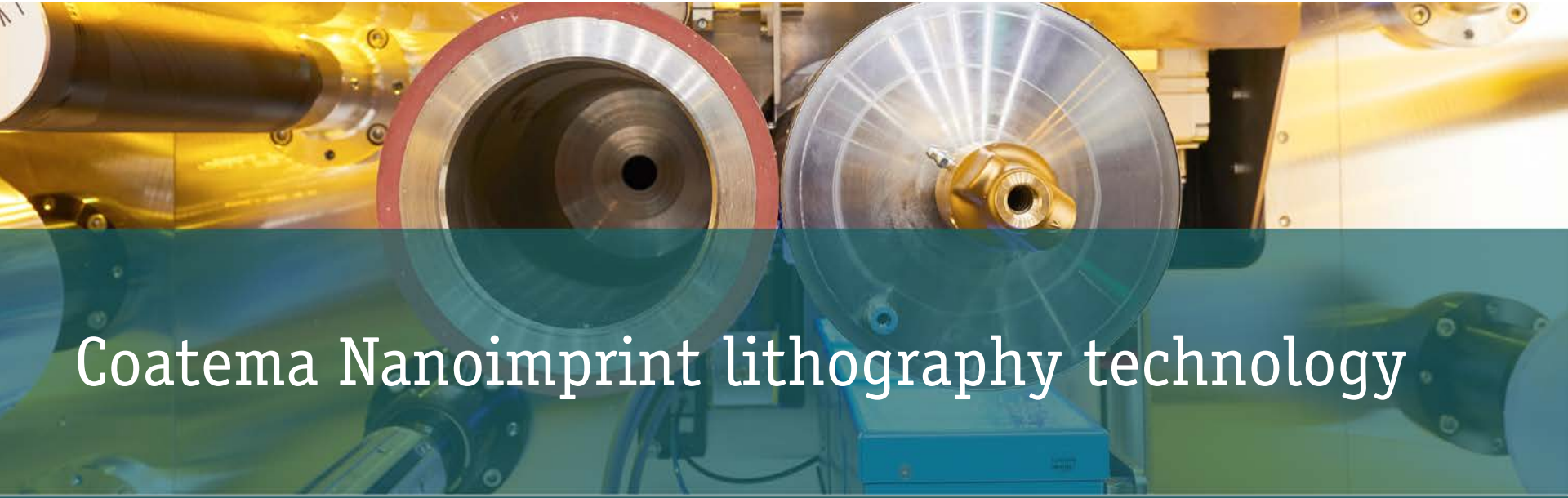


Coatema Nanoimprint lithography technology

Summary

Introduction

Technologies and processes

Products

Equipment

Summary

Summary

Introduction

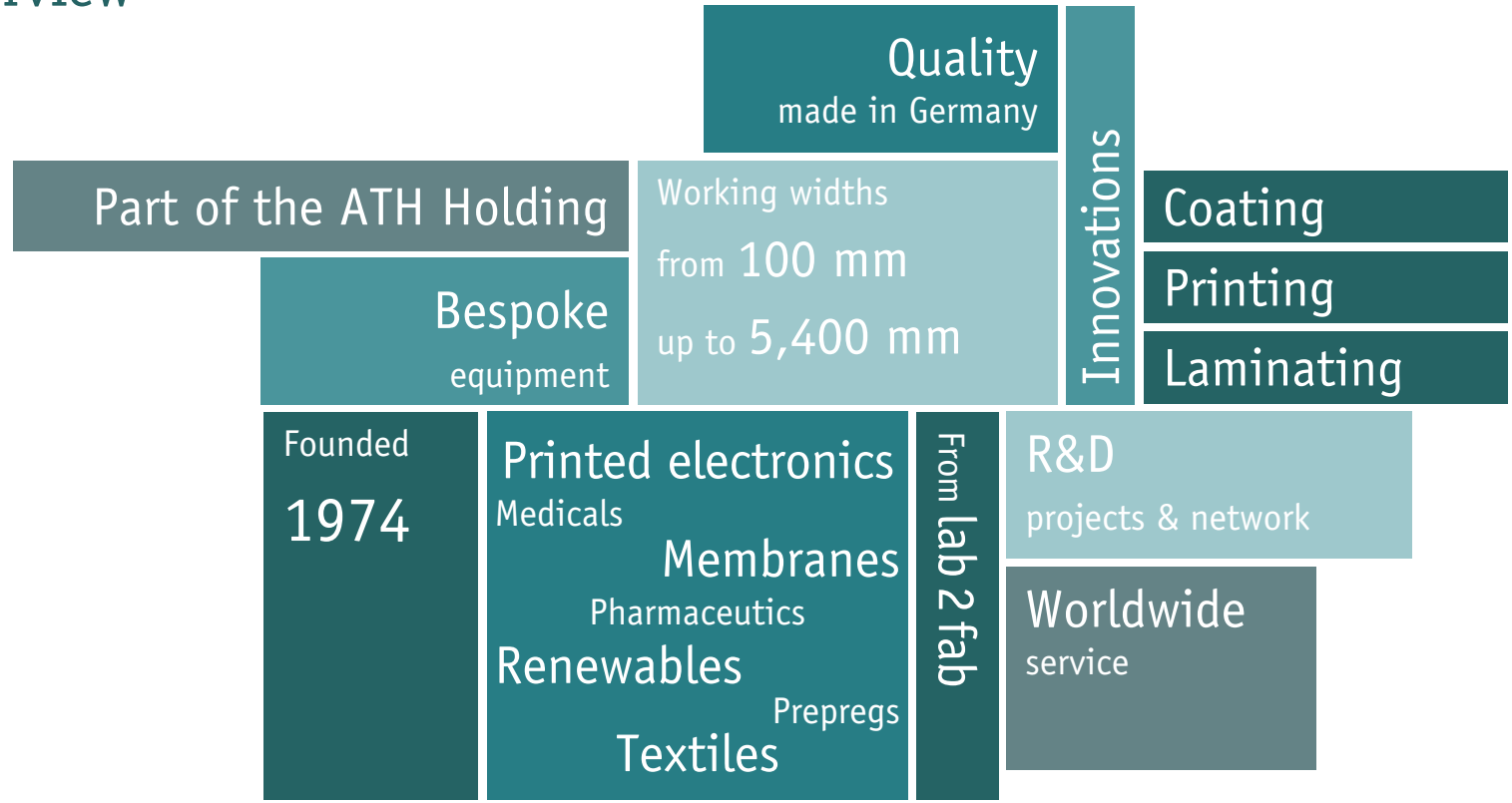
Technologies and processes

Products

Equipment

Summary

Overview



Group of companies

- ✓ Founded 1903
- ✓ Approx. 200 employees
- ✓ Located in Hamburg

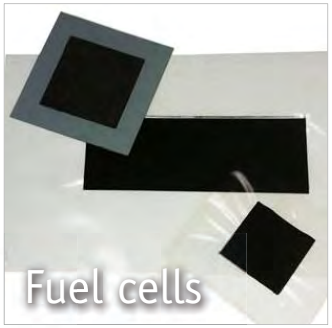
- ✓ Founded 1995
- ✓ Approx. 50 employees
- ✓ Located in Norderstedt

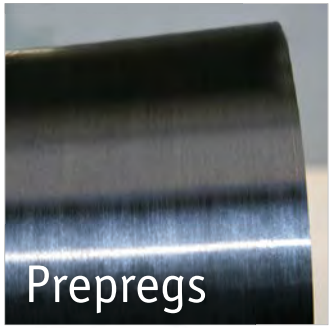
- ✓ Founded 1974
- ✓ Approx. 50 employees
- ✓ Located in Dormagen

- ✓ Founded 1919
- ✓ Approx. 140 employees
- ✓ Located in Hamburg

Represented worldwide

Our markets





Our work in associations – global networking

Board Member:
OE-A

Advisory Board:
Fraunhofer ITA

Coatema customers

R&D customers

R&D projects overview 2020

PowderSizing

FLEX-G

GREEN SENSE

SUPERSMART

ENP

SOLID

Oled Solar

EI-FIB
ELECTROLUMINESCENCE for FLAGS, INTERIOR and BANNERS

PEPcat

E-Nanoprint Pro

EffiLayers

REAL NANO

FLEX FUNCTION 2 SUSTAIN

SolGel PV

Summary

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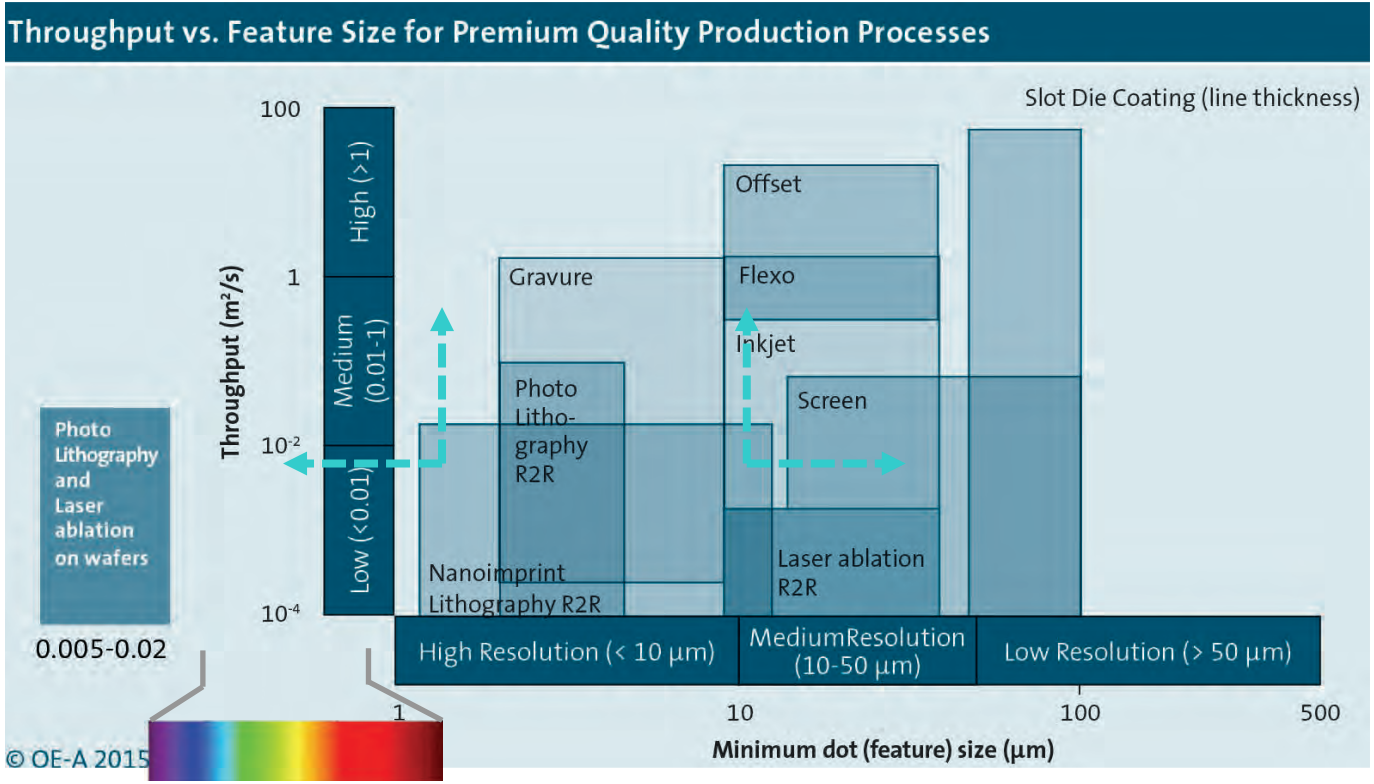
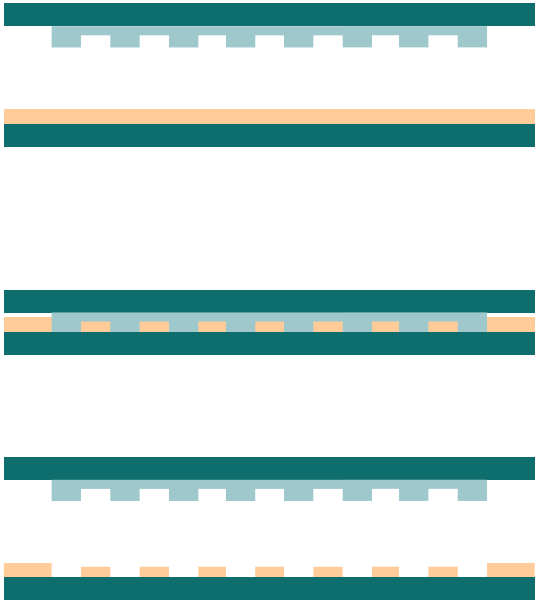
Equipment

Summary

Why is nanoimprint lithography relevant?

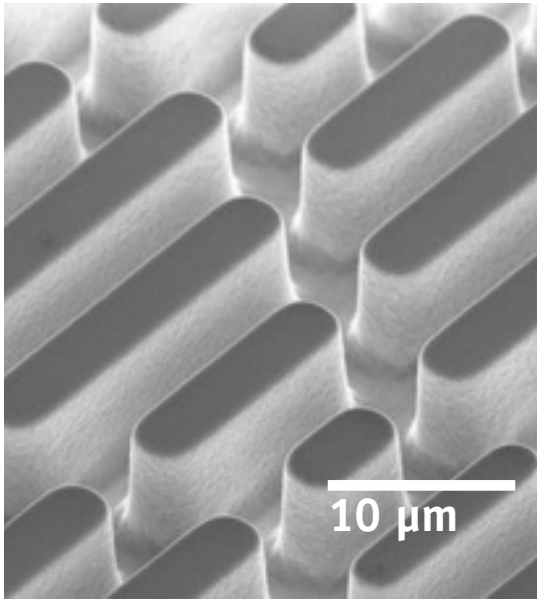


Basic principle of nanoimprint lithography



Principle

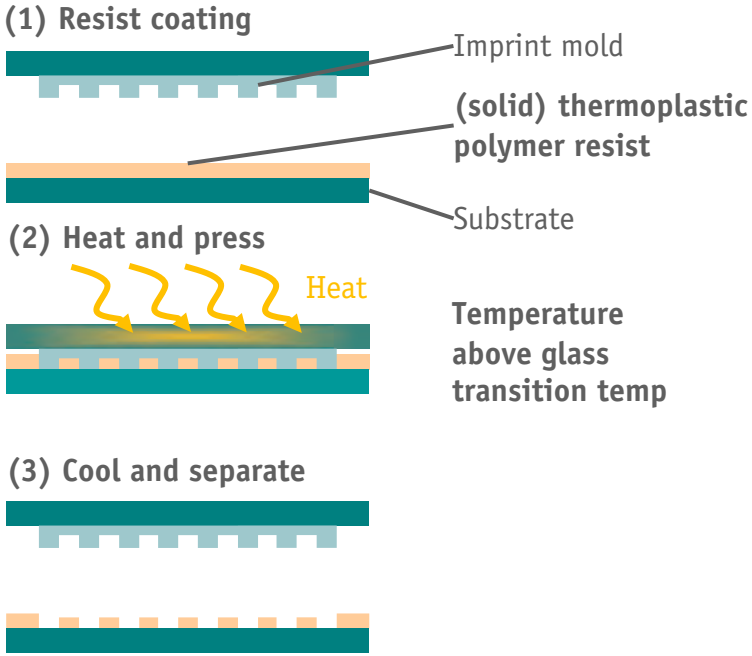
Ancient days



Modern days

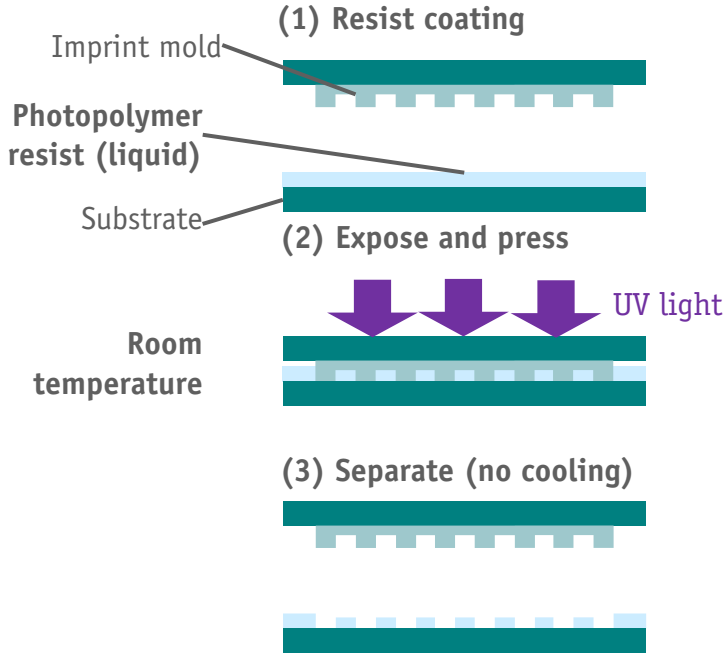
Basic principle of nanoimprint lithography

THERMAL NIL



VS

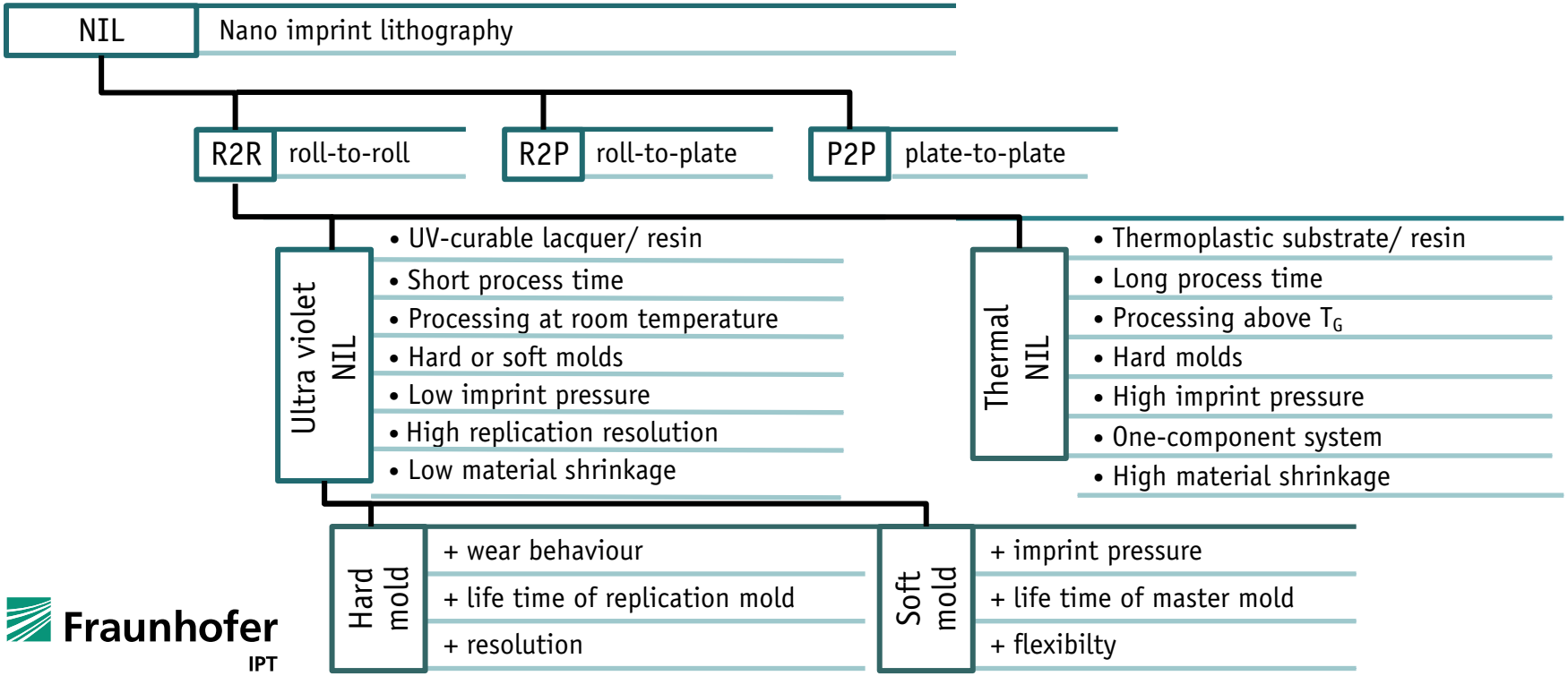
UV NIL



Basic principle of nanoimprint lithography

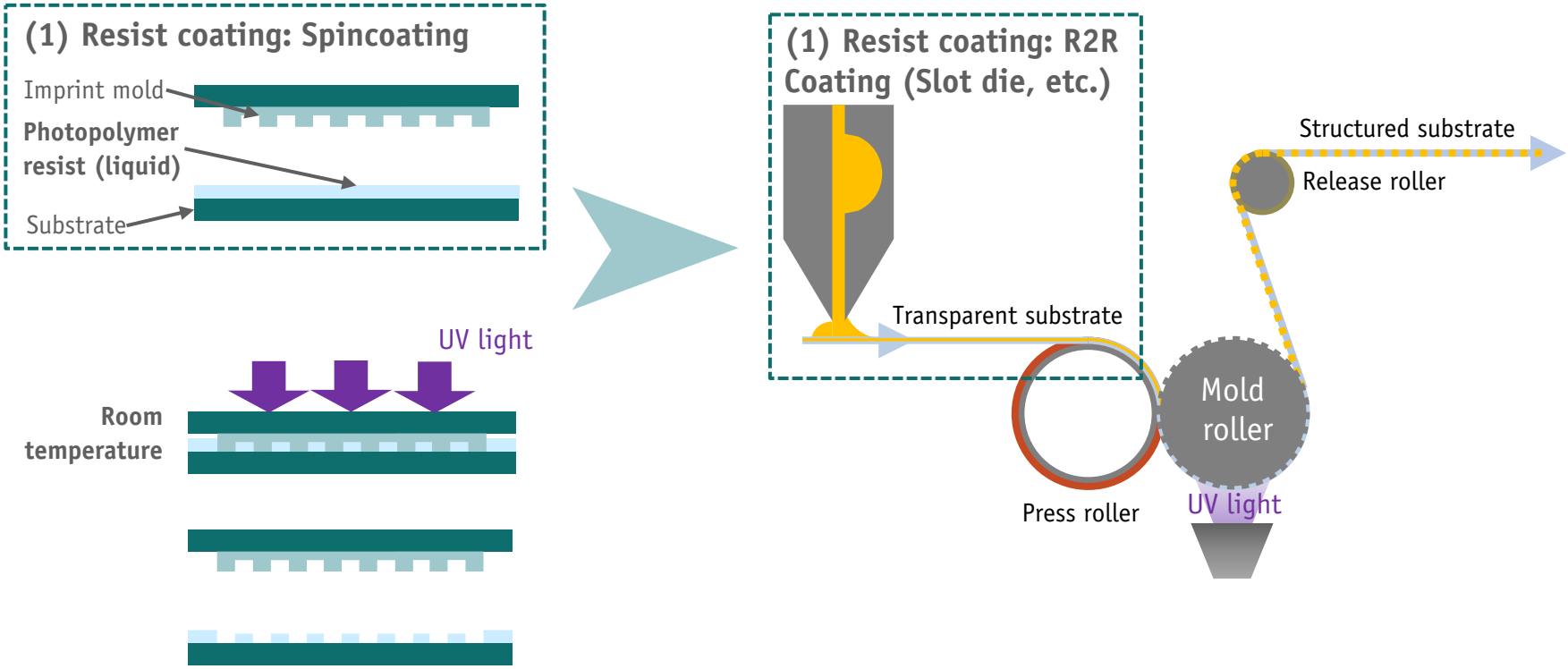
THERMAL NIL	VS	UV NIL
✓ **Imprint into substrate possible**		✓ **(faster)**
✓ **Great depths possible**		✓ **Uniformity**
✓ (slower)		✓ **Less viscous resists (less pressure)**
✓ heat distribution		✓ **Soft molds possible**
✓ Thermal conductive mold		✓ UV resists (Transparent substrate or mold)
✓ Thermal expansion of mold and resist		
✓ Cooling		
✓ Higher pressure		

Overview of nanoimprint lithography technologies and processes

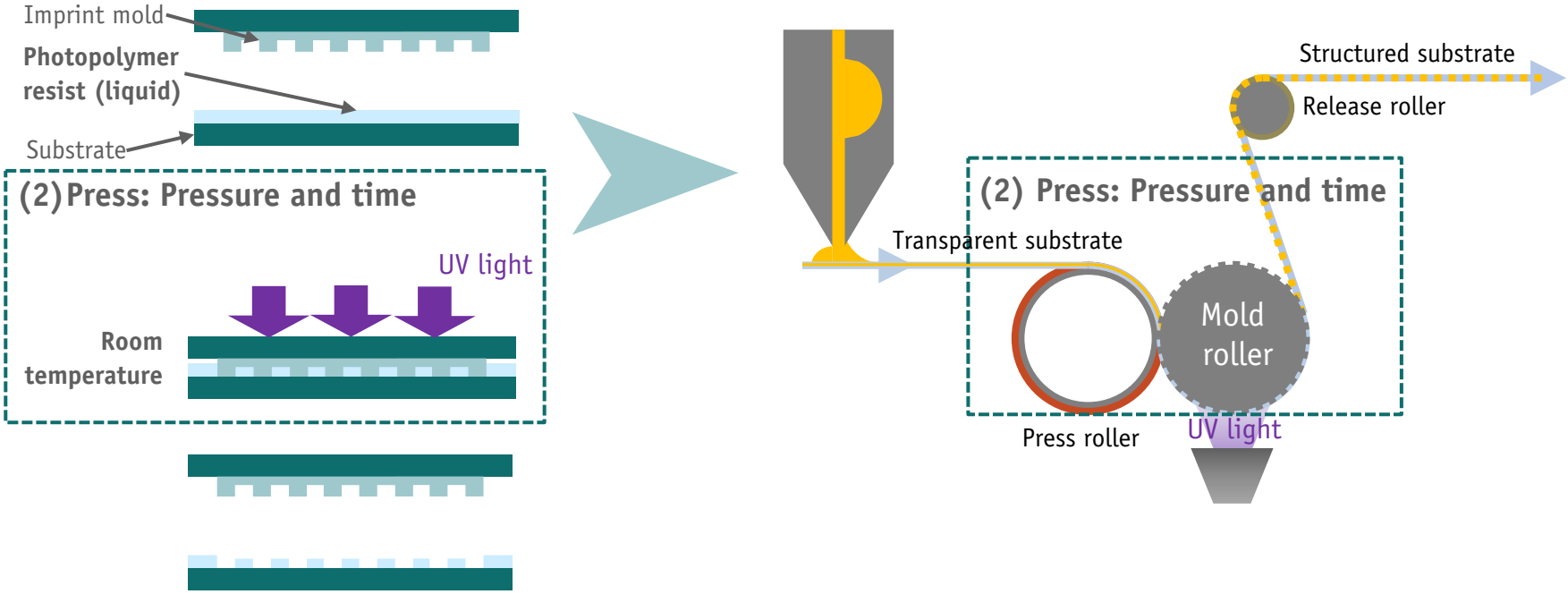


Fraunhofer IPT

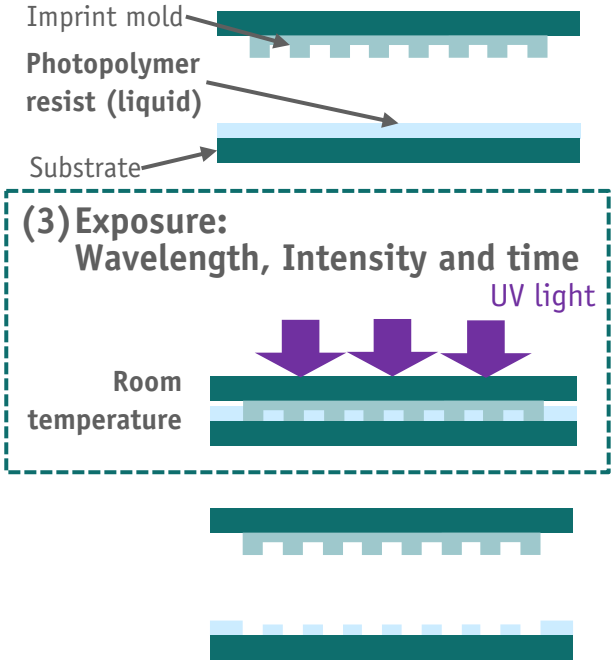
Translating from P2P to R2R

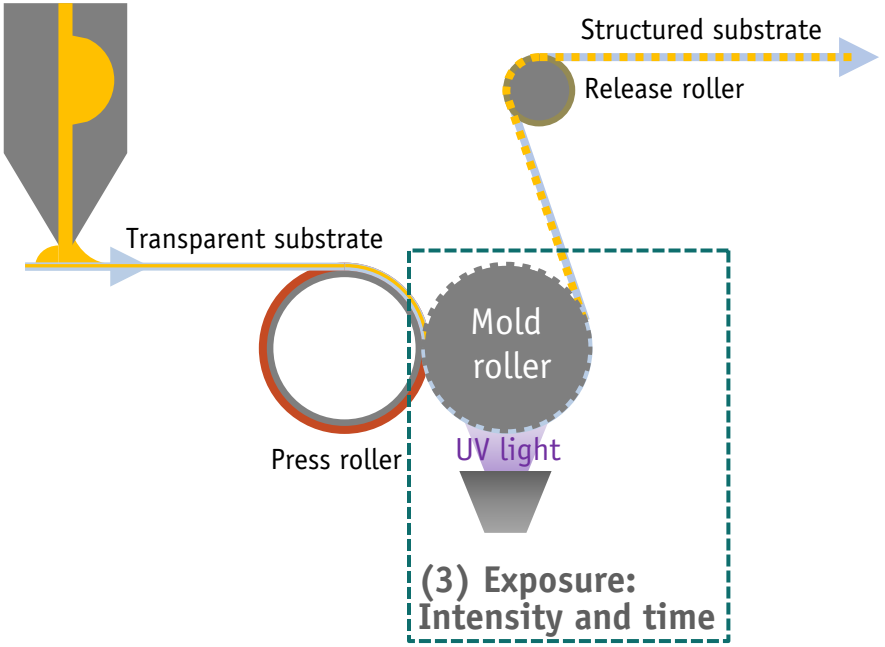


Translating from P2P to R2R

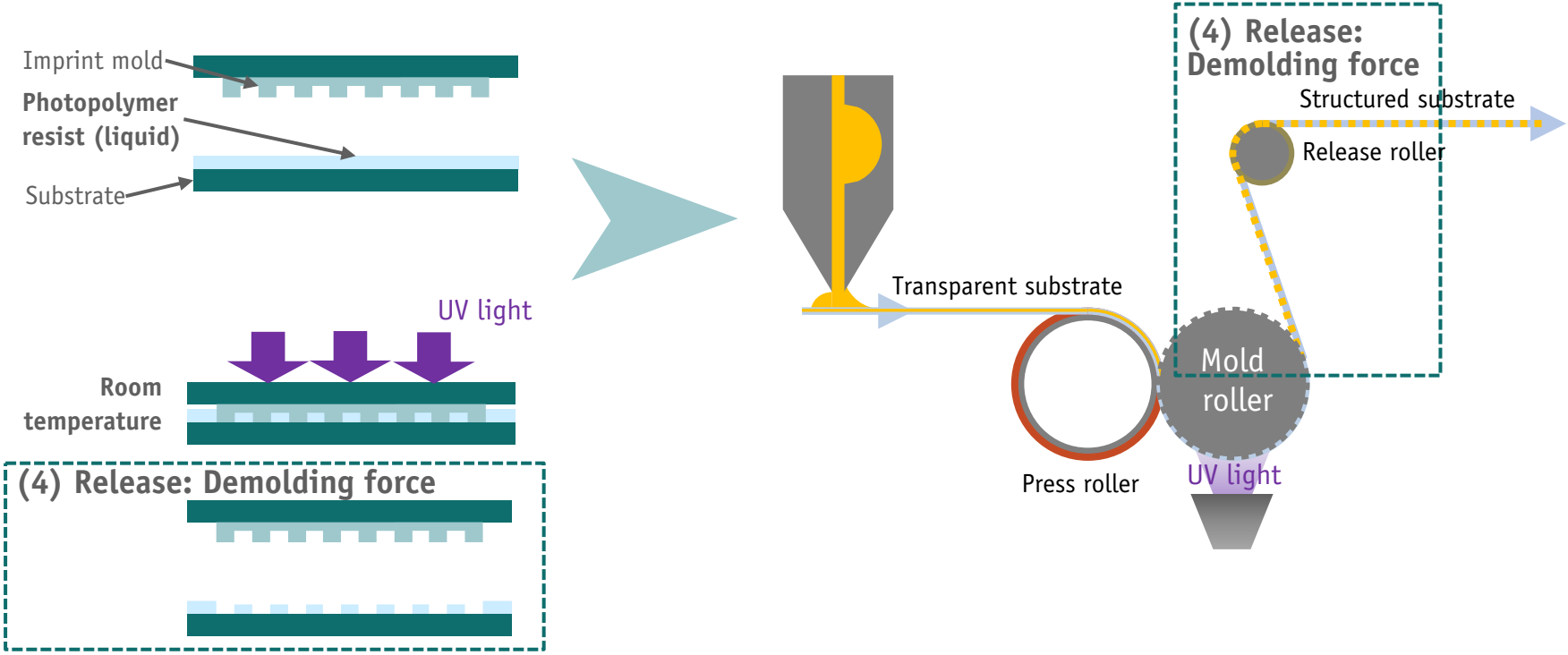


Translating from P2P to R2R

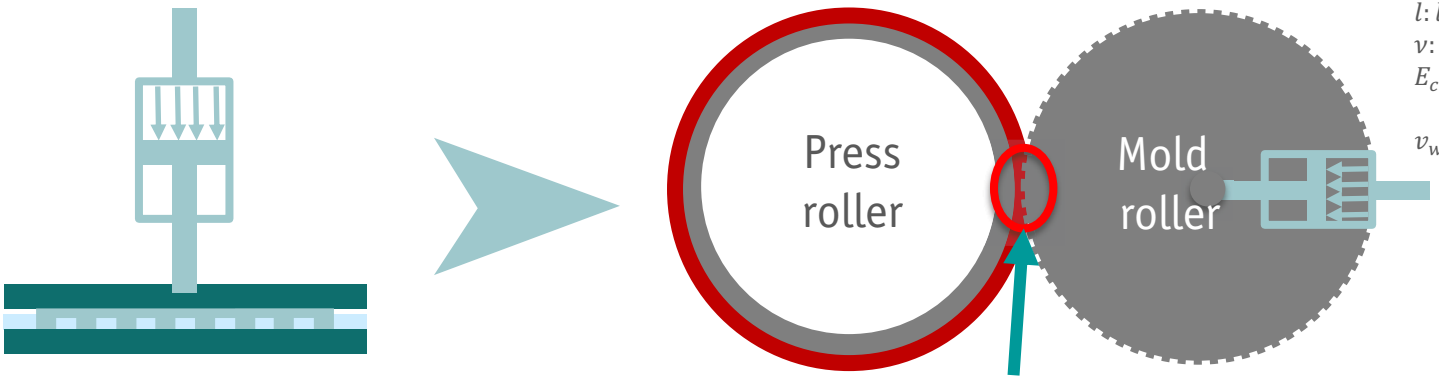




Translating from P2P to R2R



Translating from P2P to R2R



F: Force mold roller
r: Radius press roller
l: length press roller
ν: Poisson's number
E_{comb}: Combined modulus
v_{web}: Webspeed

$$p_{\text{press}} = p_{\text{cylinder}} \cdot \frac{A_{\text{cylinder}}}{A_{\text{imprint}}}$$

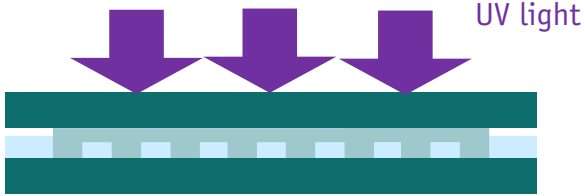
$$t_{\text{press}} = variable$$

Hertzian deformation:

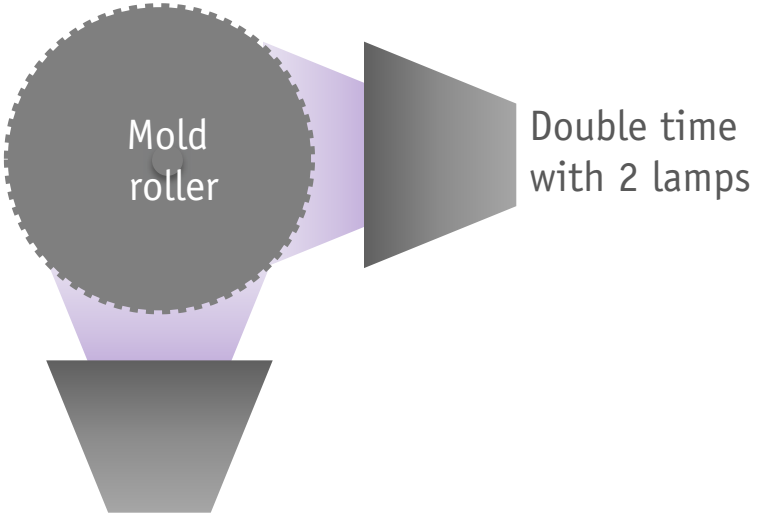
$$p_{\max} = \sqrt{\frac{F}{2\pi r l} \cdot \frac{E_{\text{comb}}}{1-\nu^2}}$$

$$t_{\text{press}} = 2 \cdot \arccos\left(1 - \sqrt{\frac{F}{2\pi r l E_{\text{comb}}} \cdot \frac{1}{1-\nu^2}}\right) \cdot \frac{r}{V_{\text{web}}}$$

Translating from P2P to R2R



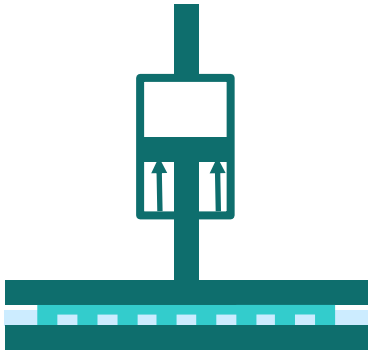
$$t_{expo} = variable$$
$$I = I_0 \cdot e^{-\alpha \cdot d_{resist}}$$

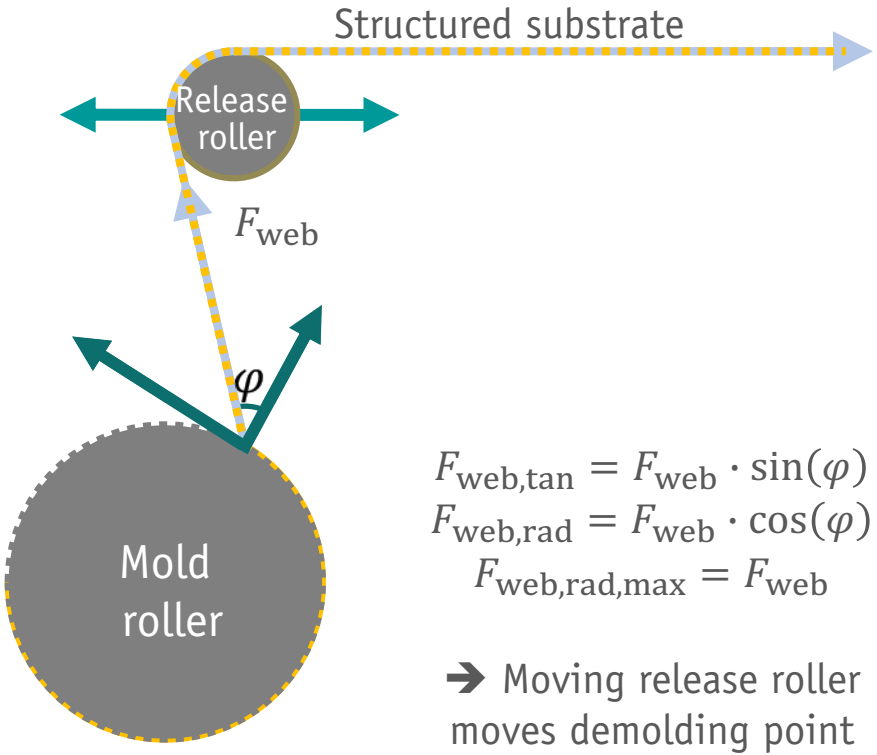


$$t_{expo} = \frac{2r}{v_{web}} \cdot \arcsin\left(\frac{w_{lamp}}{2r}\right)$$
$$I = I_0 \cdot e^{-\alpha \cdot d'_{resist}}$$
$$\text{with } d' = \sqrt{(r+d)^2 - x^2} - \sqrt{r^2 - x^2}$$

Translating from P2P to R2R

$$p_{\text{release}} = p_{\text{cylinder}} \cdot \frac{A_{\text{cylinder}}}{A_{\text{imprint}}}$$





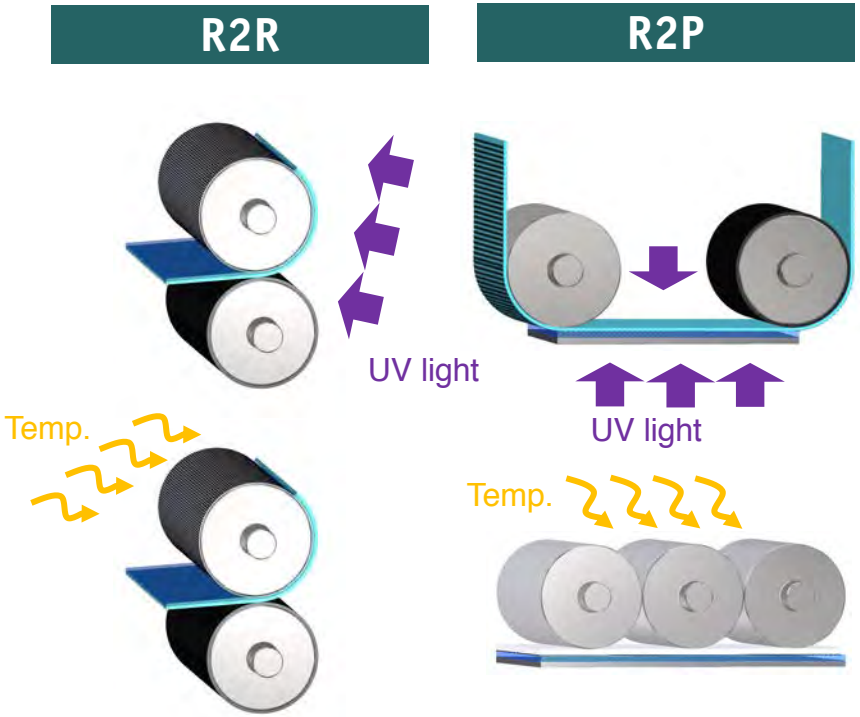
$$F_{\text{web,tan}} = F_{\text{web}} \cdot \sin(\varphi)$$
$$F_{\text{web,rad}} = F_{\text{web}} \cdot \cos(\varphi)$$
$$F_{\text{web,rad,max}} = F_{\text{web}}$$

➔ Moving release roller moves demolding point

Translating from P2P to R2R

Parameter	P2P (lab)	R2R (1 m/min)
Coating thickness	5 µm (Spin coating)	5 µm (Slot die)
Dimensions	25 x 25 mm²	250 mm
Press pressure	1 bar	Up to 3.6 bar
Press time	2 s	~3 s (increase with softer press roller)
Exposure time	4 s	~6.4 s (1 lamp)
Release force	15 N	~120 N
Release angle to normal	0°	53° (@200 N)
Tensile force	-	Up to 250 N
Throughput	3 samples/minute (0.001875 m²/min)	0,25 m²/min Factor >120

Technologies and processes



UV NIL system designs:

- ✓ Surface activation
  Corona, plasma, chemical treatment
- ✓ Coating
  Slot die, knife, roller coater …
- ✓ UV curing
  Mercury, LED UV radiator

NIL system designs:

- ✓ Heating
- ✓ IR/ NIR, inductive, laser heating or heated fluids in embossing drum

Replication mold:

- ✓ Drum, endless belt, film
- ✓ One-/ Multi-Temperature zones

Technologies and processes

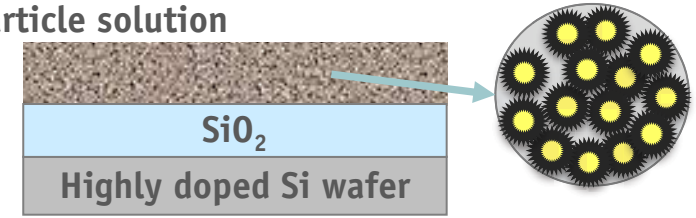
Process parameters (selection):

- ✓ Resist
  - ✓ Chem. formulation
  - ✓ Viscosity / rheology
- ✓ Film
  - ✓ Chem. formulation
  - ✓ Chemical / mechanical pre-treatment
- ✓ Tool
  - ✓ Hard / soft mold
  - ✓ Anti-adhesion layer
- ✓ UV-source
  - ✓ Spectral distribution
  - ✓ LED- / conventional source

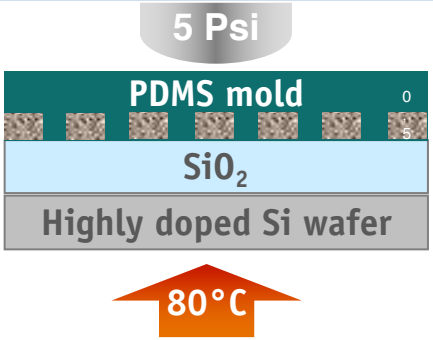
Innovative coating of gold contacts:

A. Coating of substrate

Nanoparticle solution



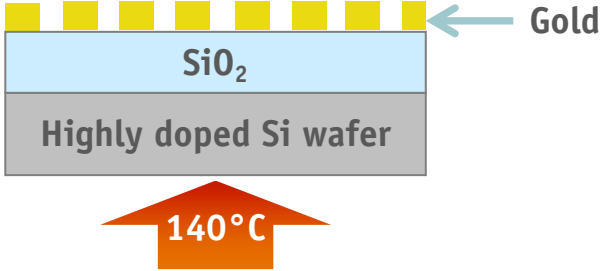
B. Thermal imprint



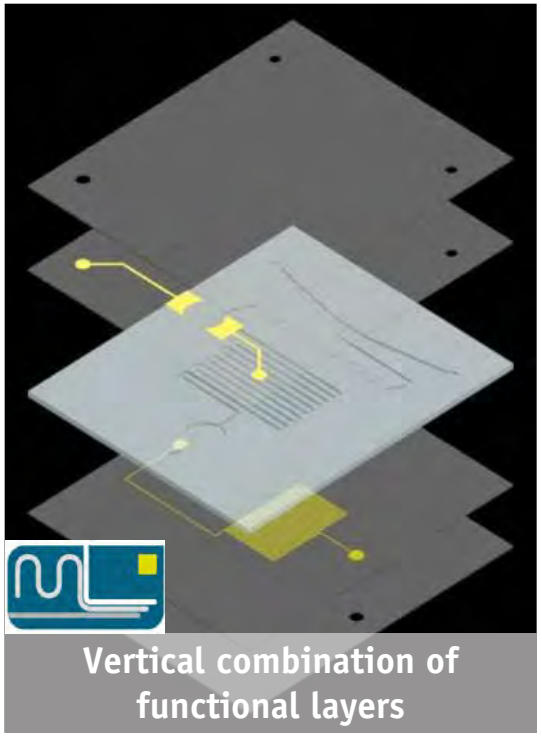
C. Imprinted structure

Dried nanoparticles

D. Sintering of gold NP to gold-contacts

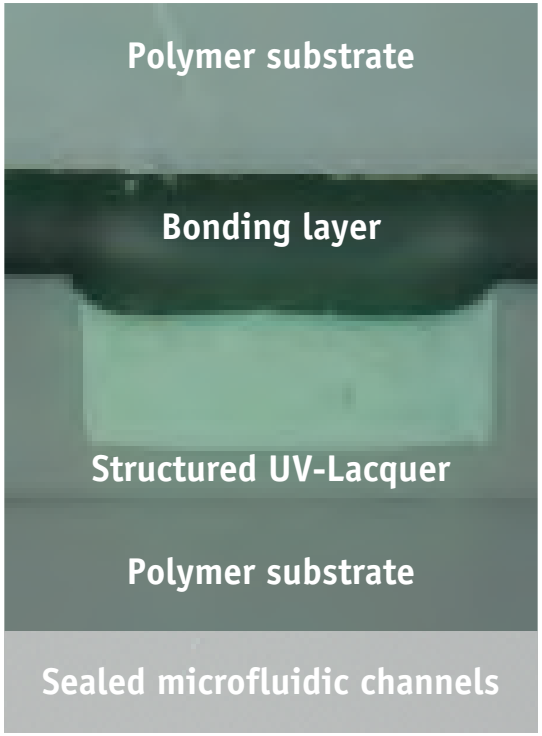


Technologies and processes



Vertical combination of functional layers

EU FP7, coordinated by Fraunhofer IPT www.ml2.eu/



Sealed microfluidic channels

1. Top sealing layer
2. Optical layer
   - ✓ light guide for fluorescence detection
3. Microfluidic layer
   - ✓ Fluid input, mixer, serpentine channel, detection well

2 stacked imprint structures

4. Electrical layer
   - ✓ Heaters for two temperature zones
5. Bottom sealing layer

Technologies and processes

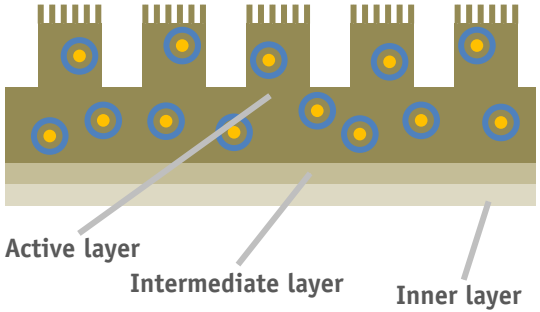
Micro pillars:

✓ Anti-sticking properties

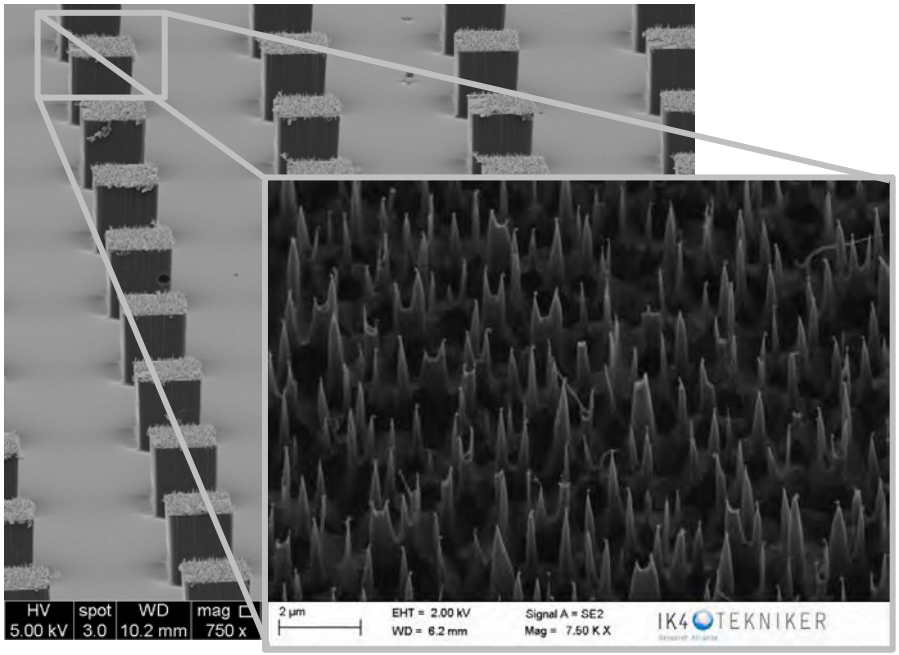
Nanospikes:

✓ Perforation

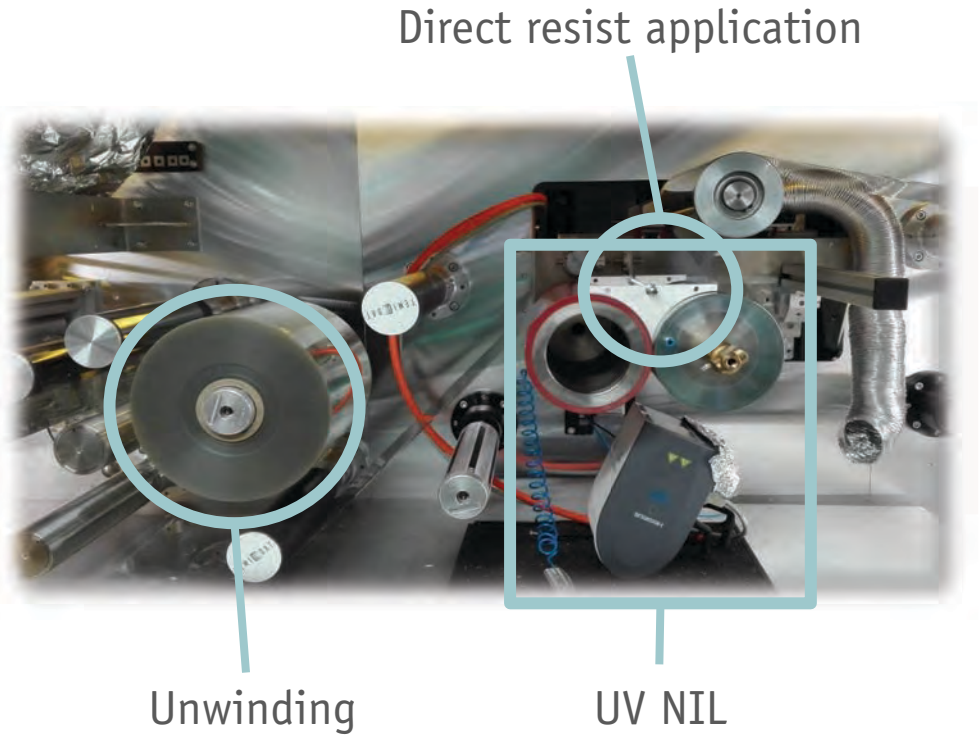
3-layered antimicrobial film

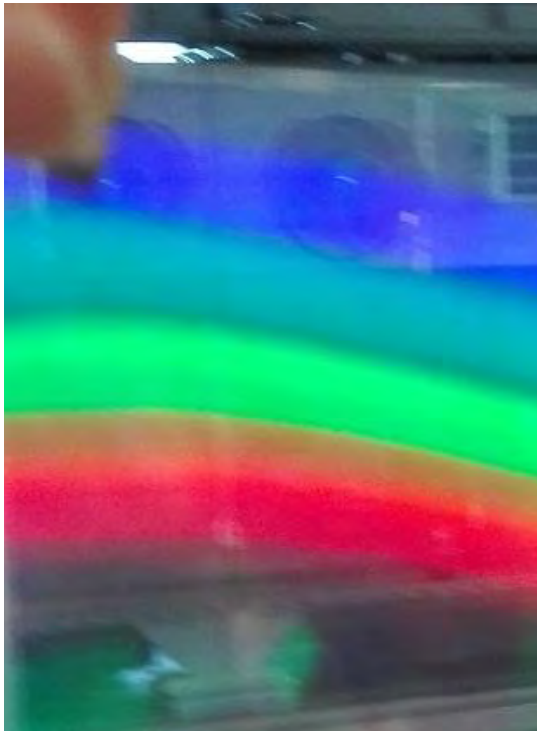


Hierarchical micro-/ nano structures



Technologies and processes

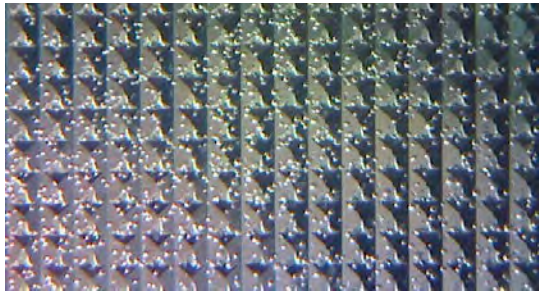




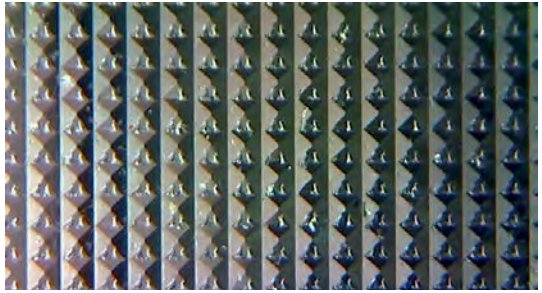
How to not do UV NIL:

- ✓ Too much resist
- ✓ Too little UV
- ✓ Too fast substrate speeds

Technologies and processes



Bubble enclosures



Geometrical defects

Influences on the quality mainly result from

Substrate:
- ✓ Impurities / Dust

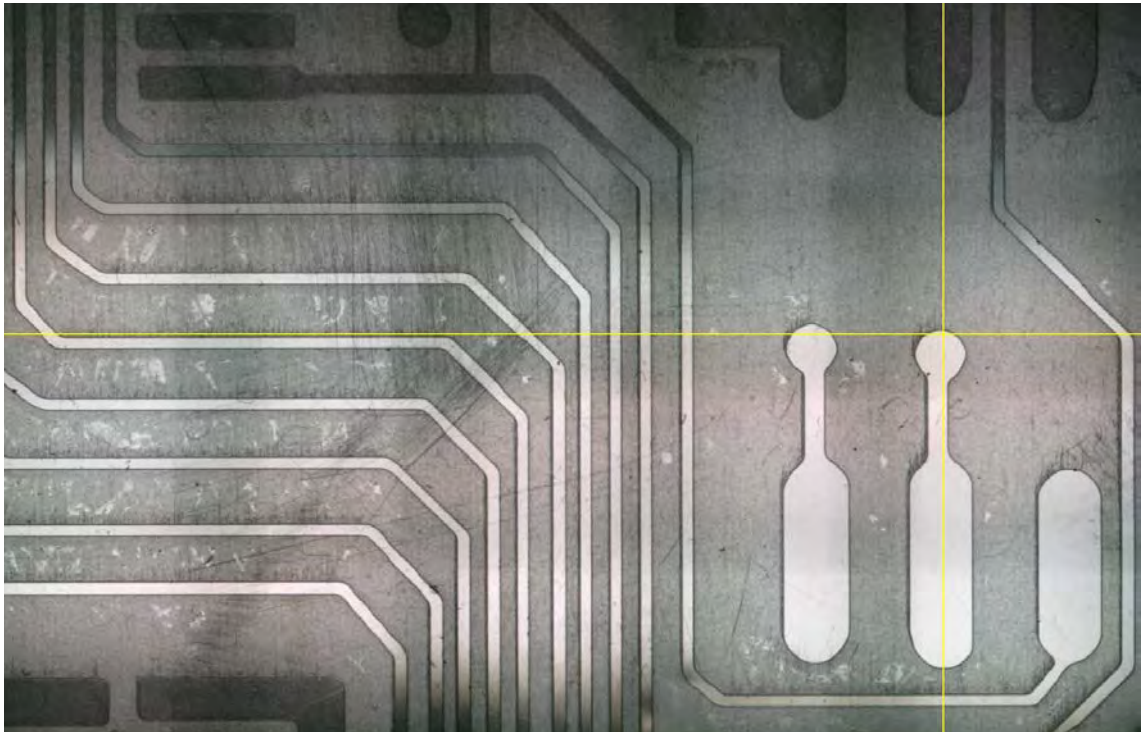
Wetting behaviour

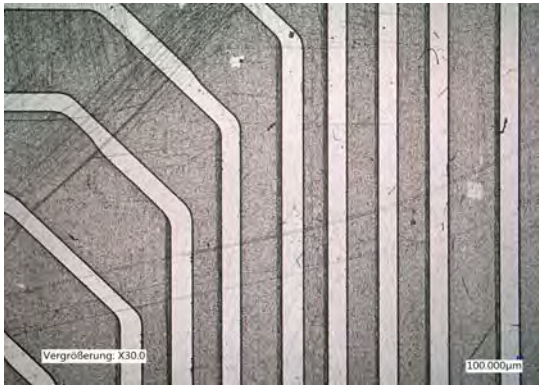
Embossing drum:
- ✓ Machining errors (e.g. badly joint sleeves)
- ✓ Wear

Partial / total lacquer adhesion

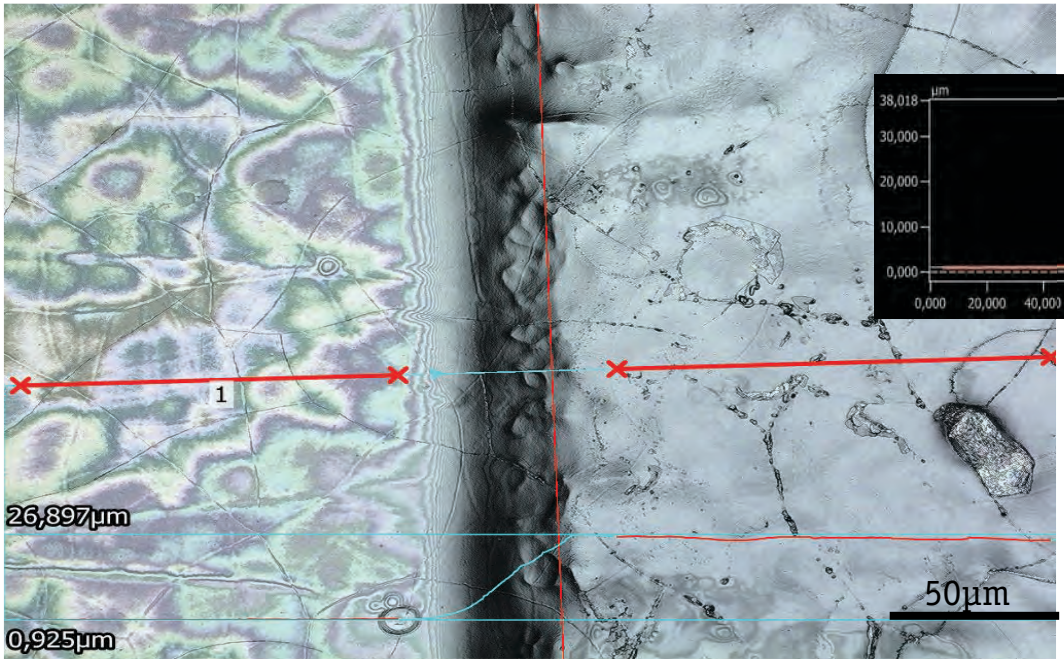
Resist:
- ✓ Impurities / Dust
- ✓ Bubbles / Foam
- ✓ Coating homogeneity

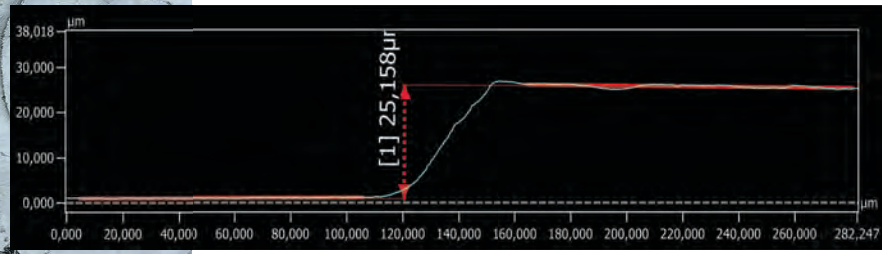
Successful imprint several mm down to 40µm feature size





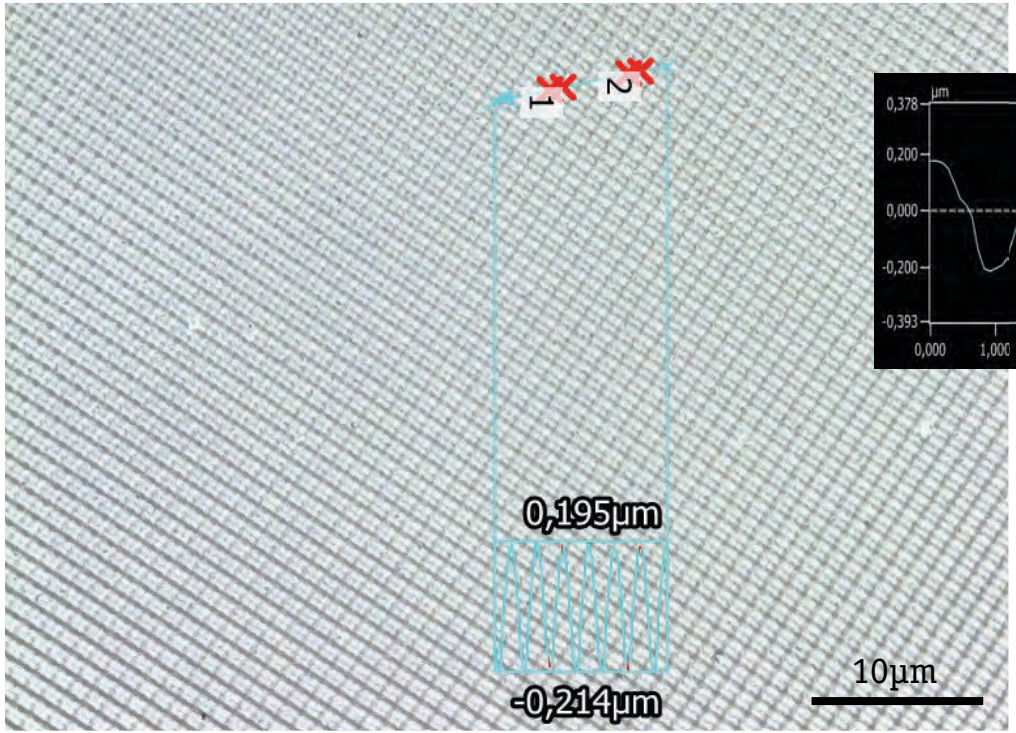
Technologies and processes

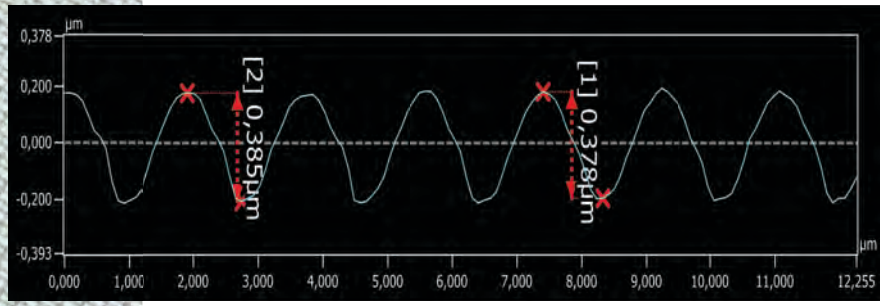




- ✓ 25µm dry layer thickness
- ✓ Aspect ratio 1:1
- ✓ But:
  Resist too brittle

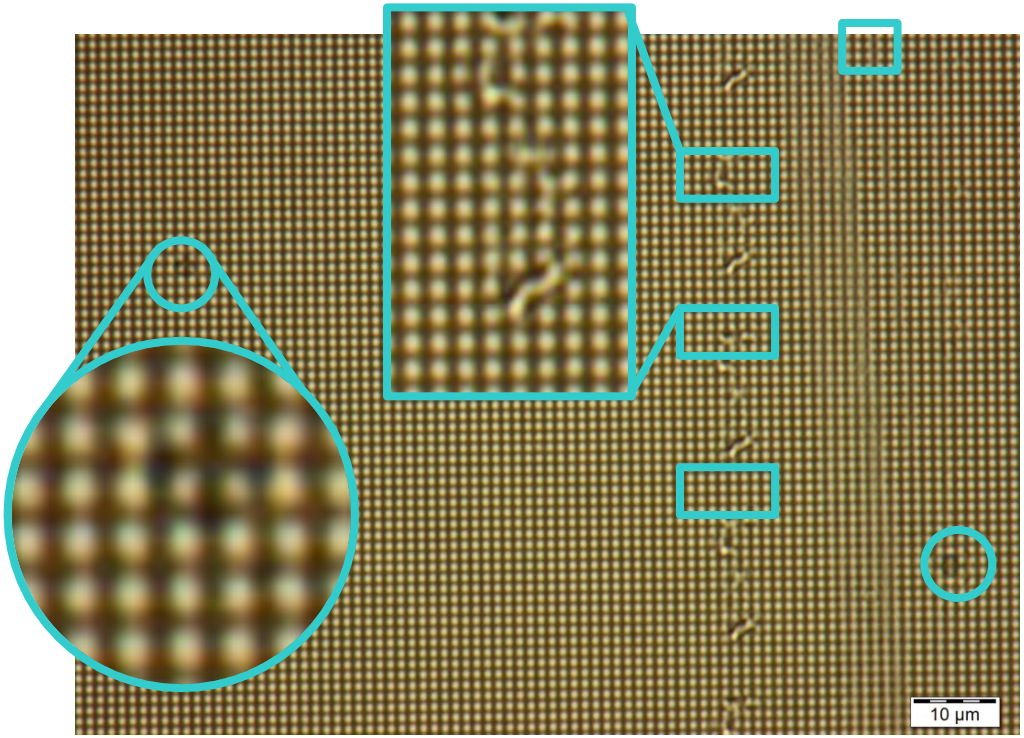
Technologies and processes





- ✓ 380nm feature size
- ✓ Aspect ratio 2:1
- ✓ Low density of defects

Technologies and processes



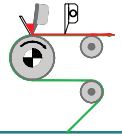
Imprint defects:

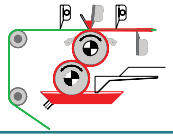
1. Surface scratches

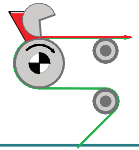
2. Point defects
   → No effect on optical purpose

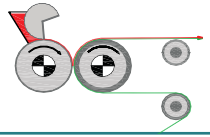
3. Damages in sleeve
   → Periodic damage in optical structure

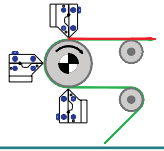
Coating systems

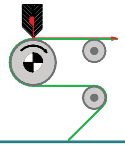

Knife system

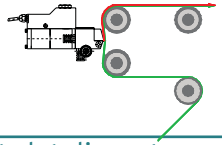

Double side system

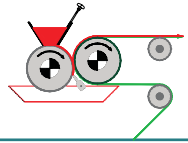

Commabar system

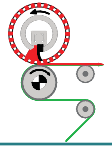

Reverse commabar system

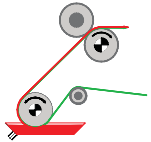

Slot die system

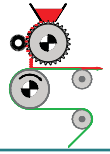

Curtain coating system

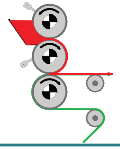

Hotmelt slot die system

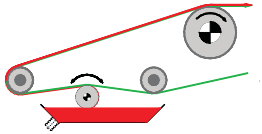

Case knife system

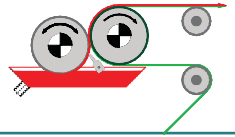

Rotary screen system

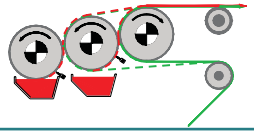

Dipping system (Foulard)

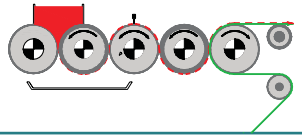

Powder scattering system


Reverse roll system

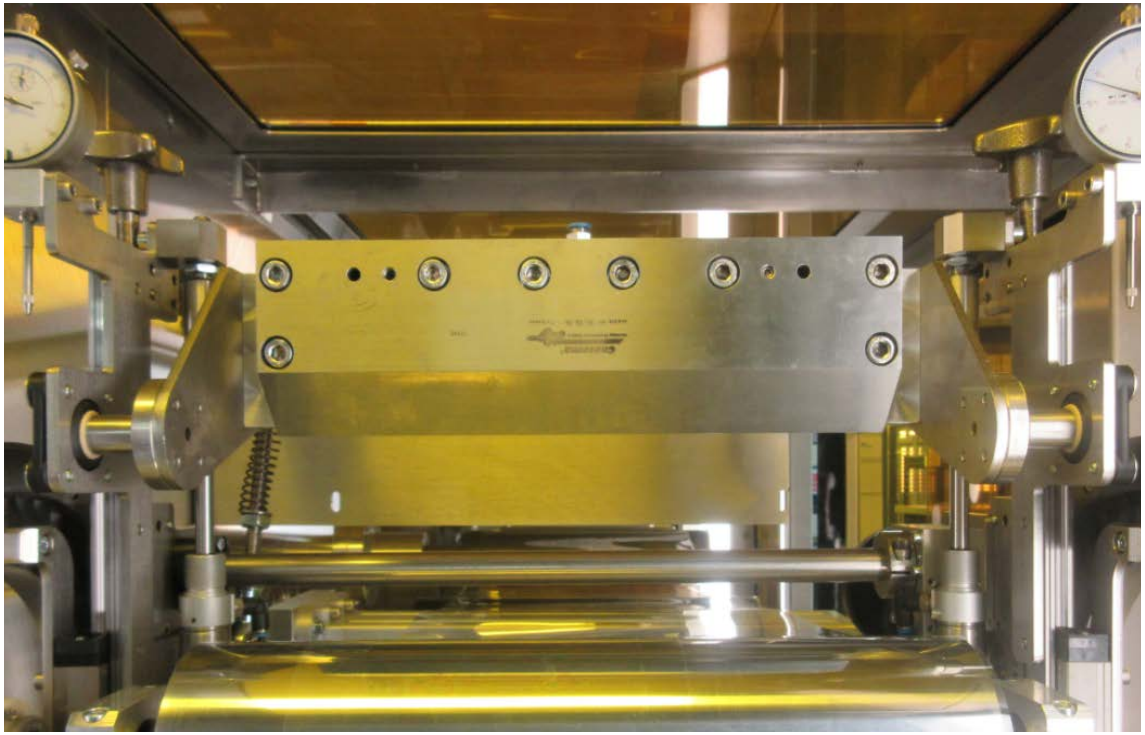

Micro roller system


2 Roller system

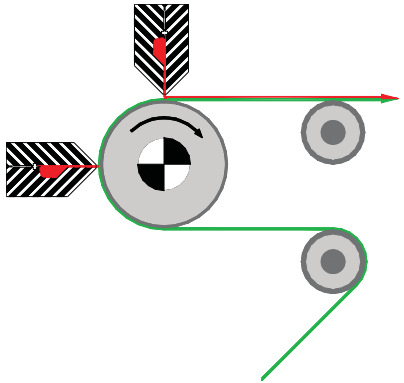

3 Roller combi system


5 Roller system

Coating and printing for nanoimprint lithography

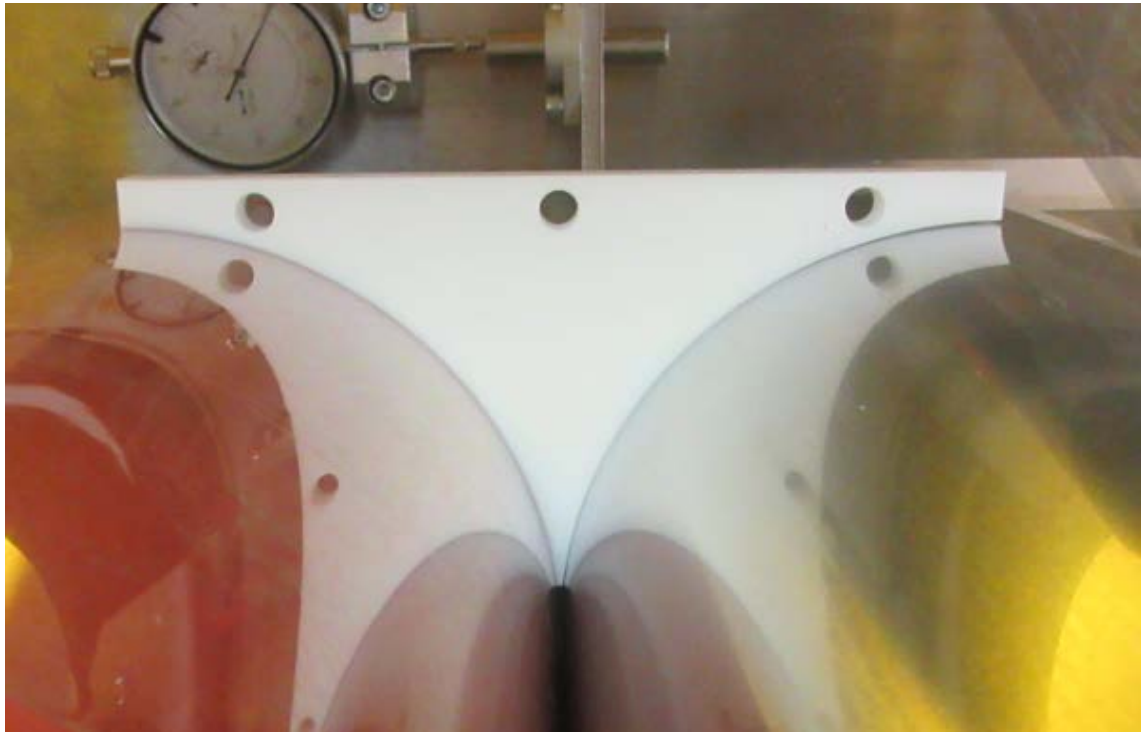


Slot die coating for
pre-metered film coating

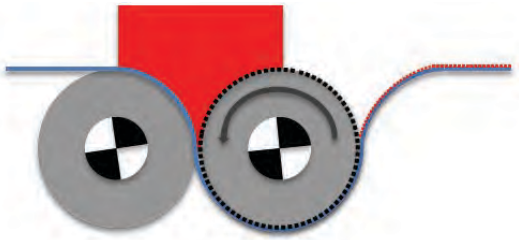


- ✓ Layer control
- ✓ Level control in the nip
- ✓ 12/9” position

Coating and printing for nanoimprint lithography

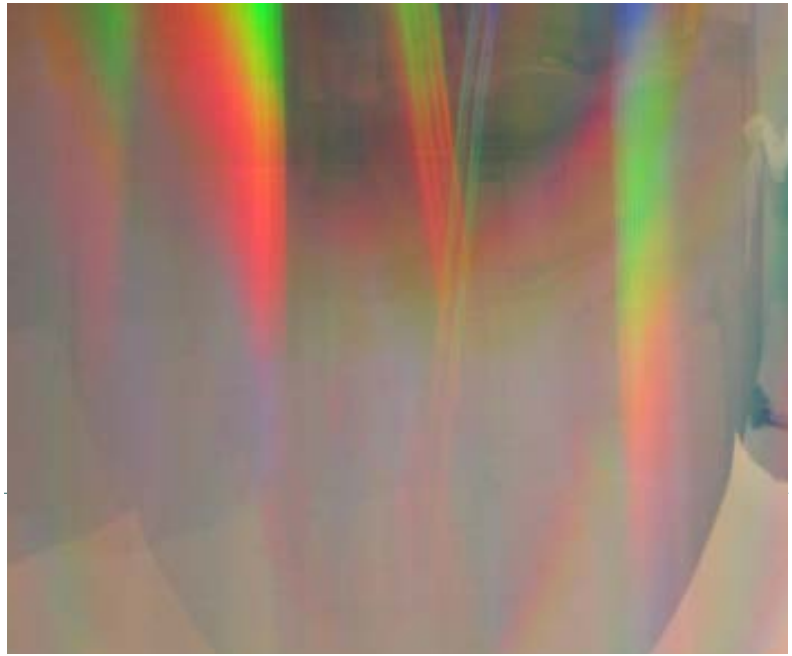


Nip coating

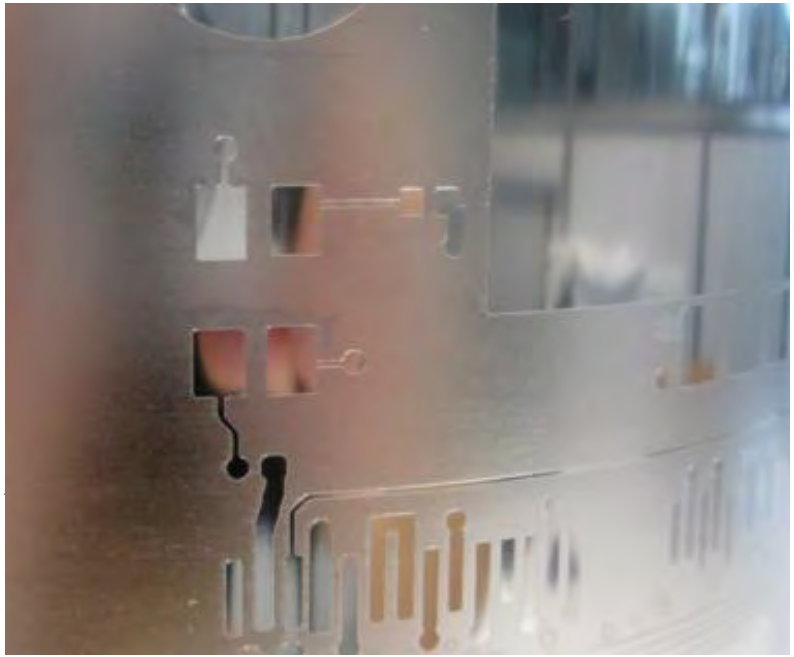


- ✓ Layer control by gap
- ✓ Level control in the nip
- ✓ Compact process

Coating and printing for nanoimprint lithography

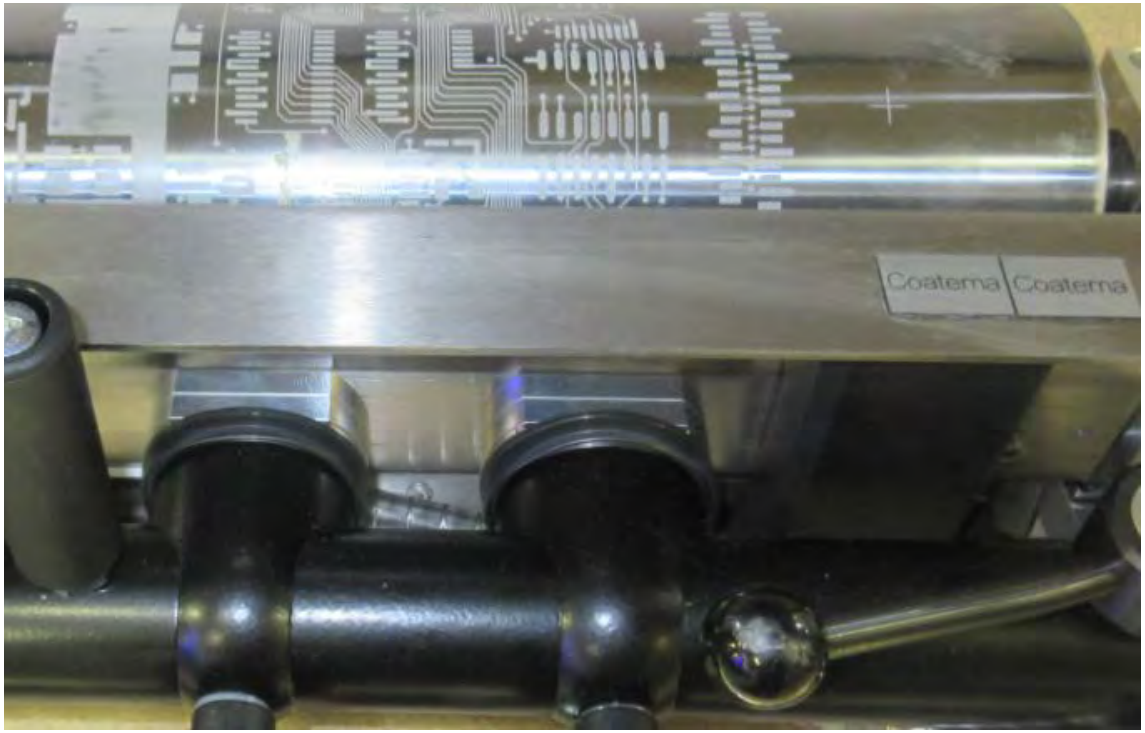


Homogeneous structure

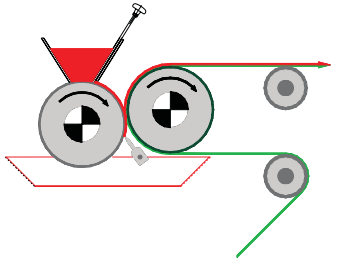


Inhomogeneous structure

Coating and printing for nanoimprint lithography



Printing for inhomogeneous structures?

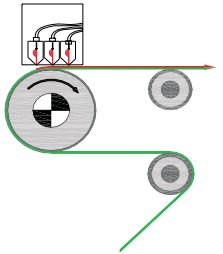


Case knife

- ✓ Layer control „inhomogeneous“
- ✓ Matched level control in the nip
- ✓ Nip material fits „sleeve consumption“

Coating and printing for nanoimprint lithography

Printing for inhomogeneous structures?



Inkjet

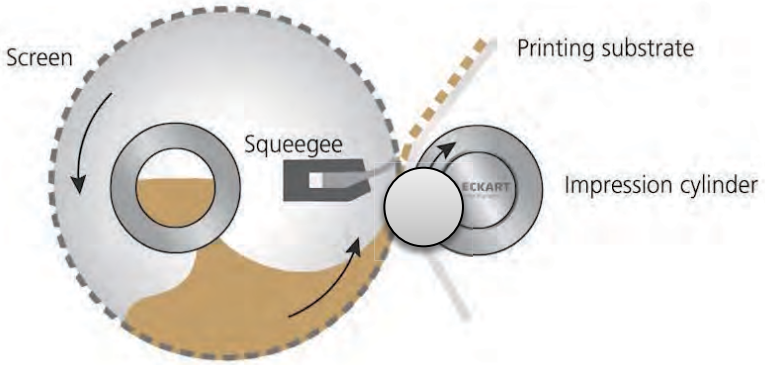
- ✓ Layer control „inhomogeneous“
- ✓ Matched level control in the nip
- ✓ Nip material fits „sleeve consumption“

Coating and printing for nanoimprint lithography

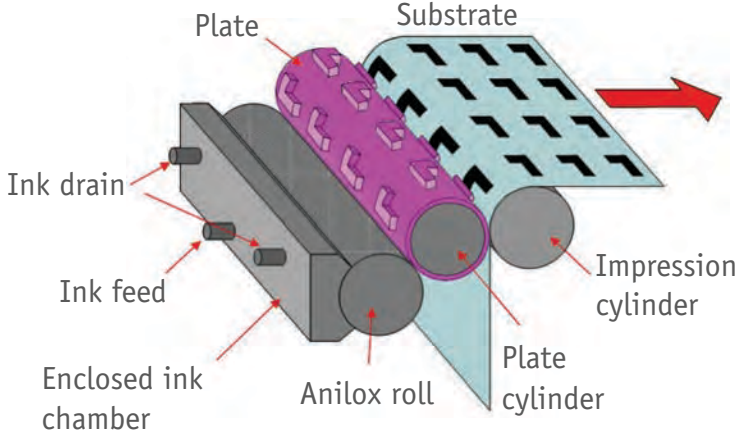
Printing for inhomogeneous structures?

- ✓ Layer control „inhomogeneous“
- ✓ Matched level control in the nip
- ✓ Nip material fits „sleeve consumption“

Rotary Screen Printing



Flexographic Printing



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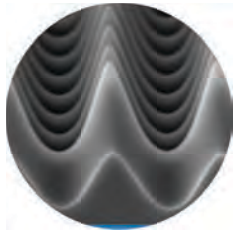
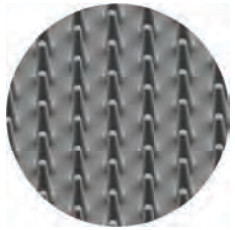


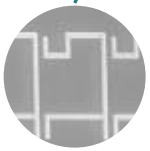
Display

Photonics



Bionics

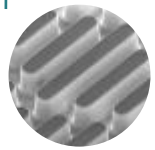
Life science



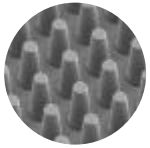
Printed electronics

Retroreflectors

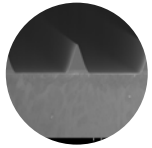
Diffractive optical elements



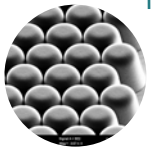
Antibacterial surfaces



Super hydrophobic surfaces



Shark skin



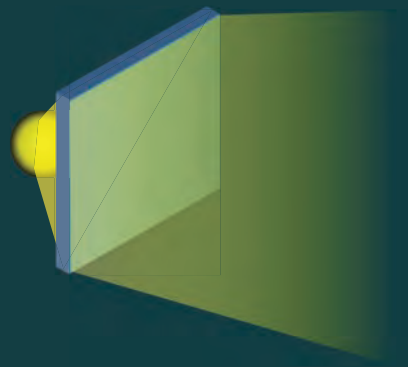
Haptic surfaces

Microfluidic structure

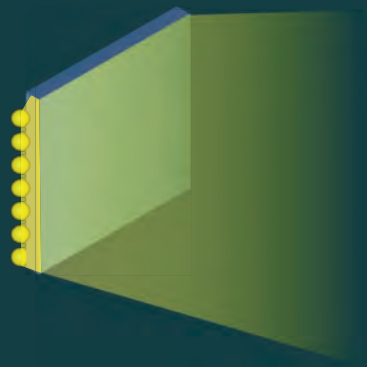
Products

Products

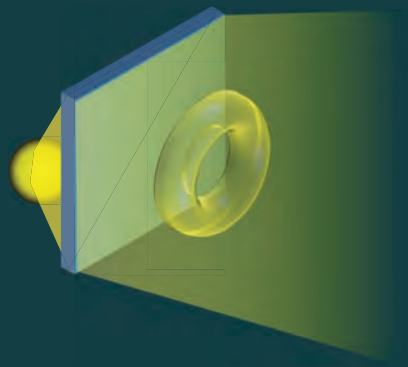
temilux® TO
Transmission optics



temilux® LG
Lightguide solutions



temilux® 3D
3D lighting effects



More ideas: PrintoCent Designer's Handbook

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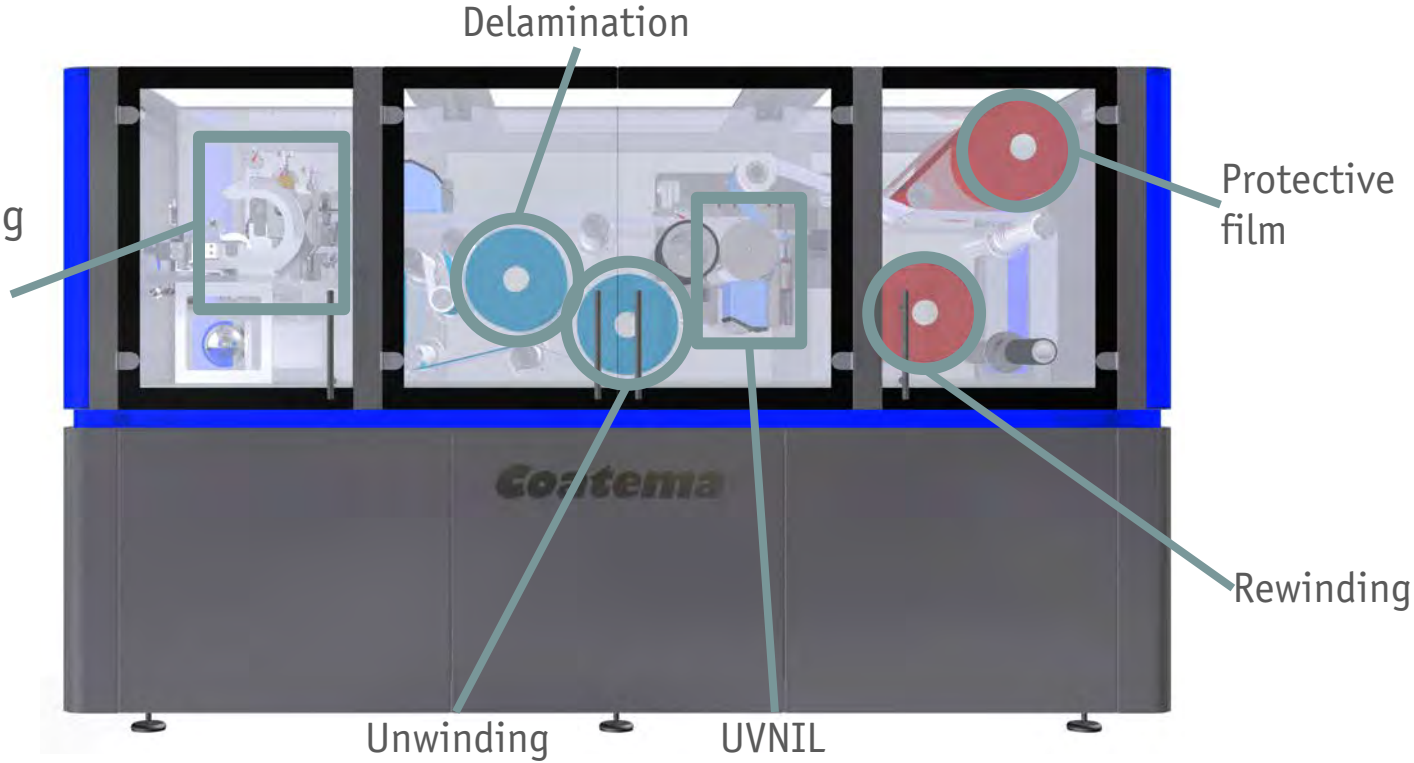
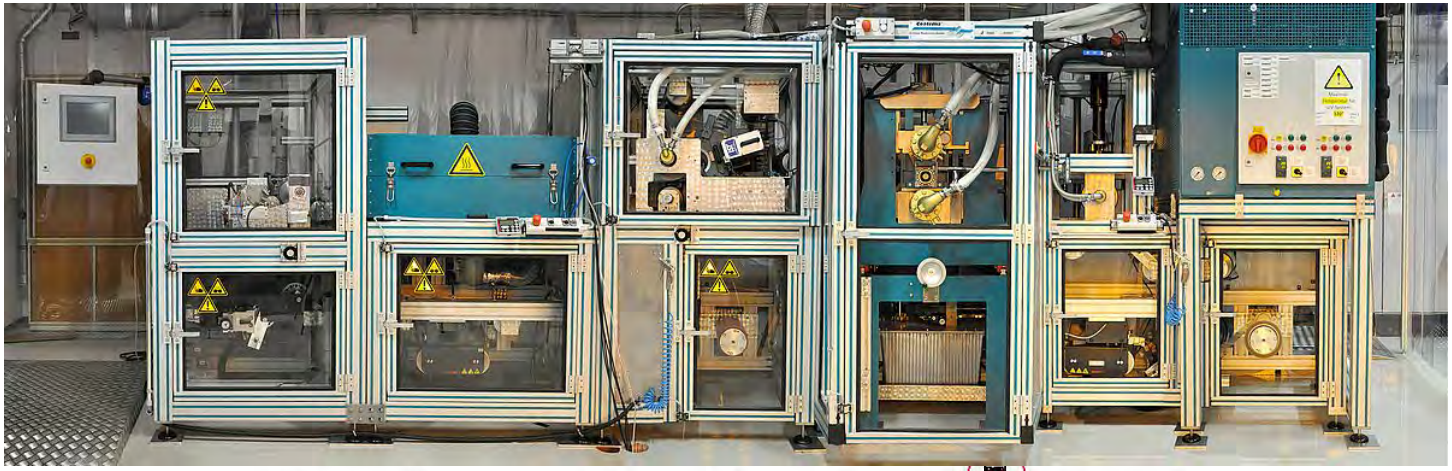
Equipment

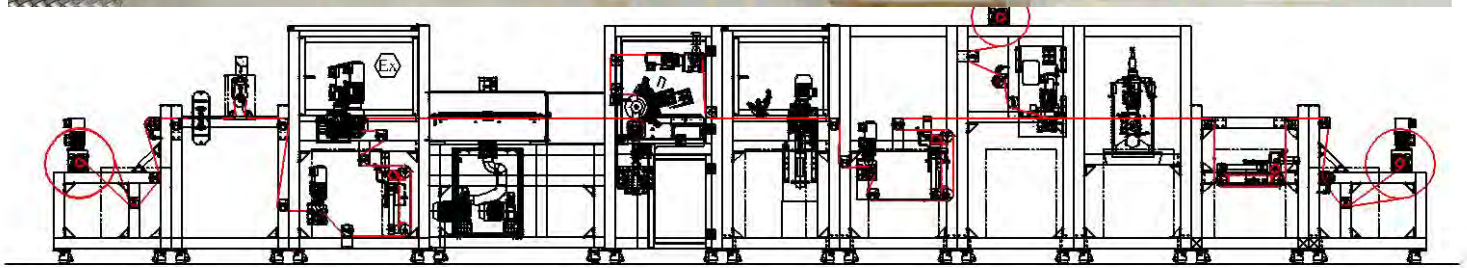
Coating Unit:

- ✓ Knife coating
- ✓ Slot die coating
- ✓ Inkjet
- ✓ Flexographic printing
- ✓ Rotary screen printing



Equipment

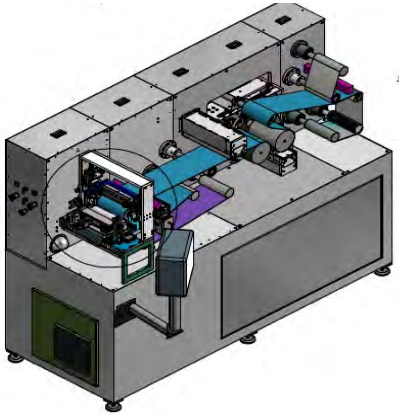




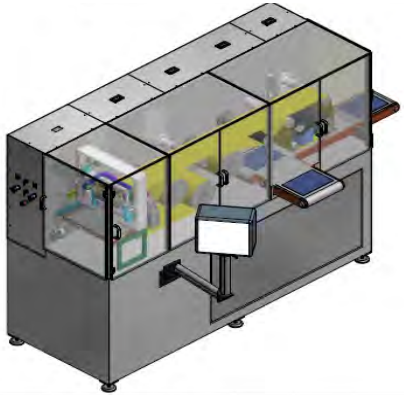
Equipment

Temicoat
Test Solution S2S

Temicoat
Test Solution R2R



Temicoat
NIL 300 R2R



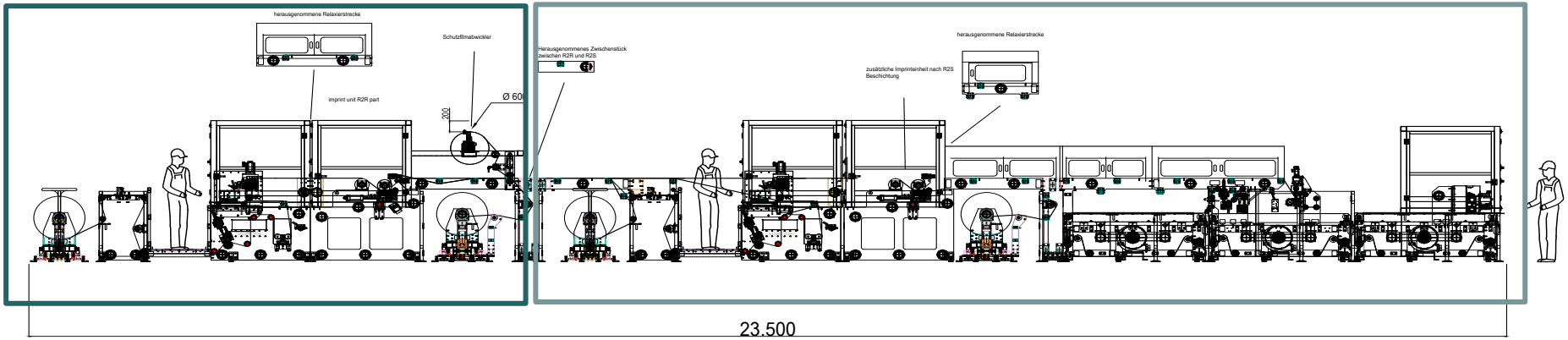
Temicoat
NIL 300 R2P

Equipment

R2R + R2P-Machine for Temicon

Specs:

Working width R2R:	1100 mm
Dimensions R2P:	1000 mm x 1600 mm
Speeds:	6 – 60 m/min
Coating unit:	Slot die coating



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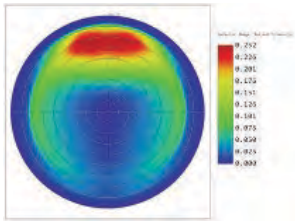

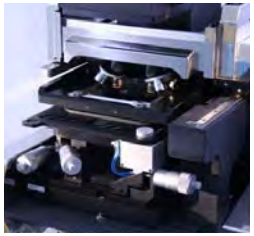

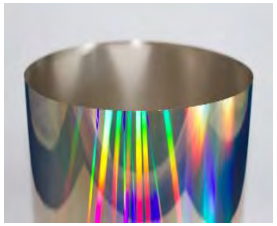

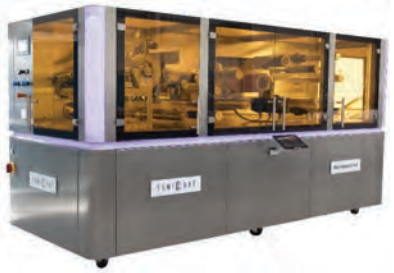

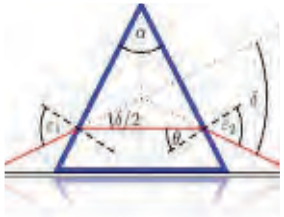

Simulation

Origination

Tooling

Replication

Do not hesitate to contact us!

Anything missing?

Let us know and we will make it happen!

Our R&D centre is worldwide the most versatile centre for coating, printing and laminating.

Sales department:
sales@coatema.de

Thank you

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Phone +49 (0) 21 33 97 84 - 0 | info@coatema.de