



# FUNCTIONAL POLYMERS IN WAFER-LEVEL OPTICS

Dr. Philipp Pahl, Oliver Matyssek | OST Coffee Lectures | 16.11.2022



**AGENDA**



*Company Introduction*



*Chemistry*



*Applications*



*Materials*



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*Chemistry*



*Applications*



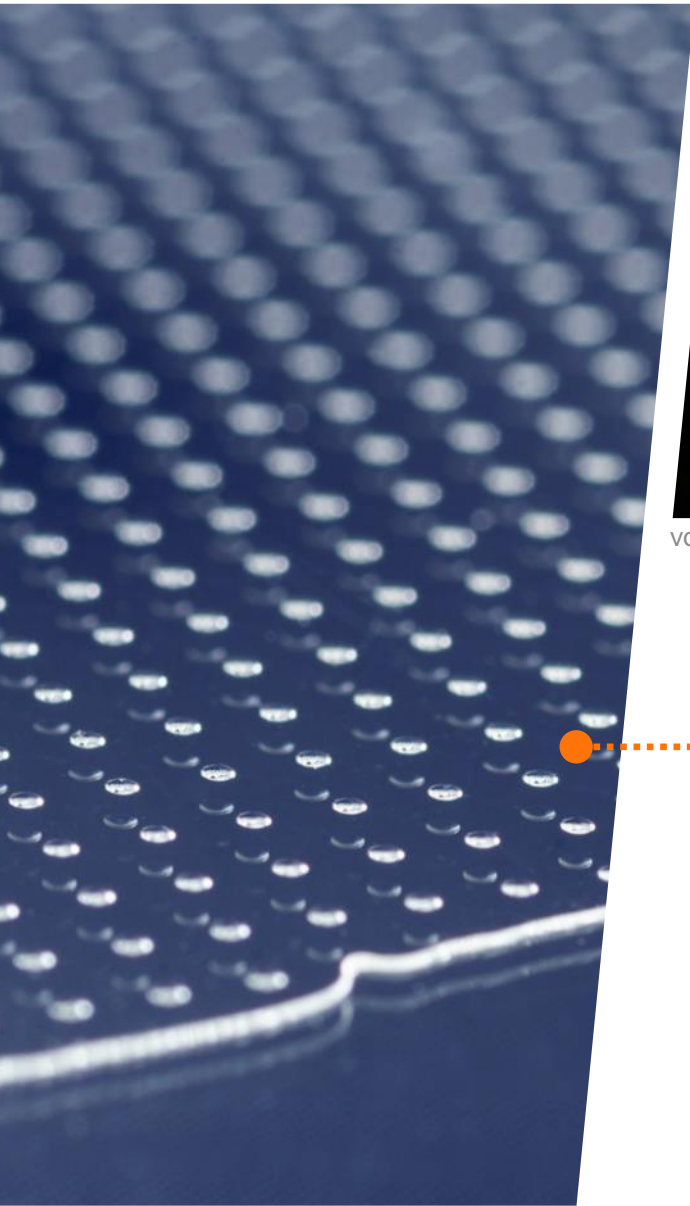
*Materials*

FAMILY-  
OWNED

€ 182 M.  
REVENUES

890  
EMPLOYEES





3D sensing	Ambient sensing	AR / MR	Headlamps	Projection
voonze.com	entwickler.de	techspot.com	the-verge.com	BMW

## Wafer-level micro-optics

- ▶ Optical grade polymers
- ▶ Polymer-on-glass or monolithic
- ▶ Mass manufactured on wafer-level
- ▶ Lenses and DOE

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Market leader & premium partner



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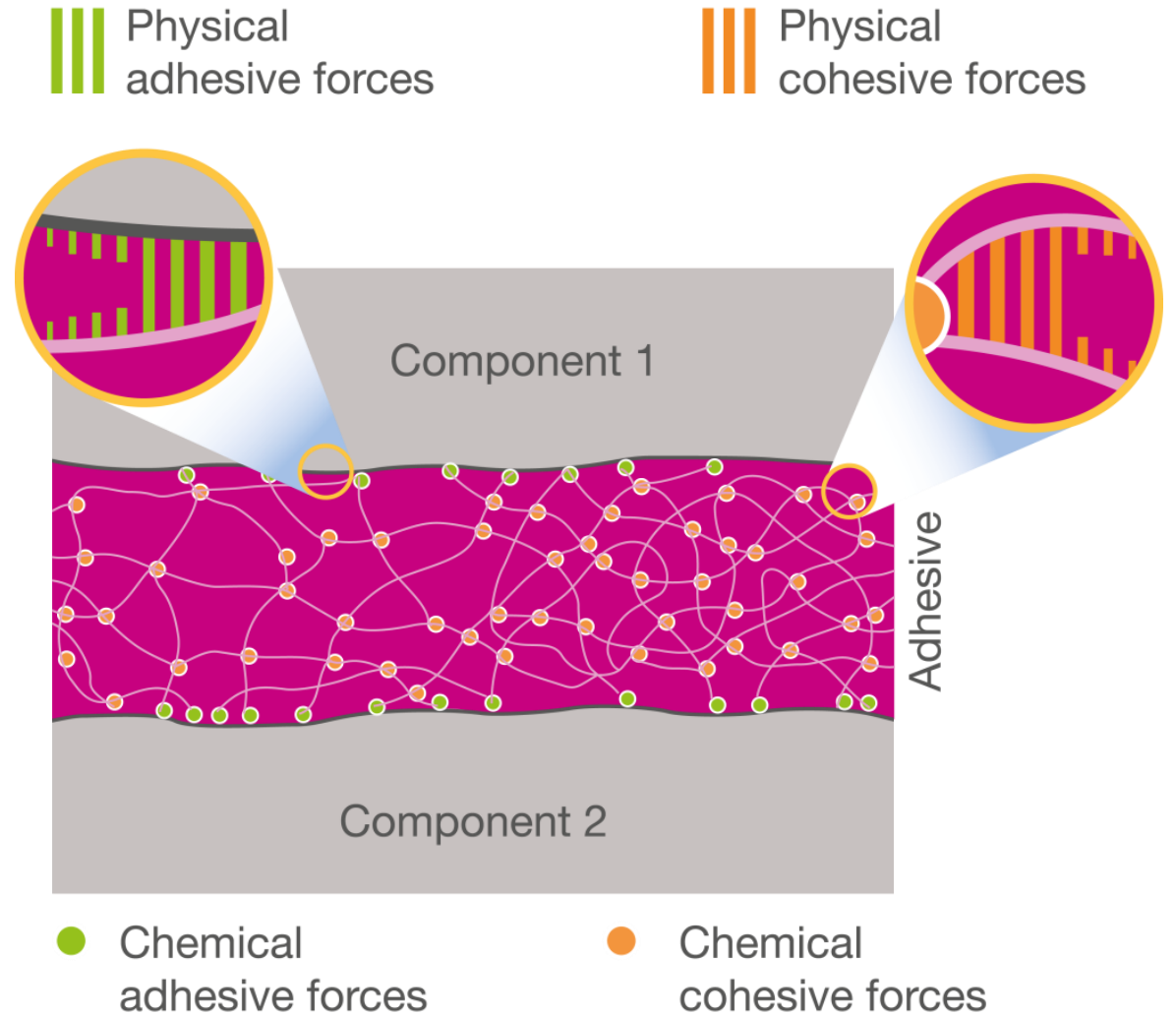


*Materials*

## DIN EN 923

### Adhesive

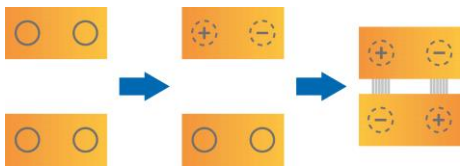
- ▶ is a non-metal
- ▶ acts through surface adhesion and inner strength (cohesion)



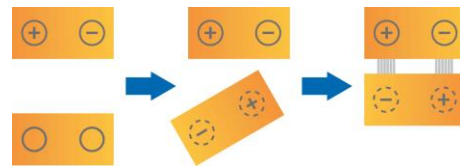


- ▶ Intermolecular forces: Forces between molecules
- ▶ Intramolecular forces: Forces within a molecule → covalent bond
- ▶ Polarity = Distribution of the shared electrons between two atoms in a chemical bond
- ▶ High electronegativity difference between two atoms → more polar/ionic.

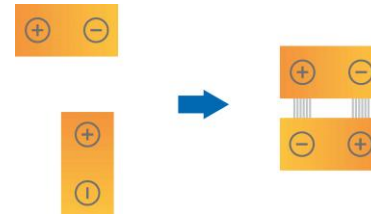
Unpolar-unpolar



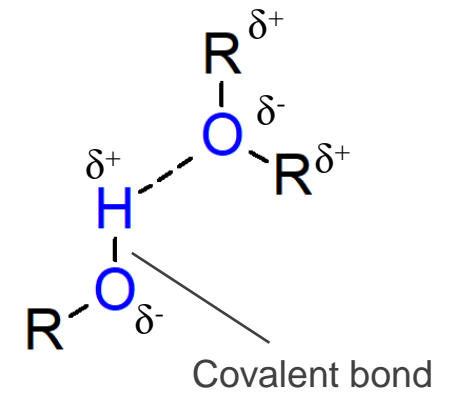
Dipole-unpolar



Dipole-dipole



Hydrogen bonding



⇒ Physical interactions < covalent bonds

## Adhesives

### Non reactive adhesives

#### Physically setting

- ▶ Hot melts
- ▶ Solvent adhesives
- ▶ Dispersion adhesives
- ▶ Plastisols

#### Pressure-sensitive adhesives (PSA)

- ▶ Adhesive tapes
- ▶ Transfer adhesives

### Chemically curing adhesives

#### Polymerization



- ▶ Light- and UV-curing acrylates / epoxy resins
- ▶ Cyanoacrylates
- ▶ Anaerobic-curing adhesives



- ▶ Methyl methacrylates
- ▶ Unsaturated polyester

#### Polyaddition



- ▶ Epoxy resins
- ▶ Polyurethanes



- ▶ Epoxy resins
- ▶ Polyurethanes
- ▶ Silicones

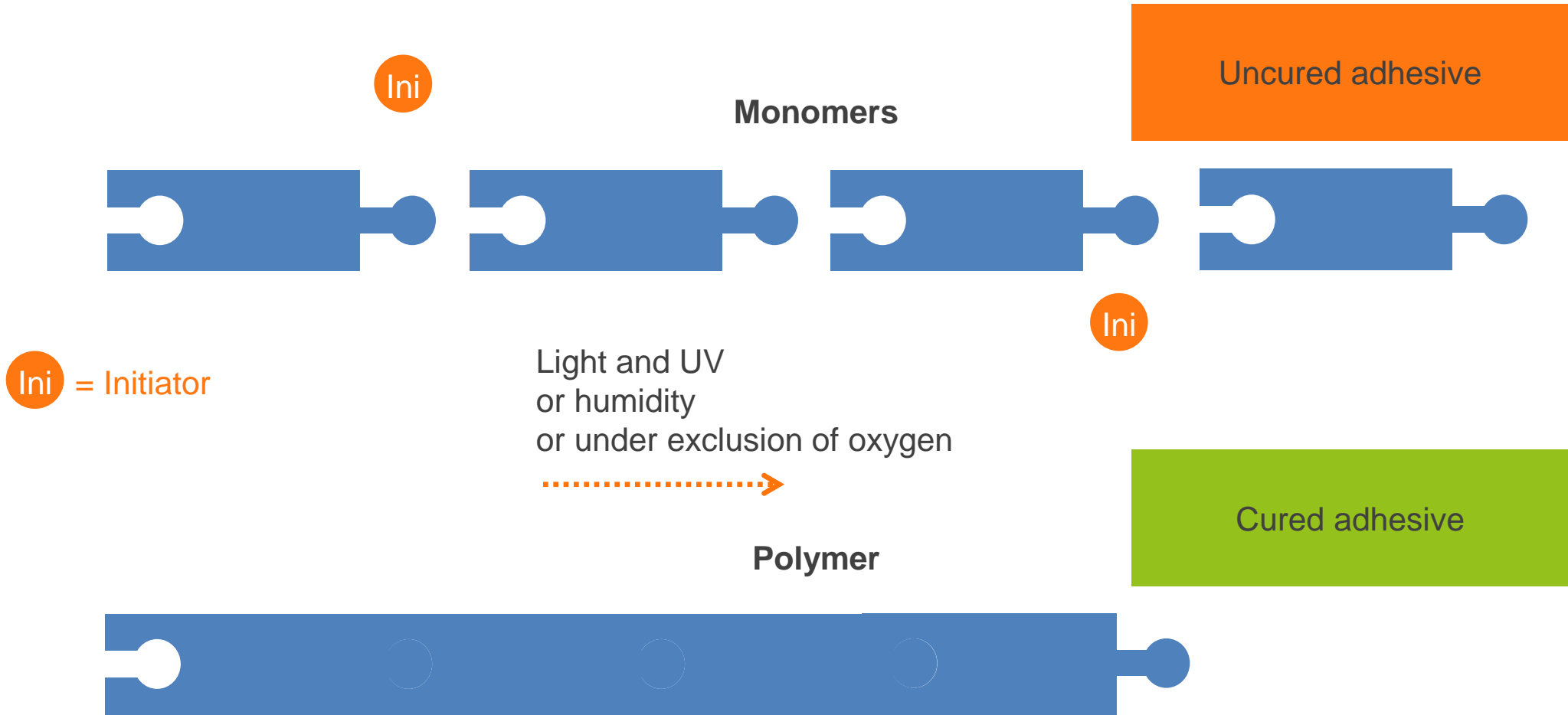
#### Polycondensation



- ▶ Silicones
- ▶ Phenolic resins
- ▶ Polyimides
- ▶ Silane-mod. polymers



- ▶ Silicones
- ▶ Silane-mod. polymers



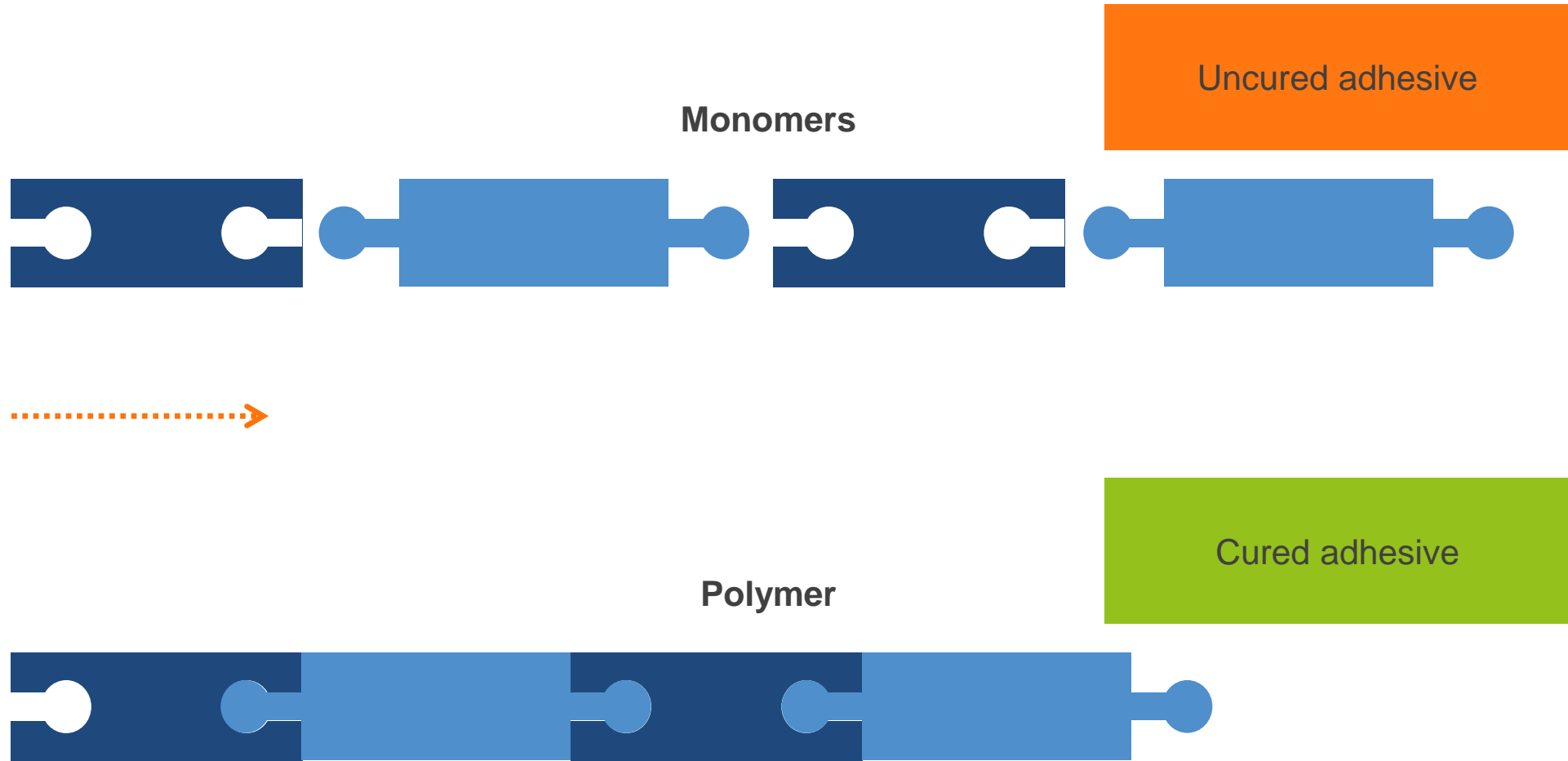
**Ini** = Initiator

Light and UV  
or humidity  
or under exclusion of oxygen



**Polymer**

➡ More functionalities → crosslinking



⇒ Example: Epoxy resin + amine hardener

**Attention!**

Monomers



Uncured adhesive



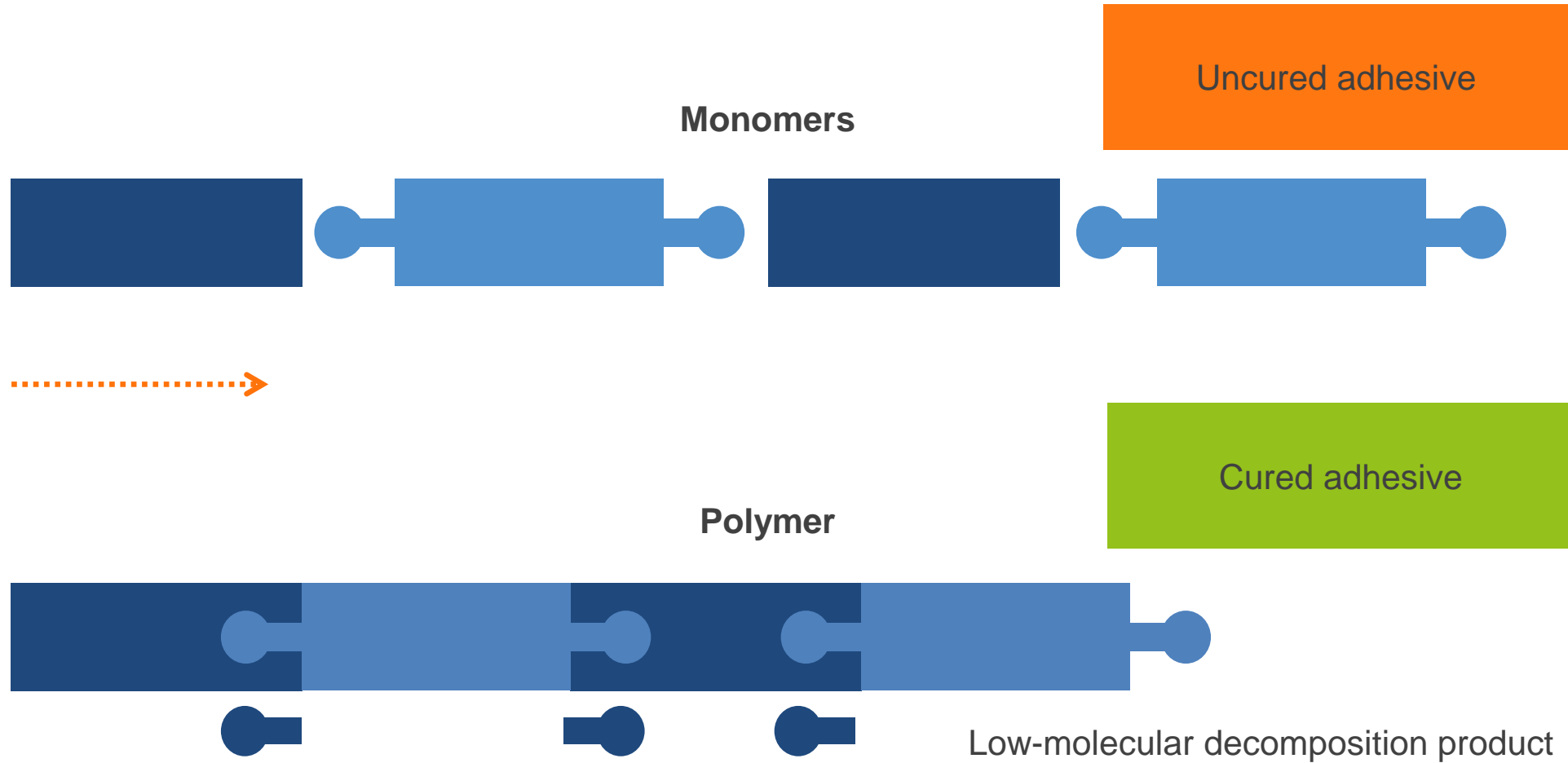
Cured adhesive



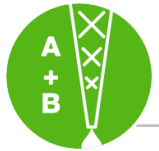
Uncured adhesive



Residual monomers are present!



⇒ Example: Silicone



2 Components – Separation of resin and hardener



Heat – Initiator/hardener/accelerator is activated or melted to start the reaction by external heat



(UV) Light – Initiator is activated by illumination

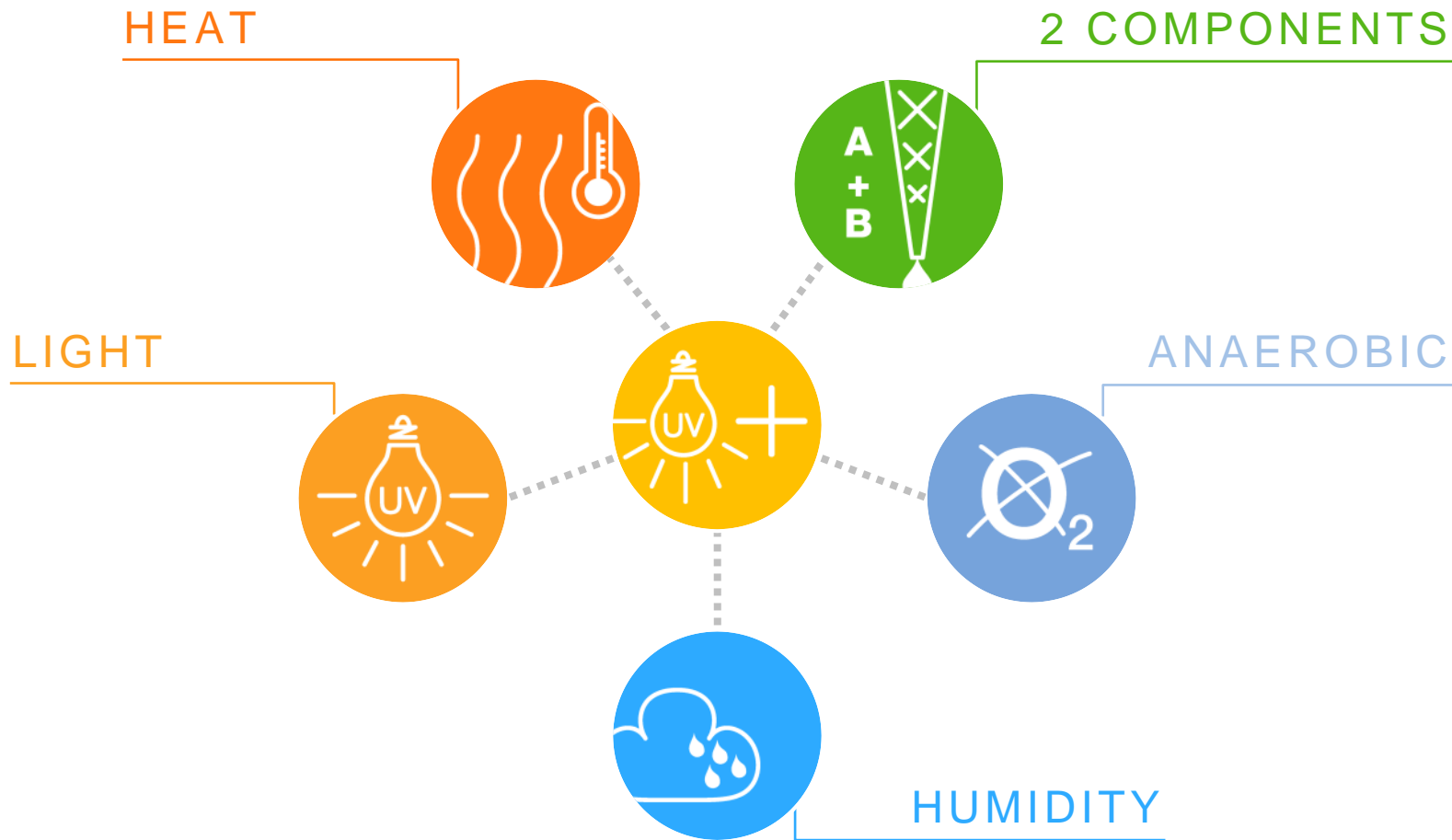


Humidity – Hydrolysis starts the curing



Absence of oxygen starts the curing





# DUAL CURING FOR HIGHER PRODUCTION RATE





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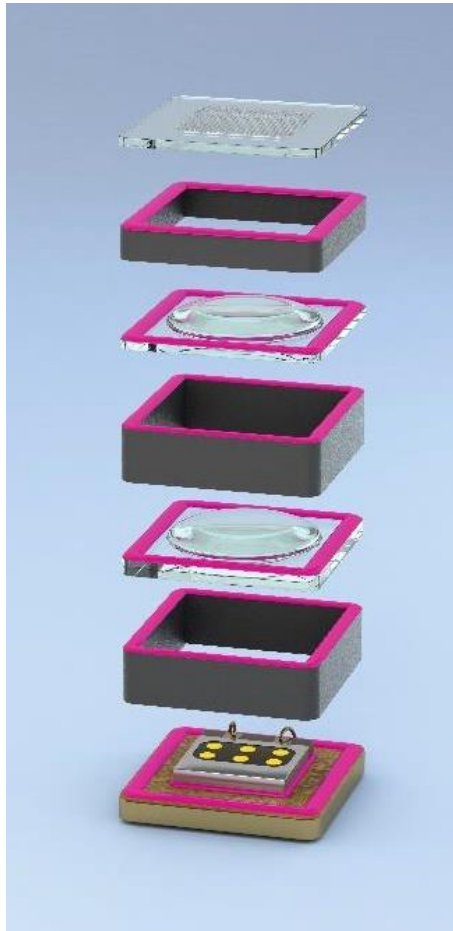
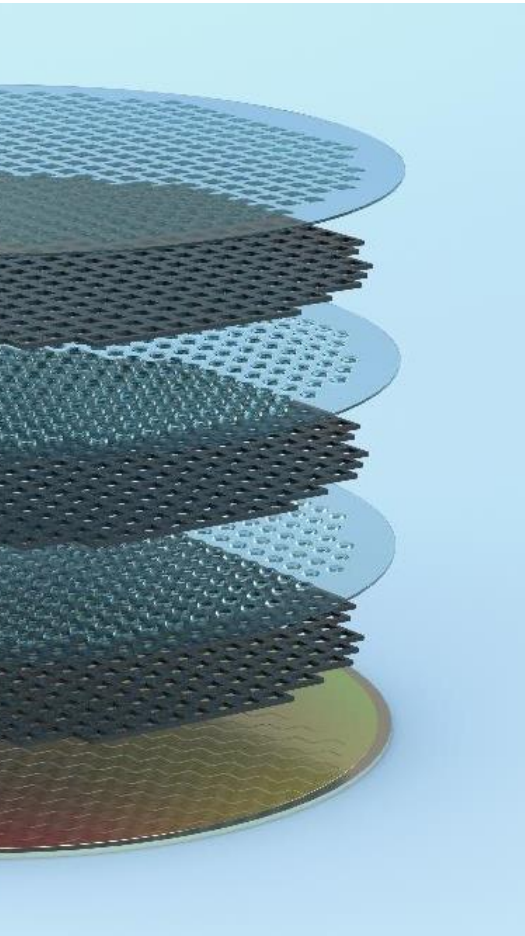
*Chemistry*



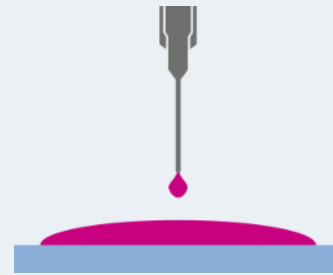
*Applications*



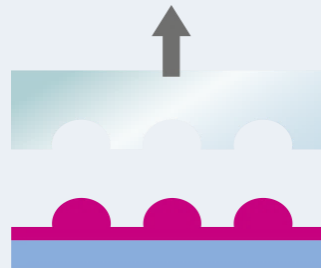
*Materials*



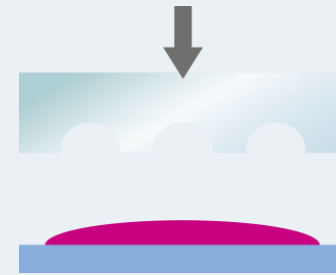
Dispensing



Demolding



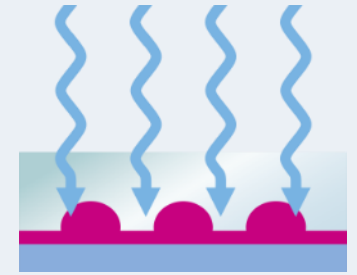
Imprinting



Finished Wafer



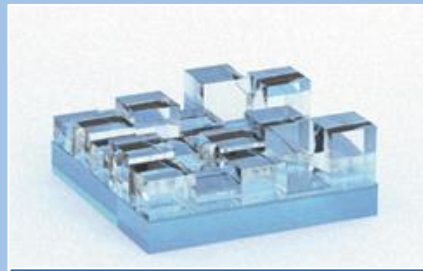
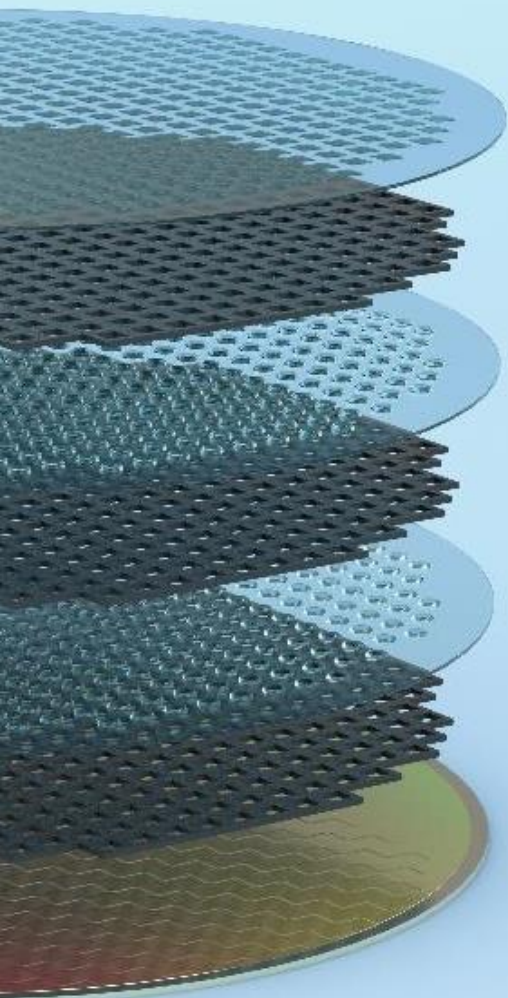
UV curing




Dicing



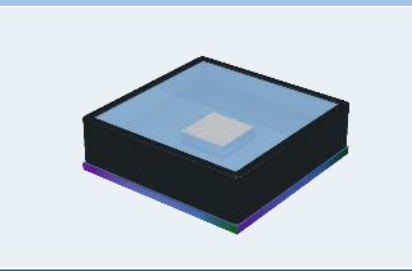
Functional polymers are highlighted in magenta.



Nano structures

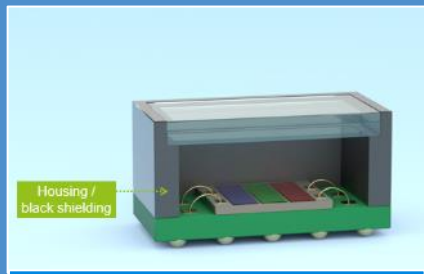


Lens structures

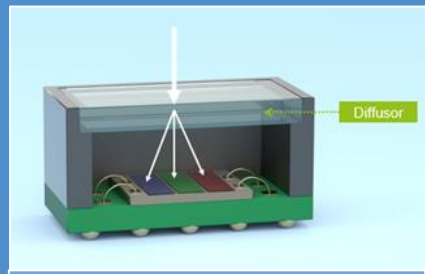


Encapsulation

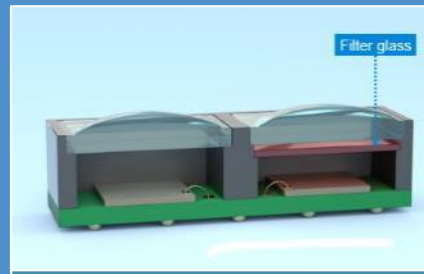
Optical solutions



Light blocking




Diffuser material




Filter material

Functional solutions



Wafer bonding



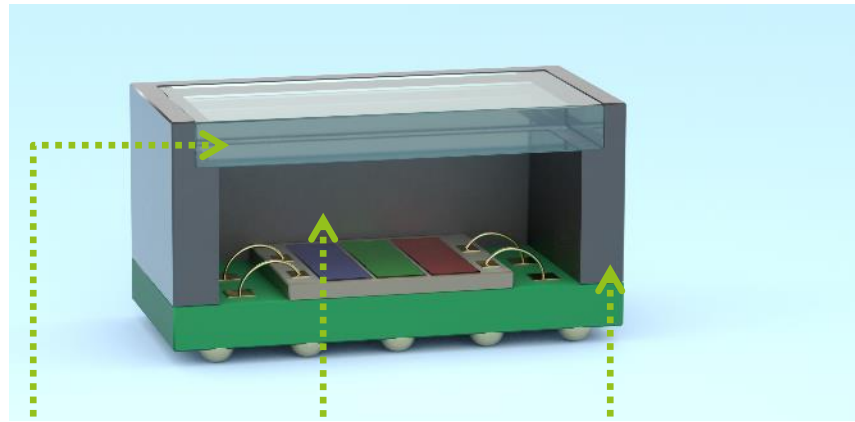
Wafer stacking



Stamp material

Process solutions

## Ambient light sensor



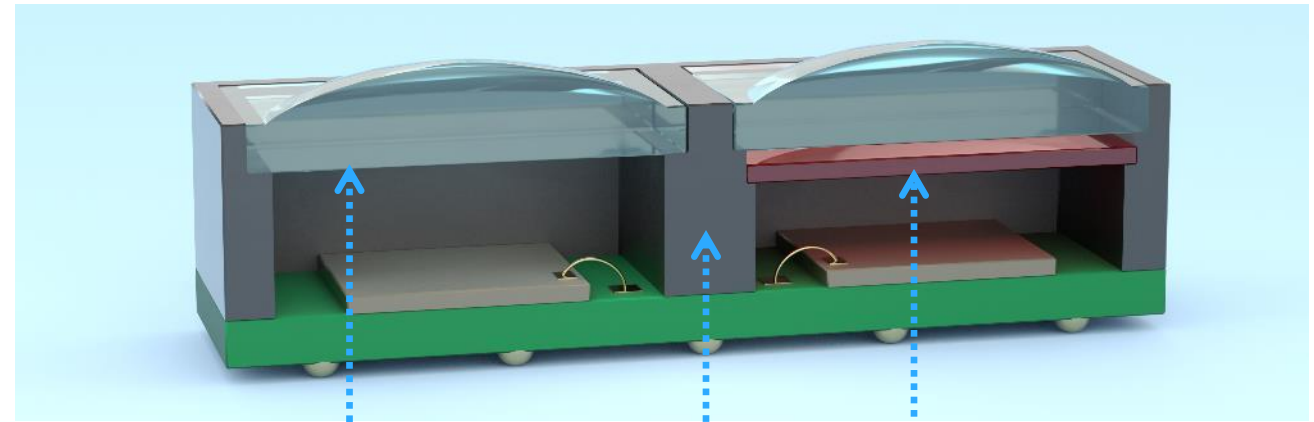
Diffusor

Encapsulation + black shielding



Combined DELO solution

## Proximity sensor



Lens imprint + encapsulation

Black shielding

Filter glass + encapsulation



Combined DELO solution



All microstructures can be made of liquid optical materials, and are highlighted in magenta.



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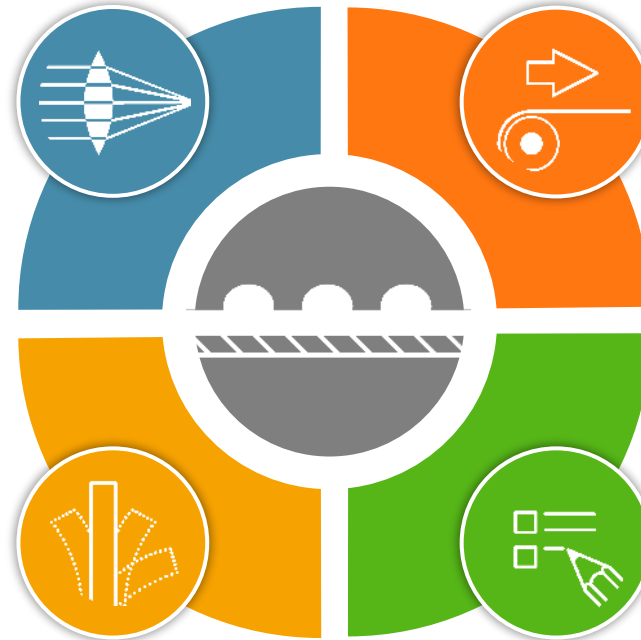
*Materials*

## Optical properties

- Index of refraction
- Dispersion
- Transmission
- Scattering

## Mechanical properties

- Young's modulus
- Glass transition temperature
- Thermal expansion
- Scratch resistance



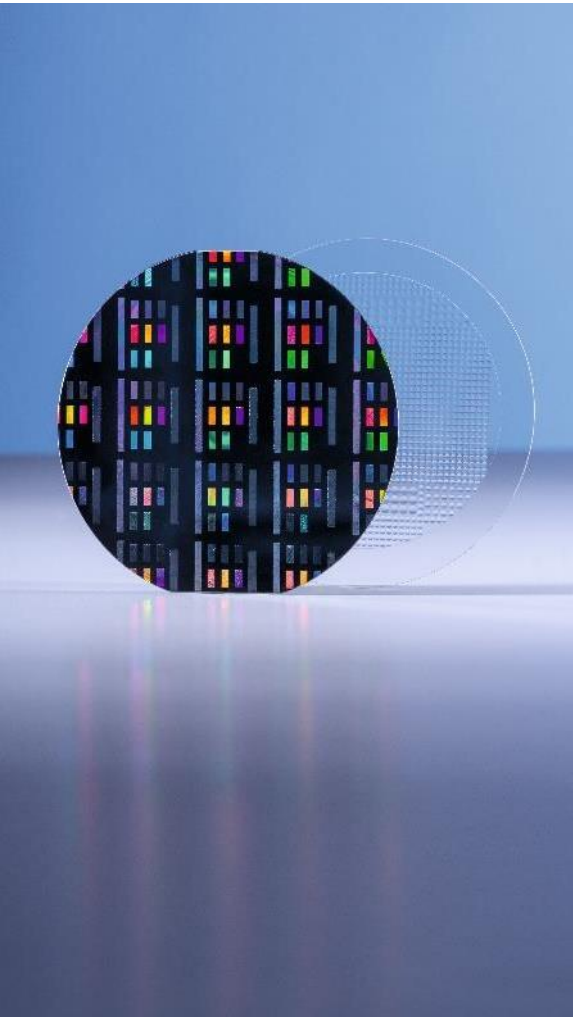
## Processing

- Good filling of structures
- Stamp interaction
- Demolding
- Shrinkage control
- UV curing

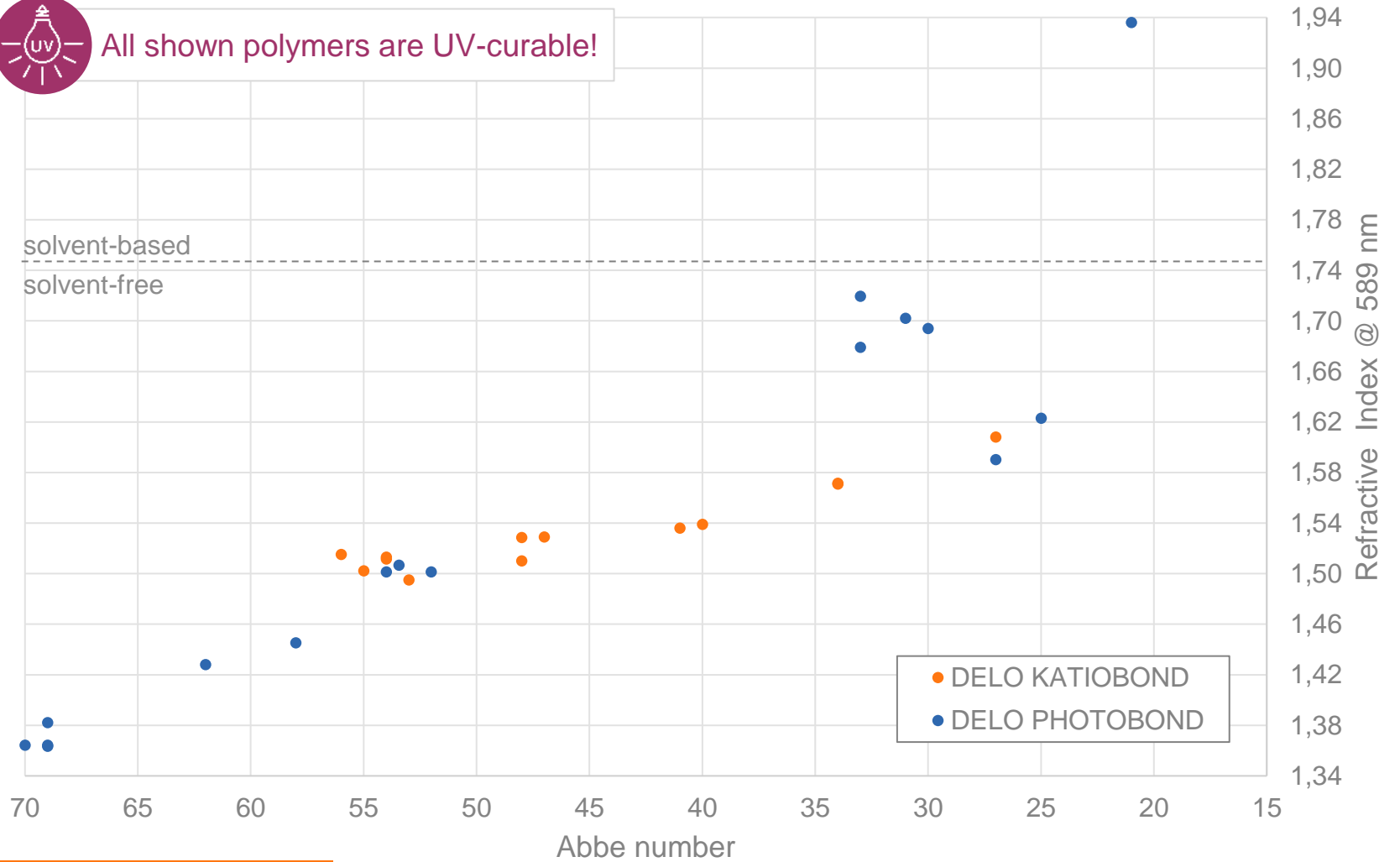
## Reliability

- Optical stability
- Dimensional stability
- Adhesion to substrate

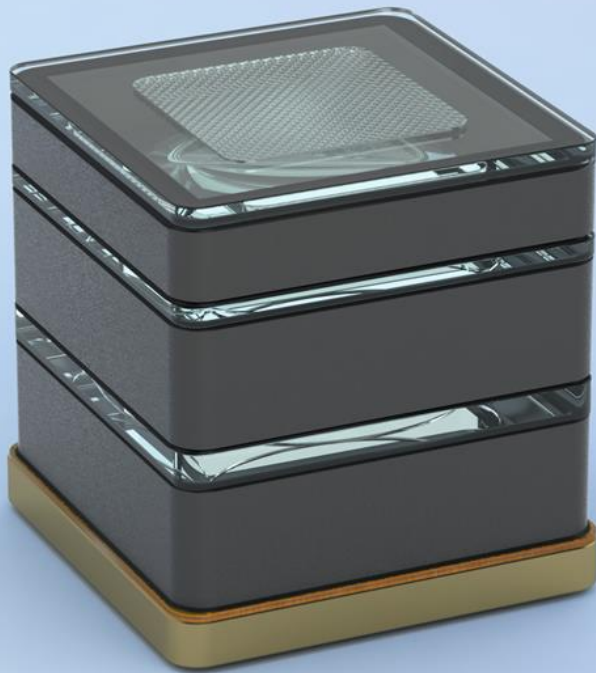
➔ High flexibility in material design to meet the requirements for different applications



All shown polymers are UV-curable!



➔ Broad range of Refractive Indices available



Customized optical & mechanical properties



Excellent reliability



Wafer-level processability



Complete material solution package





Contact us for discussion:  
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