

Strategies for the manufacturing of advanced micro and nano optics

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SwissPhotonics – Microcity Neuchâtel - November 7th 2022

CSEM SA - Guillaume Basset – gba@csem.ch

Strategies for the manufacturing of advanced micro and nano optics

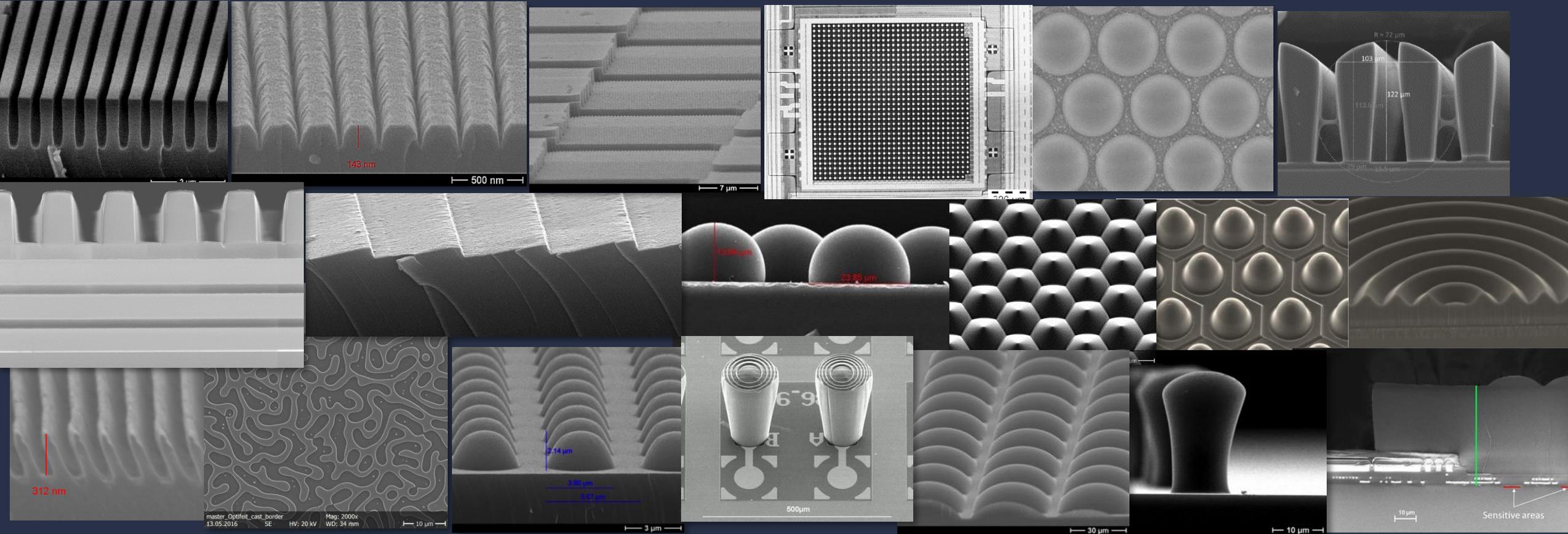
Outline

- Micro-Nano Optics?
- Materials, substrates and markets
- Origination strategies
- Tooling (very short)
- Manufacturing strategies
- Outlook

Micro and Nano Optics made at CSEM

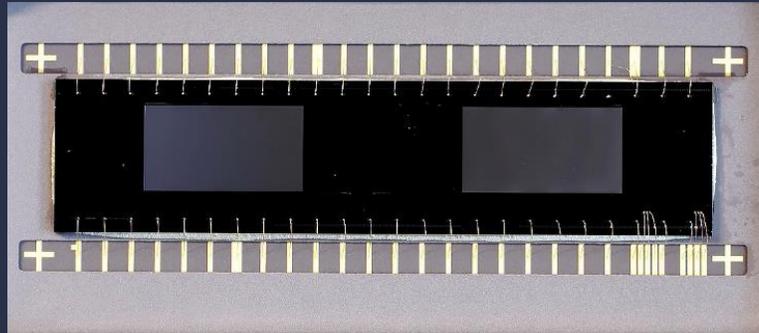
Nano

Micro

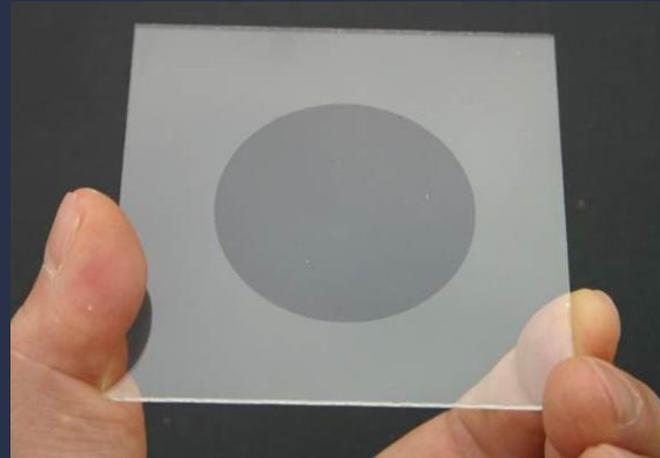


Materials, substrates and markets

On Silicon



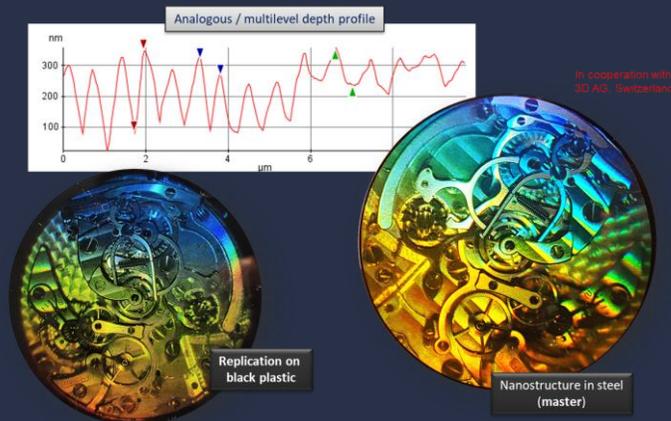
Glasses



Thin foils



Metals



Ceramics

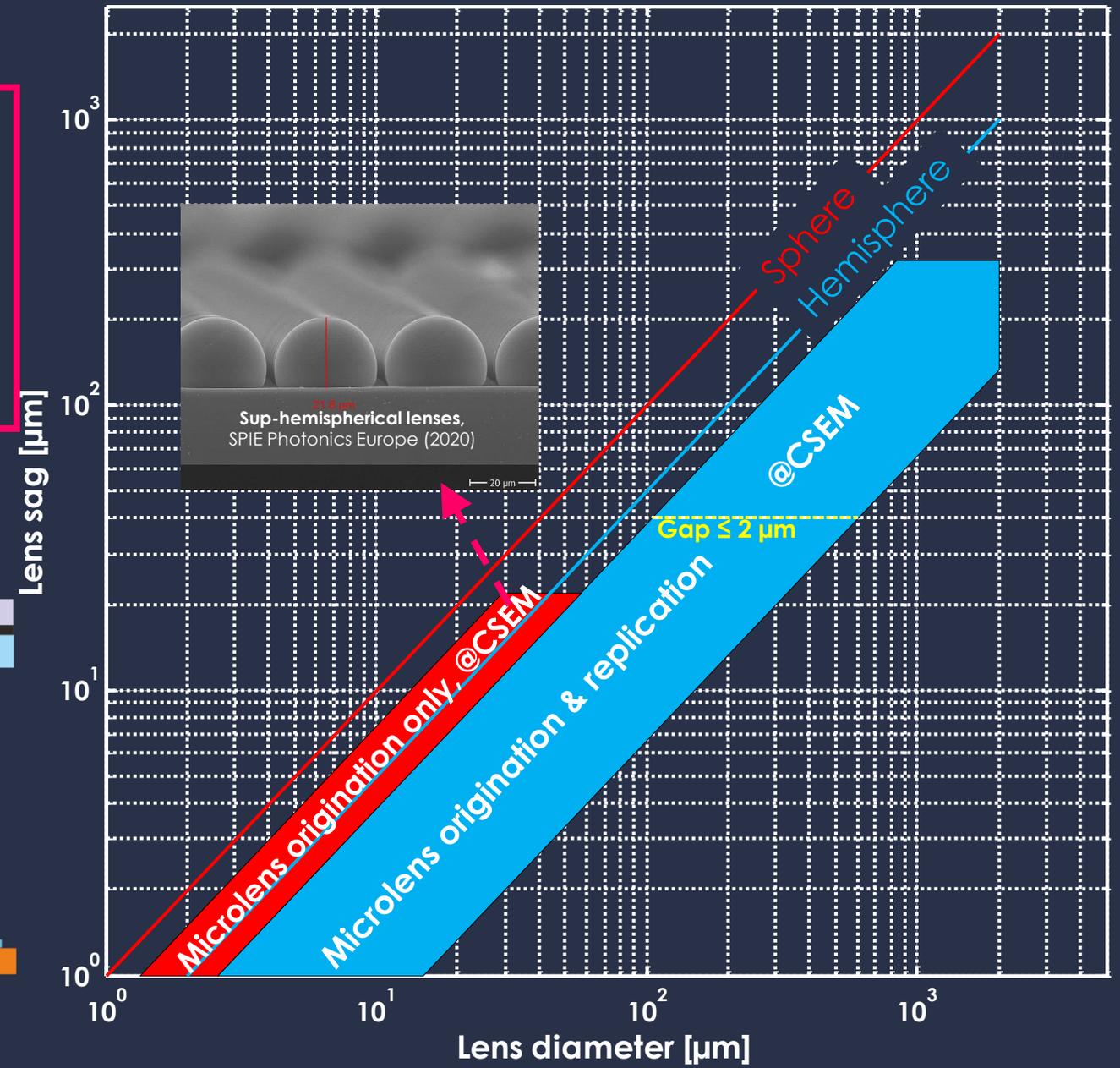
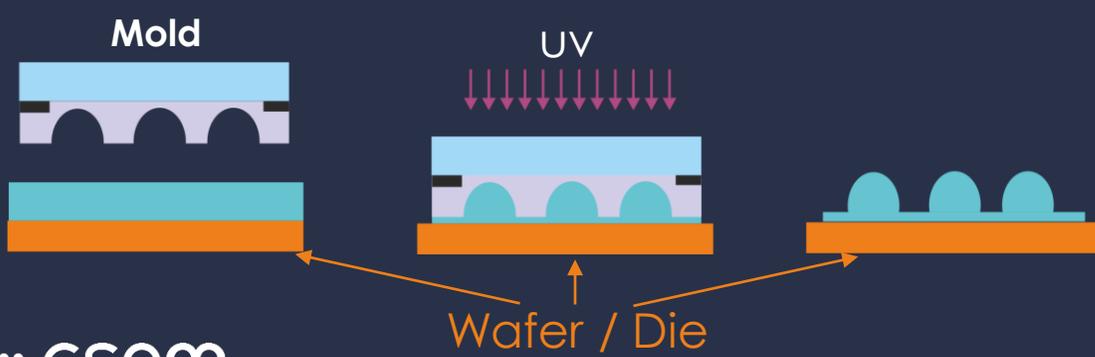
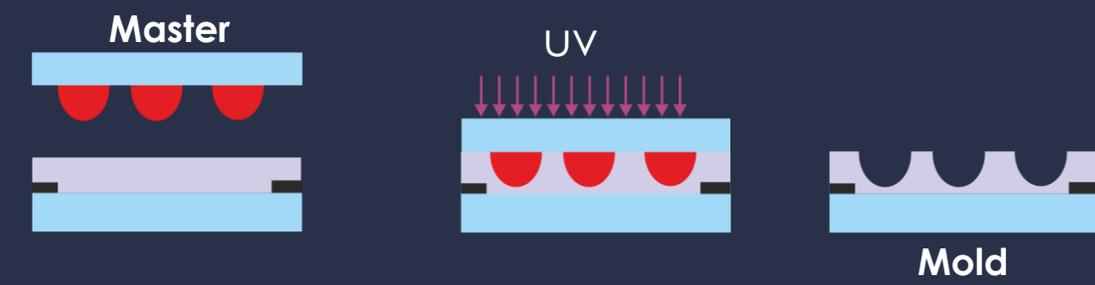
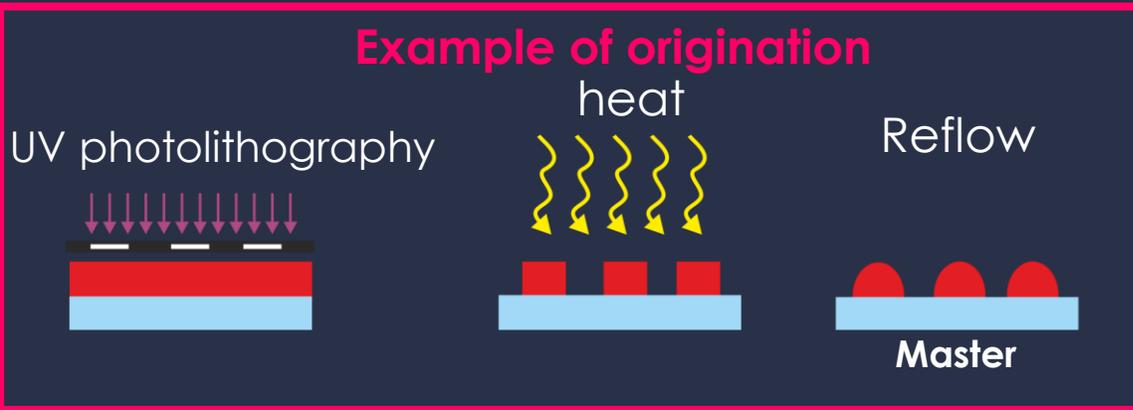


Polymers



Origination strategies

Microlenses capabilities



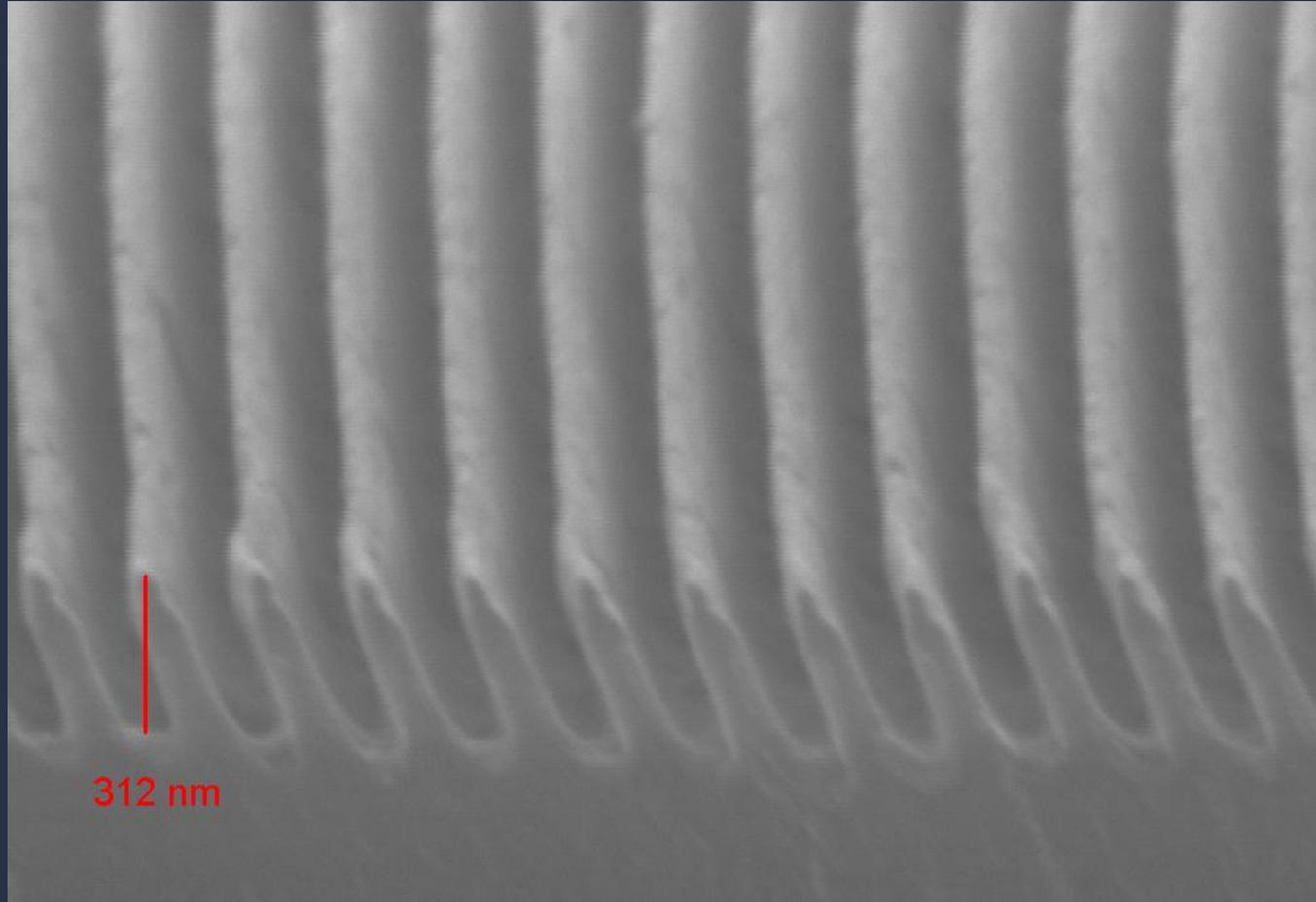
Origination strategies

- Microlens photoresist reflow
- Interference lithography (holography)
- Excimer laser through mask ablation
- Direct laser writing
- Grey-scale litho. & Two-photon abs.
- Diamond micro-turning
- E-beam lithography
- ...

+ Complementary processes

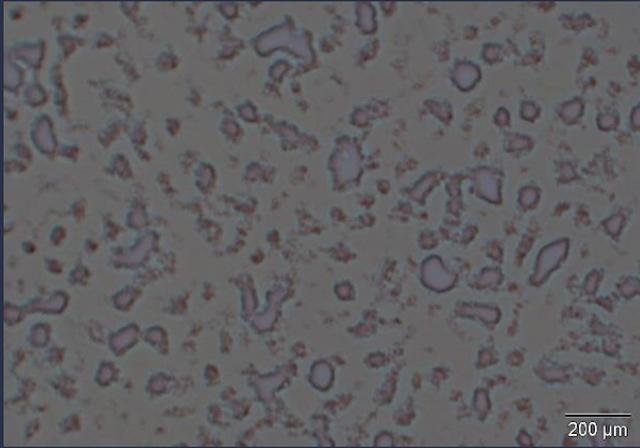
- Reactive Ion Etching (RIE)
- Wet chemical etching (e.g. with 2 photons absorption)
- Ion Beam Etching and Reactive Ion Beam Etching (IBE/RIBE)
- Physical Layer Deposition (PVD), sputtering, ALD etc.
- UV Lithography
- Nano-Imprint Lithographies (NIL)

Electron Beam Lithography + PVD + IBM +... +... +...



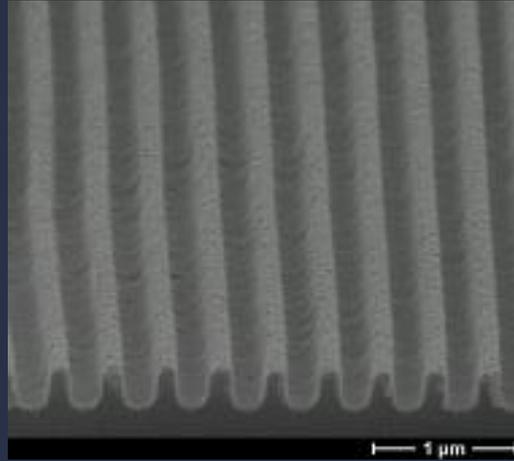
Such structures cannot be directly obtained with any single origination process

Complementary process: Soft UV Imprinting for Advanced Origination

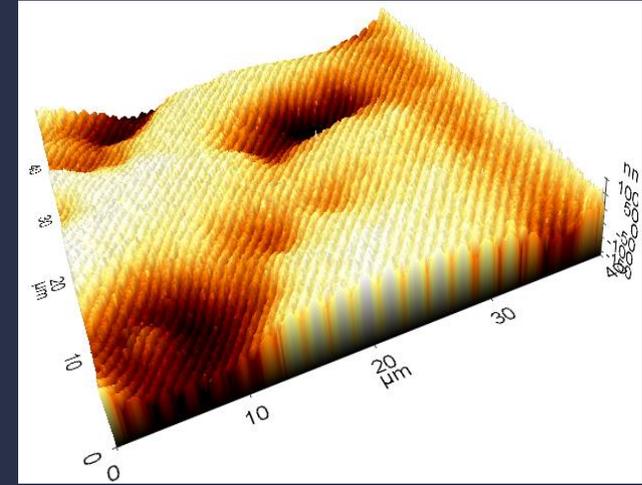


Micro/millimetric structures

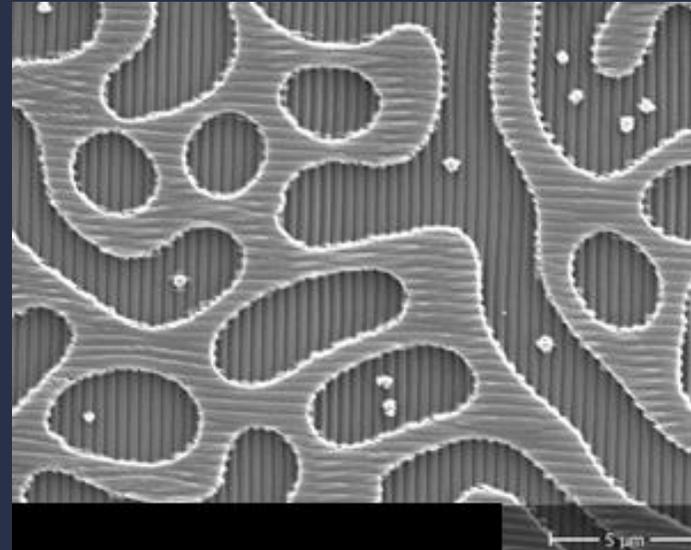
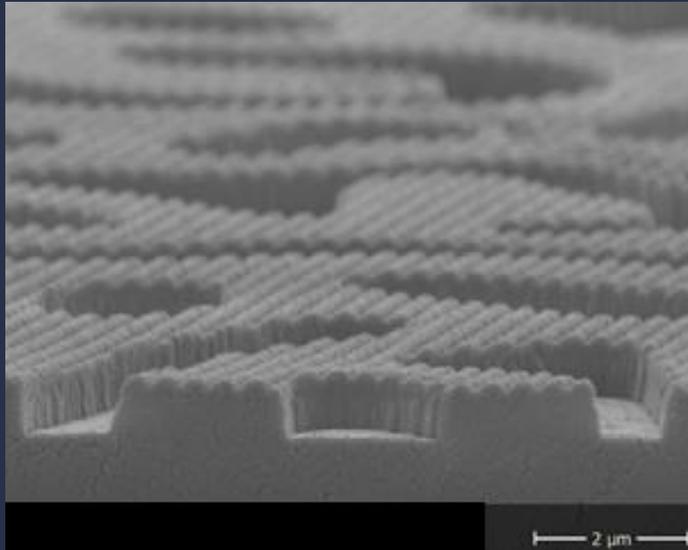
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Nanostructure



Micro + nano structures

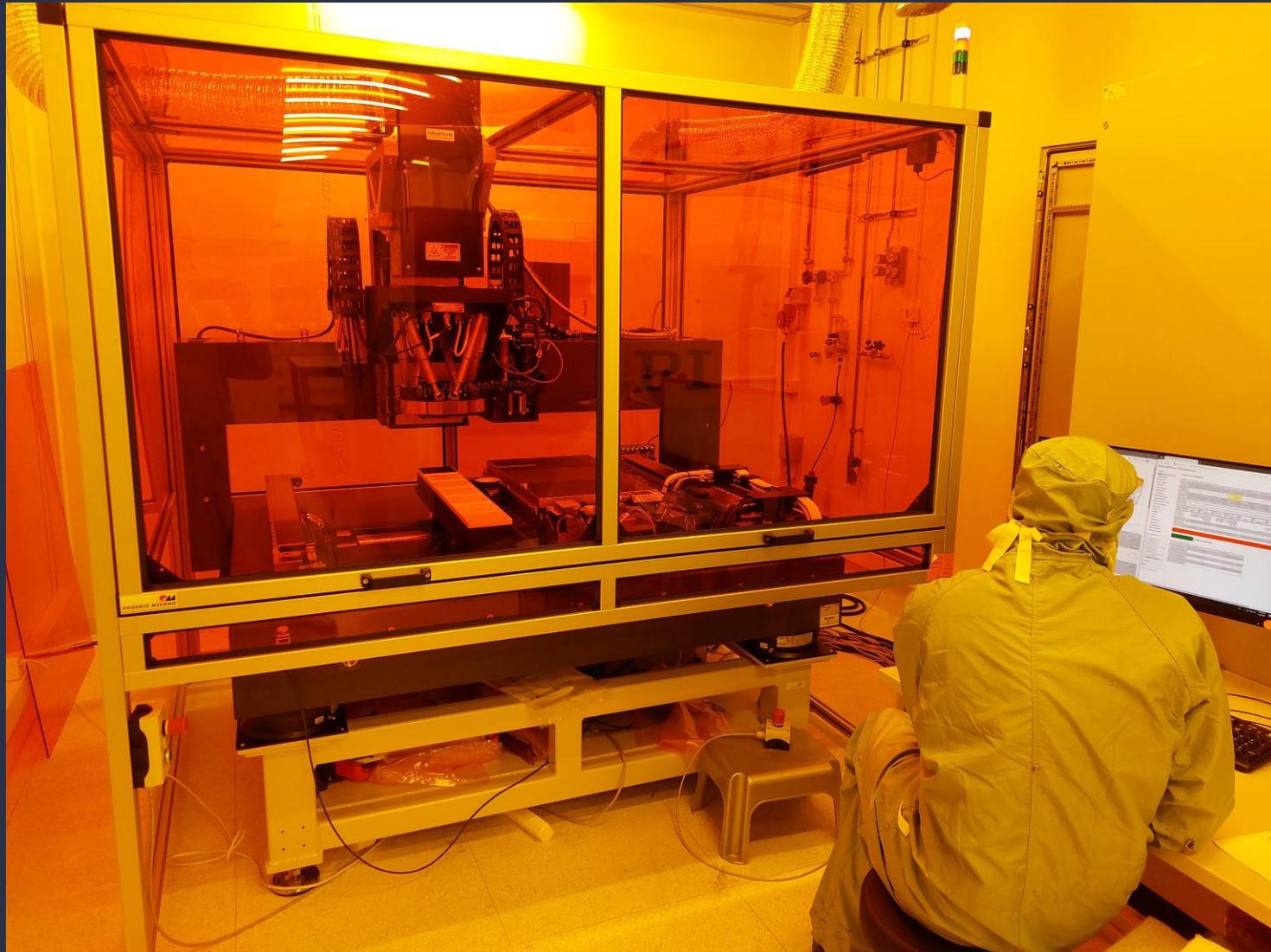


Very useful for nano-optics but also quite some cases for micro-optics

Tooling

Tooling

Nickel tools



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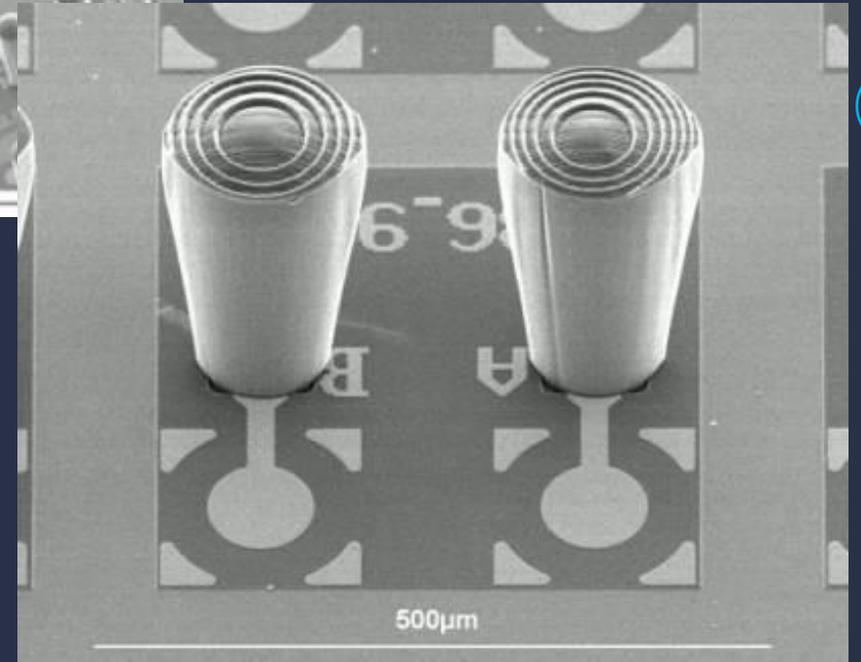
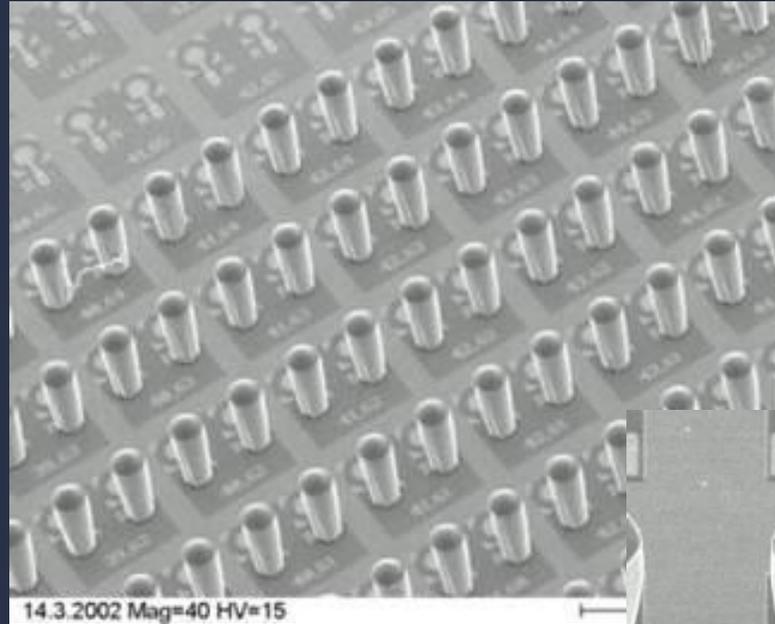
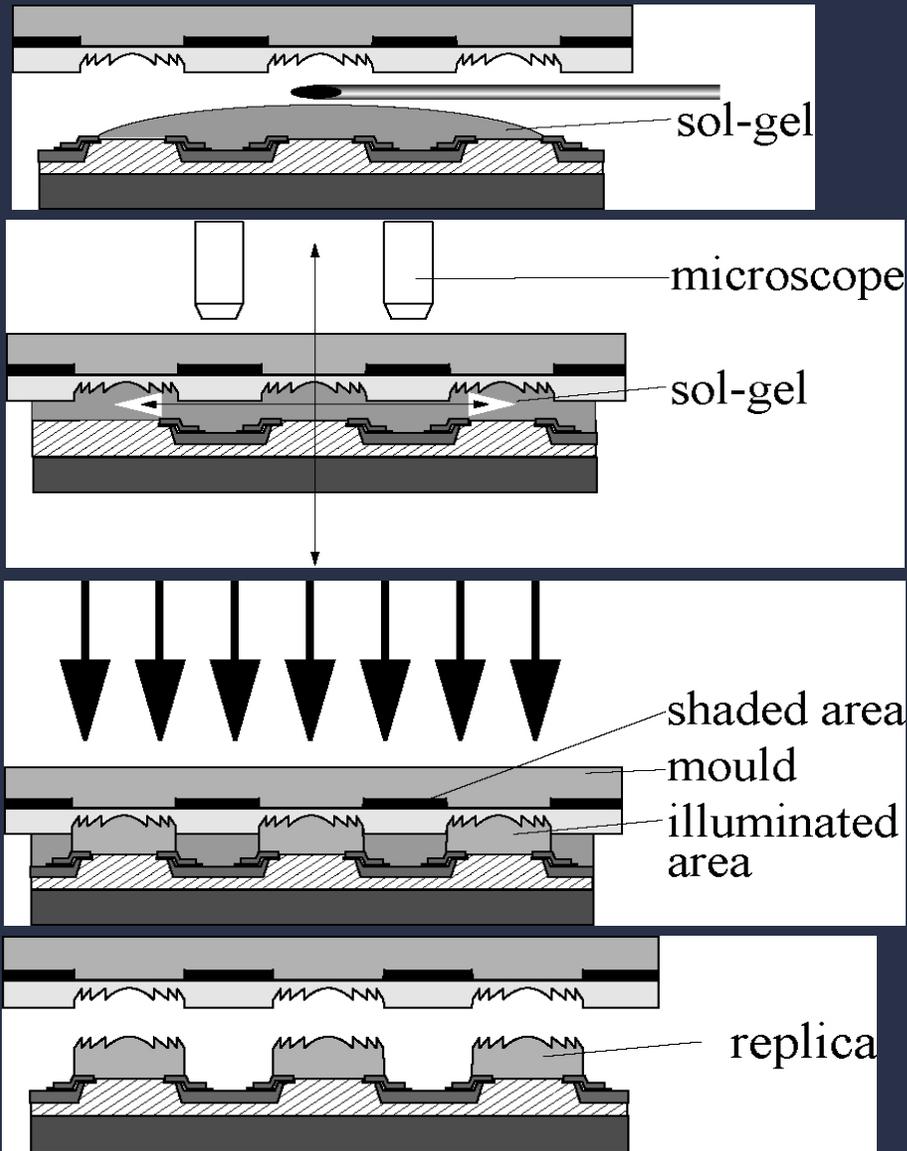
High precision step and repeat UV nano-imprint lithography



Hard steel tools

Manufacturing strategies

Classical Wafer-Scale UV Imprinting: Fresnel Microlenses on VCSELs



Thin film Nano-Optics manufacturing

Roll to roll nano-imprinting

+

Roll to roll vacuum coating

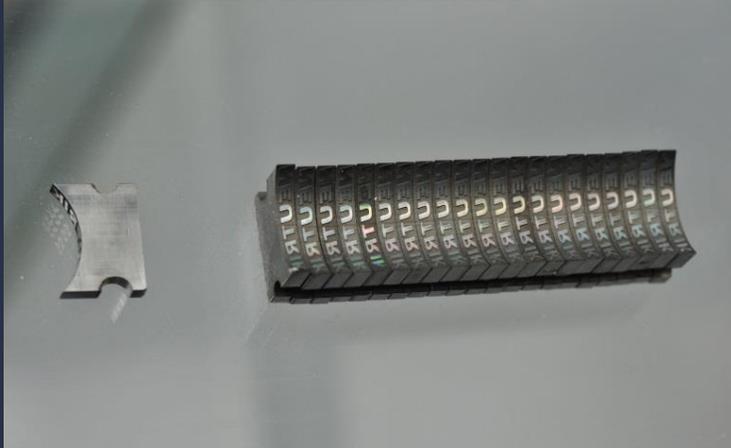


→ Typically, 4 to 8 kilometers per roll, many rolls a day

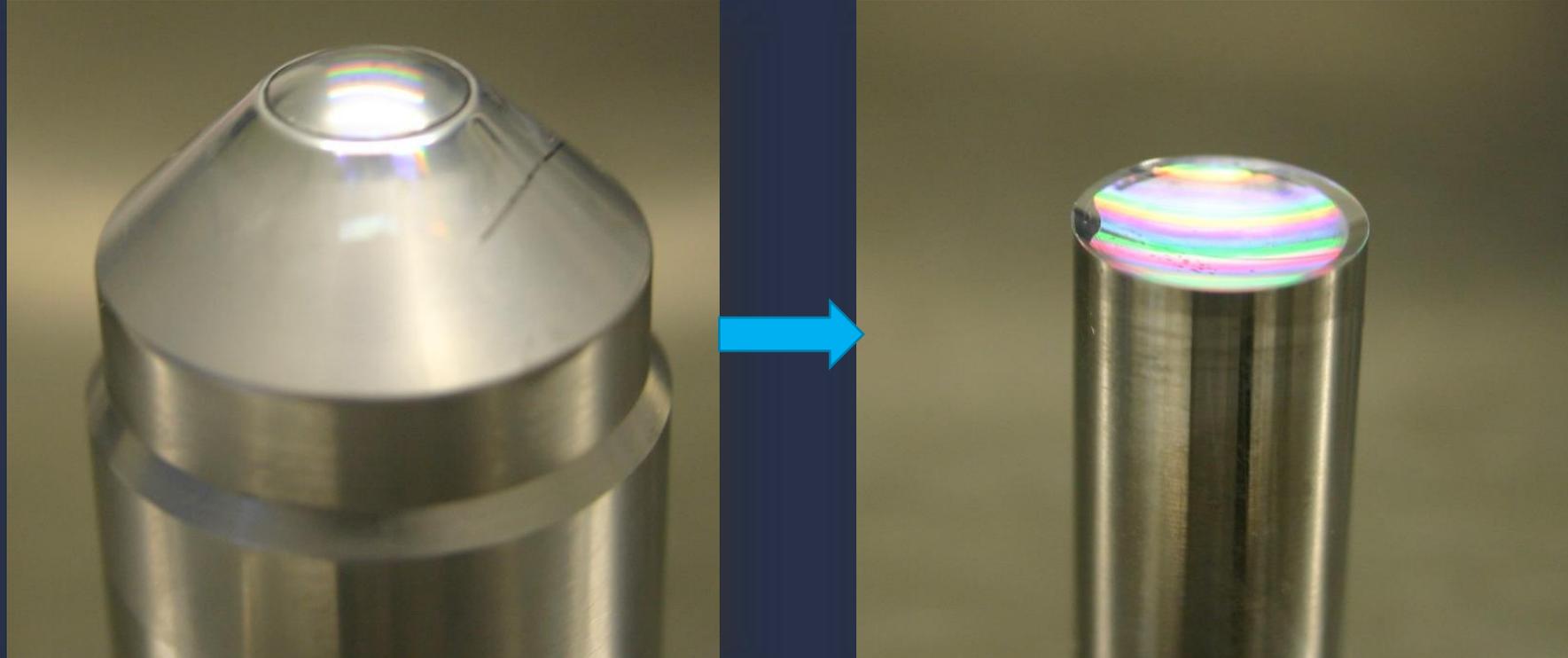
Nano-Optics: Steel tooling for injection molding



Millions of parts molded with each insert
Extremely low cost/unit
No counterfeit until today



Steel to steel or steel to titanium marking

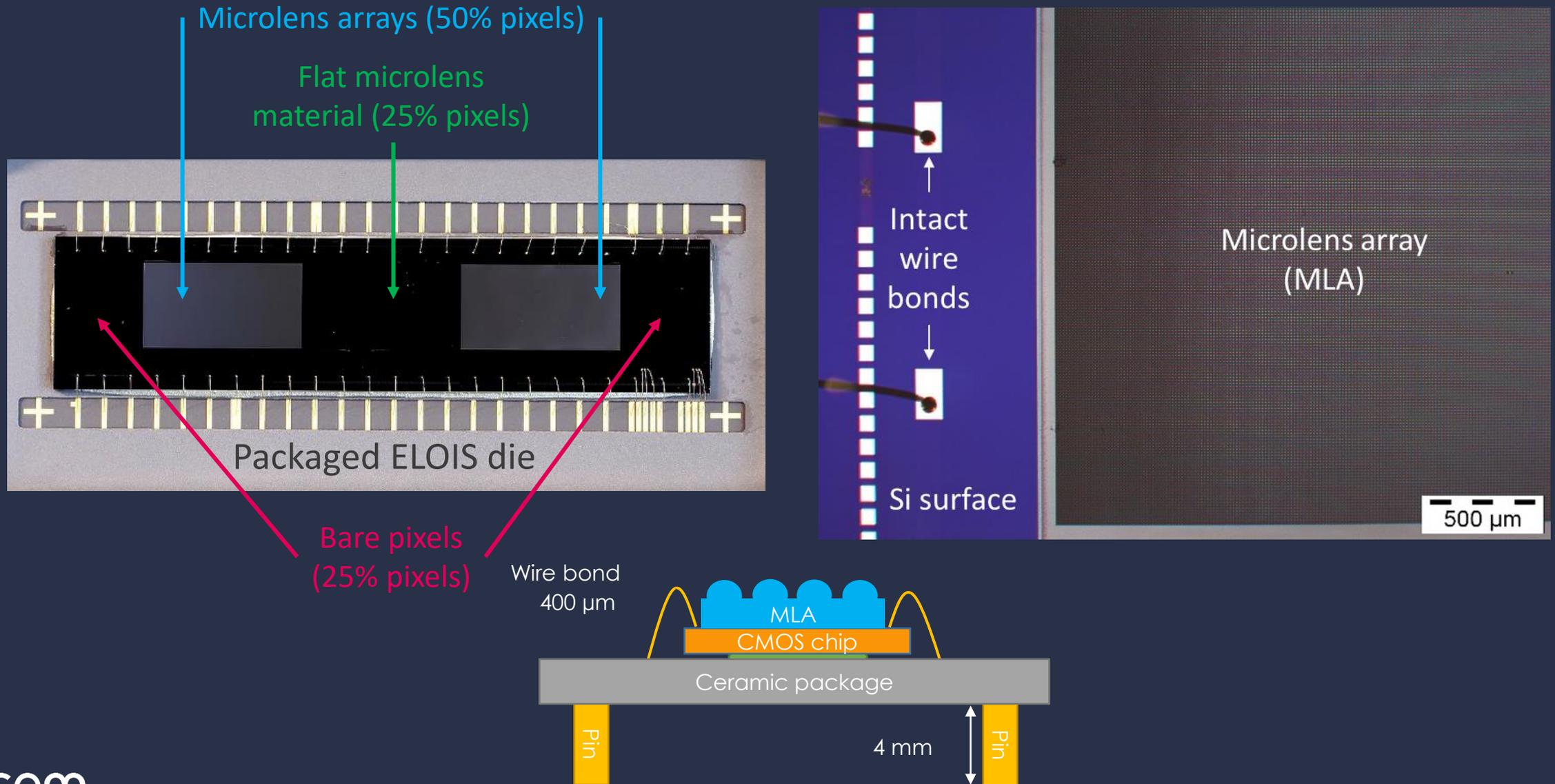


Master stamp steel: EN 1.2379 Hardness 62HrC

Secondary stamp steel : EN 1.2721 & EN 1.2363 Hardness about 15 HrC

Quantities: Typically a few thousands metal parts by hardened metal tool

Deposition of microlenses on packaged imagers: results



Pilot Line on Freeform Micro-Optics: Phabulous

Phabulo μ S

PHABULO μ S:
The European Pilot Line
For The Manufacturing
of Free-Form Micro-
Optics

EU

- csem
- JOANNEUM RESEARCH
- Fraunhofer FEP
- VTT
- leti 023 tech
- SOSS MicroOptics
- morphotonics
- NANOCOMP
- PowerPhotonix
- lasera
- Wielandts upmt
- HELLA
- limbak
- microoLED
- ZUMTOBEL
- SEISENBACHER
- SWAROVSKI
- EPIC European Photonics Industry Consortium
- AMIRÈS

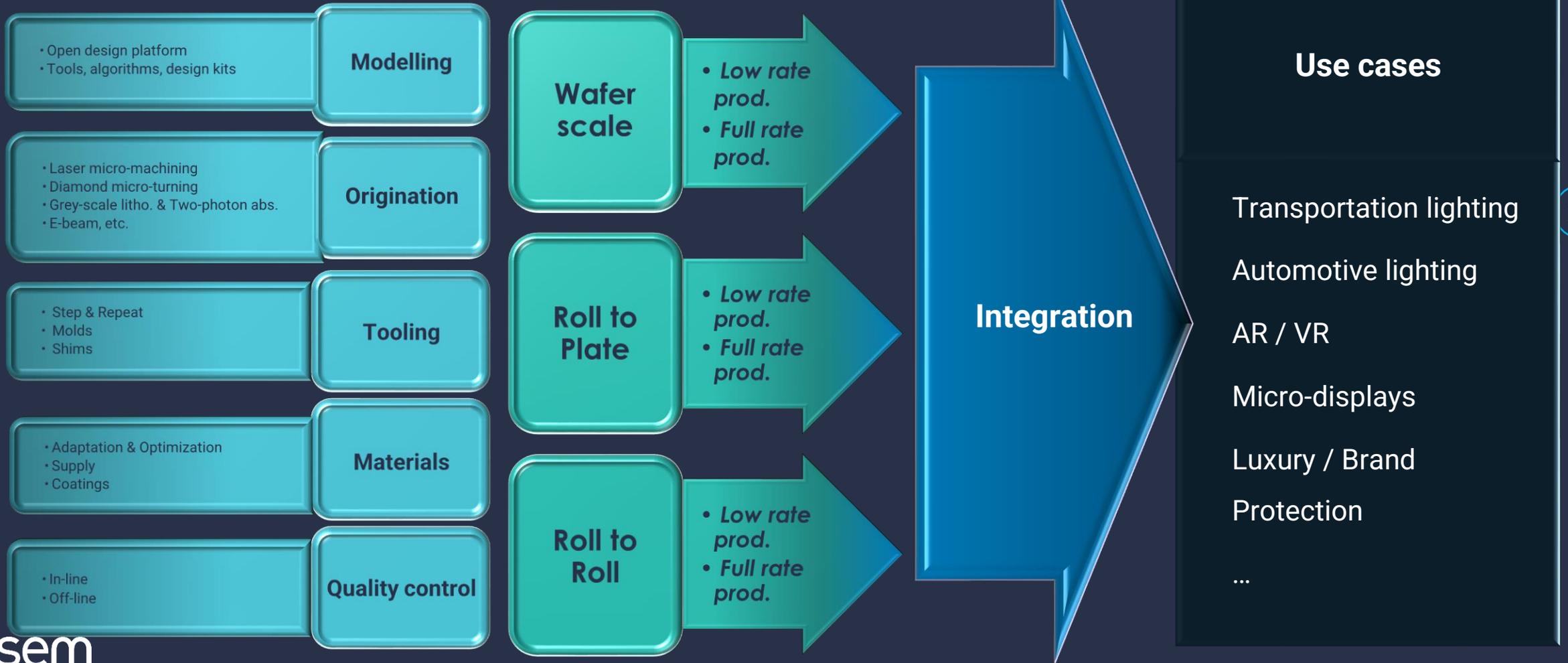
PHABULO_μS Scope

Free-form micro-optics: Micro-optics components with no symmetry constraints

Production Services & UV imprint manufacturing

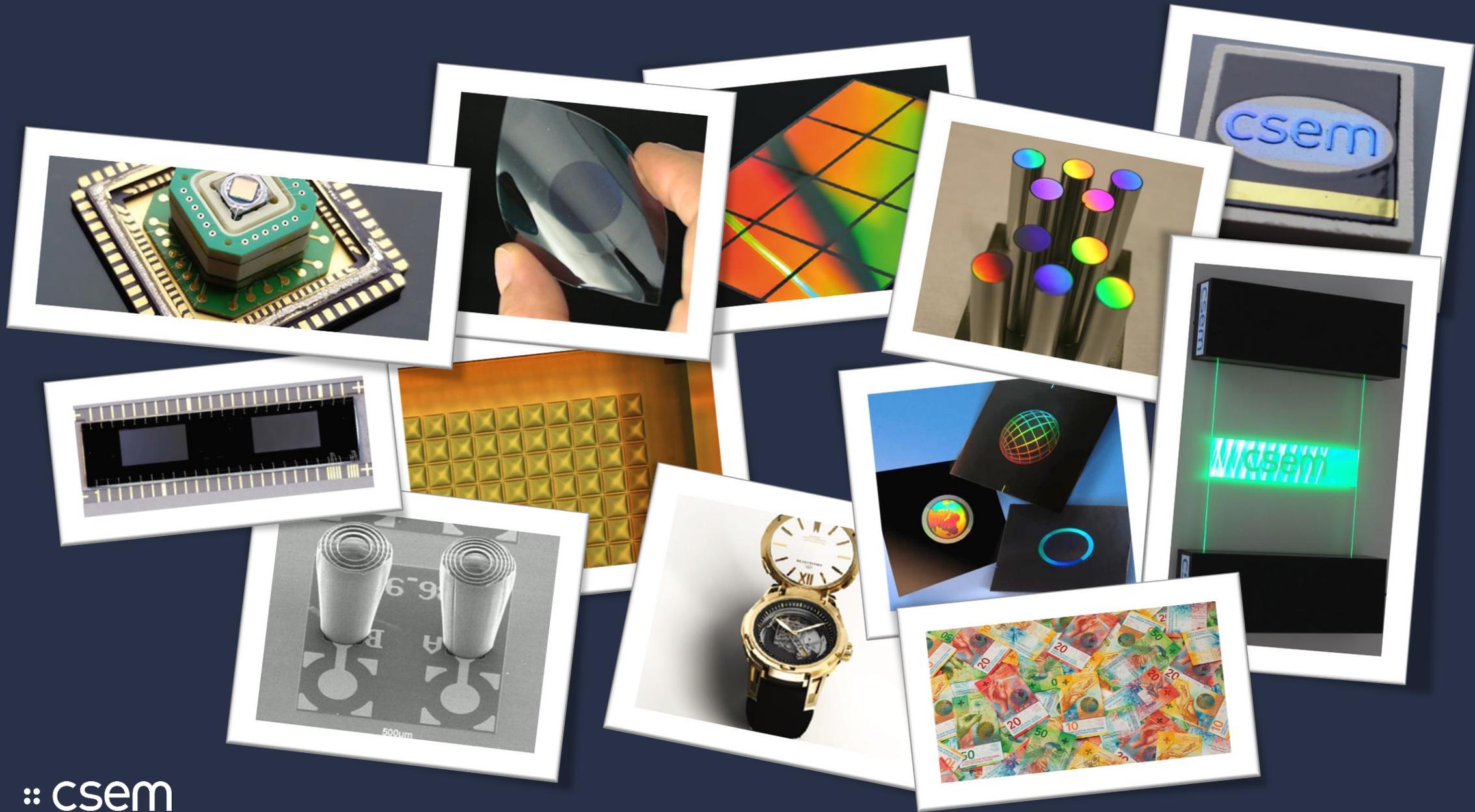
Product integration

Technology validation

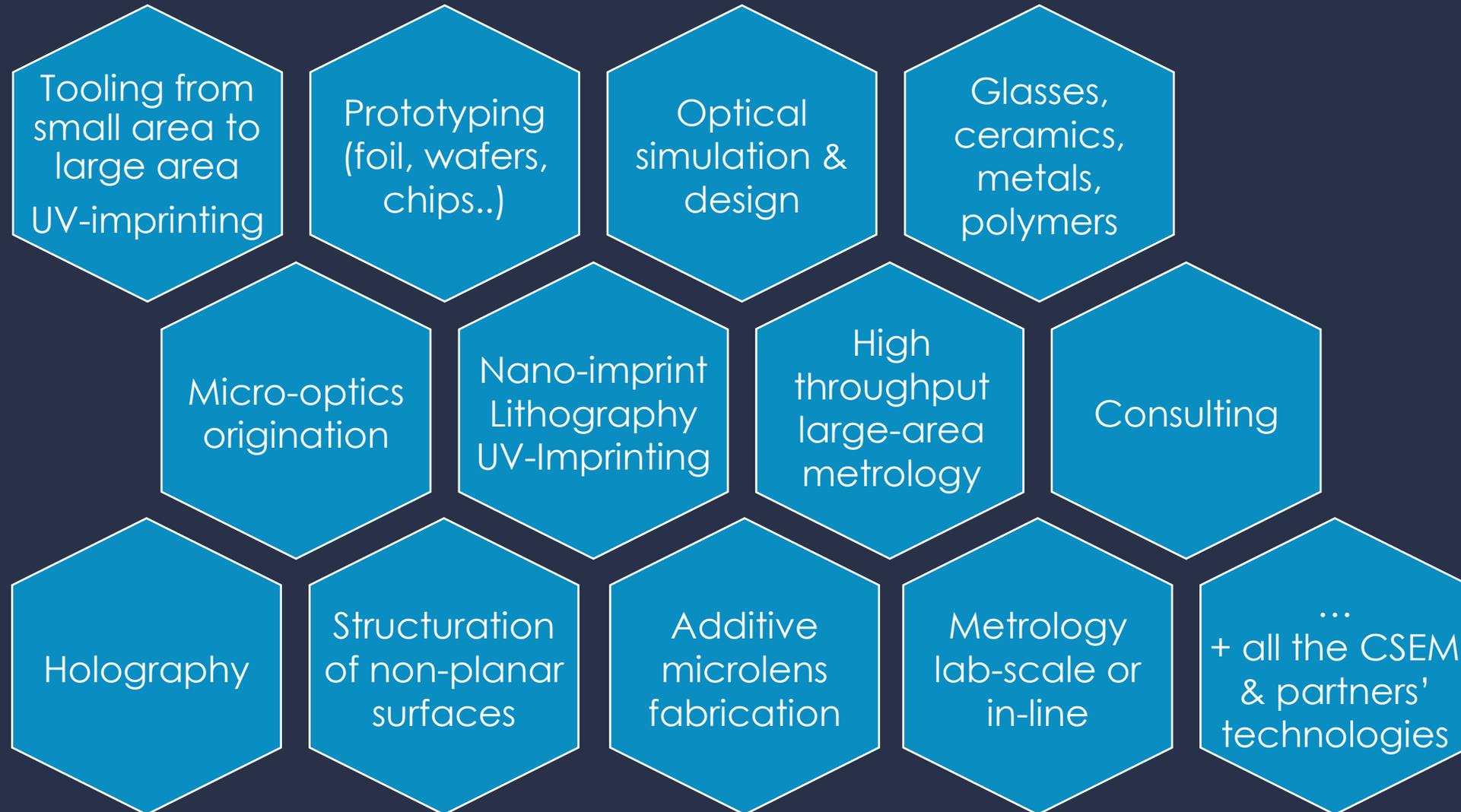


Outlook

Micro & Nano Optics applications keep expanding

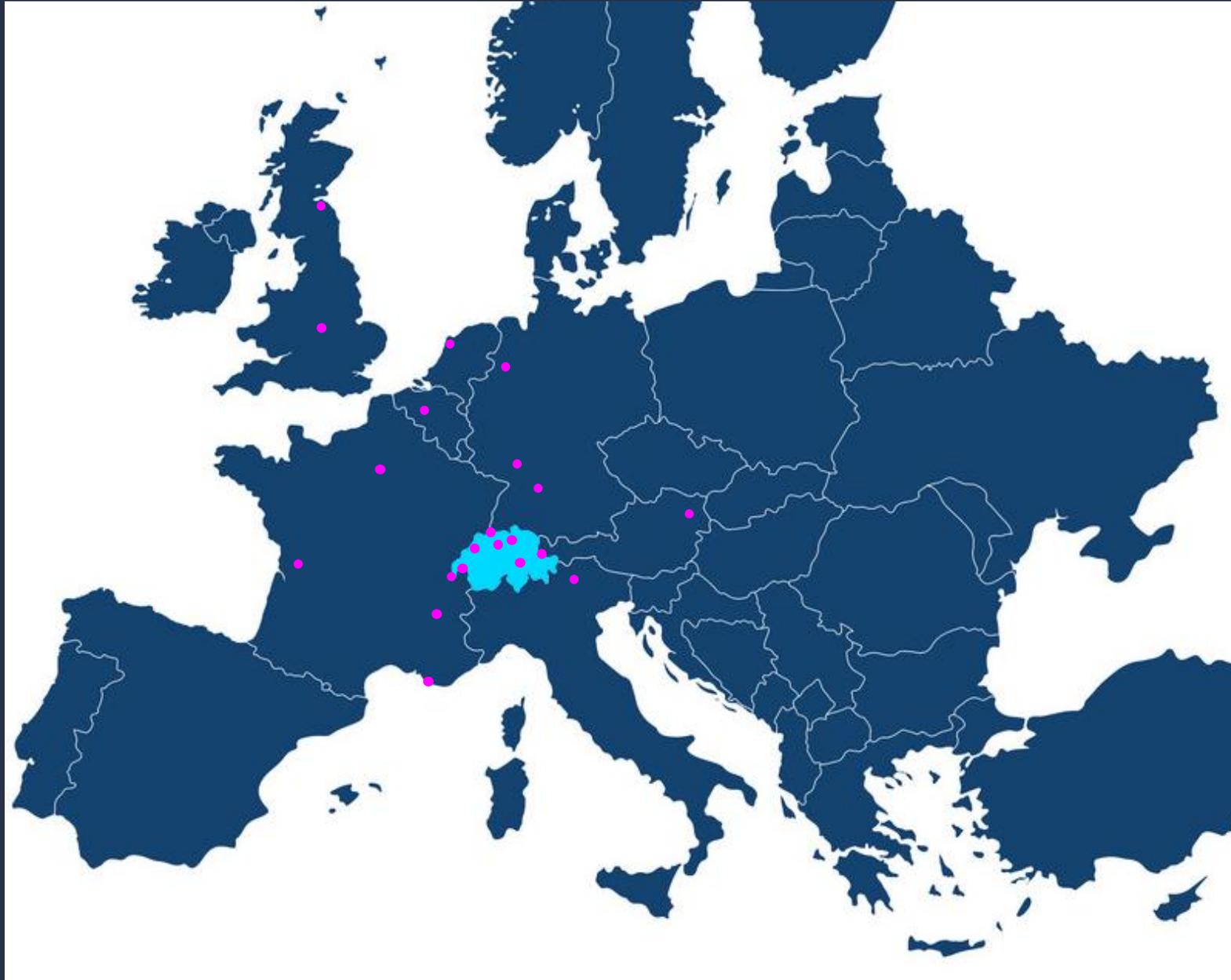


Micro Nano Optics Value-Chain at CSEM



CSEM Micro Nano Optics – Some customers Locations

USA
(CA, WI, NY)



Japan
China
South Korea

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Switzerland:
Basel, Olten, Zurich,
Neuchâtel, Lausanne,
Aldorf, Geneva...
Liechtenstein

CSEM is developing micro-optics and nano-optics solutions tailored to many different industries

Each industry and application can benefit from manufacturing know-how of other industries

Can micro & nano-optics speed-up / improve / lower the costs of development of your next product?

www.csem.ch - guillaume.basset@csem.ch

