INKRON

NAGASE Group

“RECONCILING FUNCTIONAL MATERIALS AND PROCESSES FOR AUGMENTED REALITY AND OTHER WLO”

FREE-FORM MICRO-OPTICS FOR AR/VR: MAY 24, 2022 BY

Phabulous

INTRODUCTION

- Established in 2013
- Joined Nagase group in 2017
- Global sales and distribution
- +100 customers globally

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CORE COMPETENCE

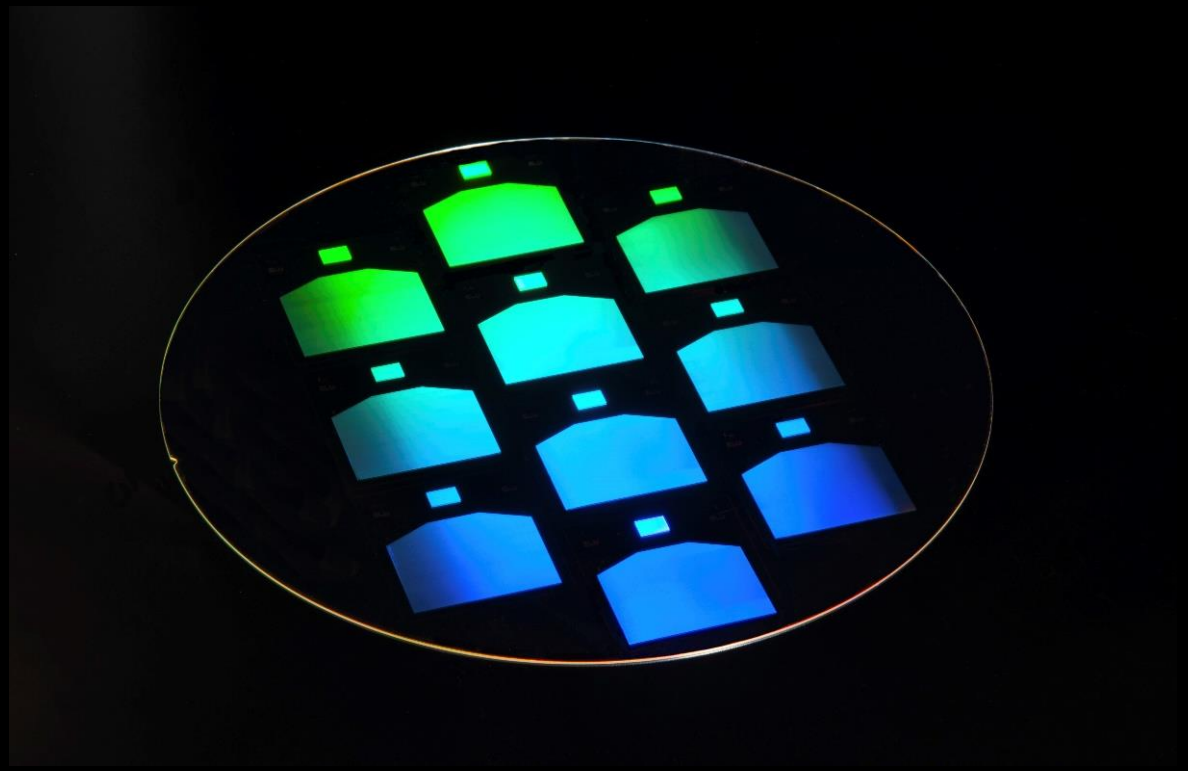
MATERIAL SOLUTIONS FOR OPTICS

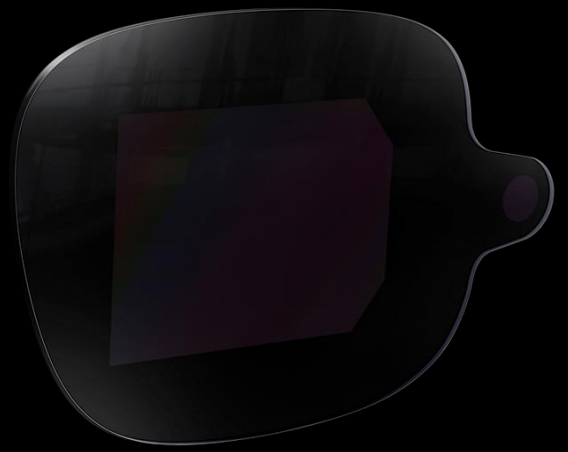
- Developer and manufacturer of siloxane based optical coatings, inks and adhesives
- In-house synthesis and formulation
- In-house made nanoparticles

NIL PROCESS PROVIDER

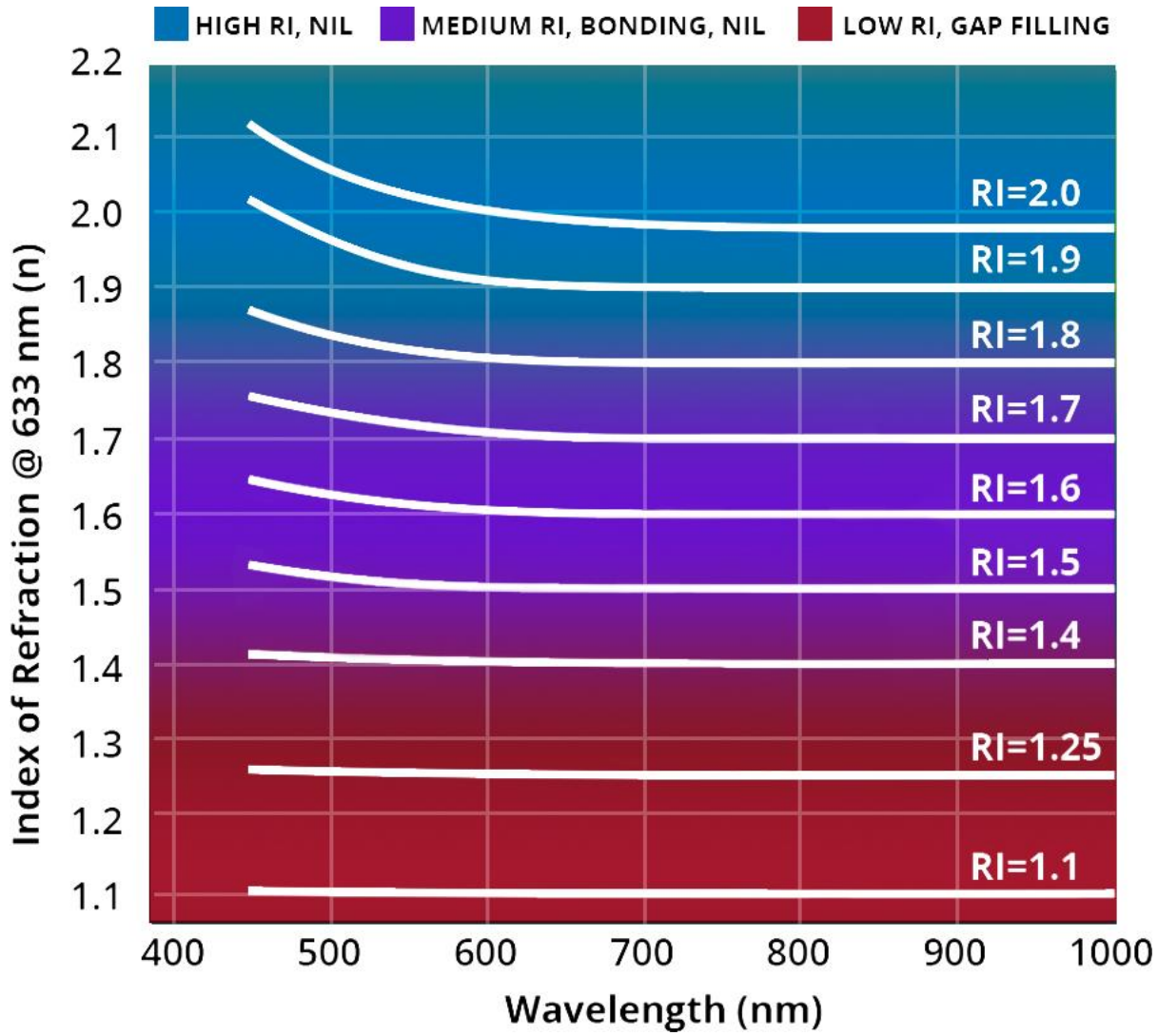
- Optimization of Materials and Process
- Process Know-How
- Production ramp up support, pilots
- Full supply chain with partners

MATERIAL SOLUTIONS FOR OPTICS AND AR





FULL RANGE OF REFRACTIVE INDICES



n = 1.5 - ≥2.0

NIL resins, Optical coatings & Light blocking

n = 1.3 - 1.7

Optical Bonding

n = 1.1 - 1.6

Optical Coatings and Gap Fill

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ESSENTIAL SOLUTIONS FOR AR & DOE

INKRON MATERIALS

HIGH RI NIL COATINGS

- RI range 1.55-1.9x

ADHESION PROMOTER

- Designed to match the NIL resin chemistry

HIGH INDEX EDGE BLACKENING

- Index matching of High RI (range 1.6-1.9x) substrates

OPTICALLY CLEAR ADHESIVES

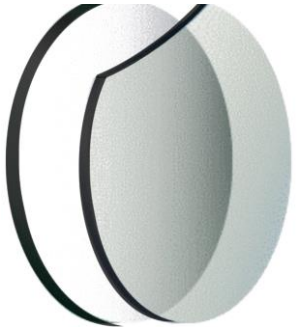
- Index range 1.37-1.6 RI

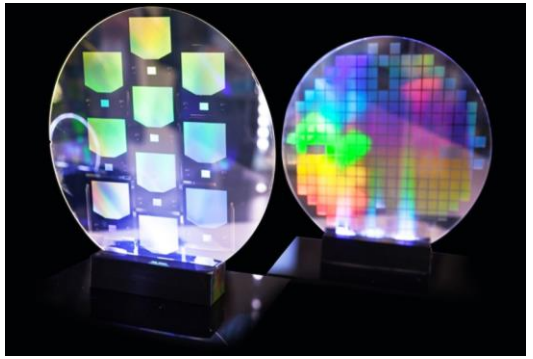
LOW RI COATINGS

- Low RI, range 1.1-1.25

INKRON'S PROCESS OPTIMIZATION

APPLICATIONS





STANDARD PRODUCT LINE OF OPTICAL COATINGS

	IOC-560 C	IOC-570	IOC-501	IOC-114	IOC-172	IOC-132	IOC-133
RI	**1.10-1.25**	**1.22**	**1.25**	**1.55**	**1.58 - 1.74**	**1.75 - 1.82**	**1.8 – 1.9x**
Solvent system	Solvent	Solvent	Solvent	Solvent free Solvent	Solvent	Solvent	Solvent
Key features	Curing: 180-230°C	Curing min: 80°C	Curing: 90-230°C	UV curing	UV-curing	UV-curing	UV-curing
				Nanoimprinting	Nanoimprinting	Nanoimprinting	Nanoimprinting

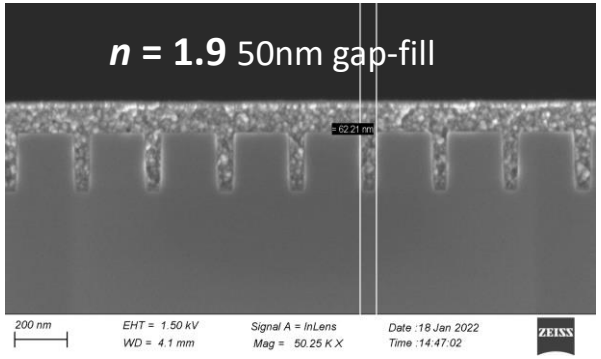
MAIN PROPERTIES

- Excellent transparency
- Low haze and scatter
- Thermally stable

PROCESSING

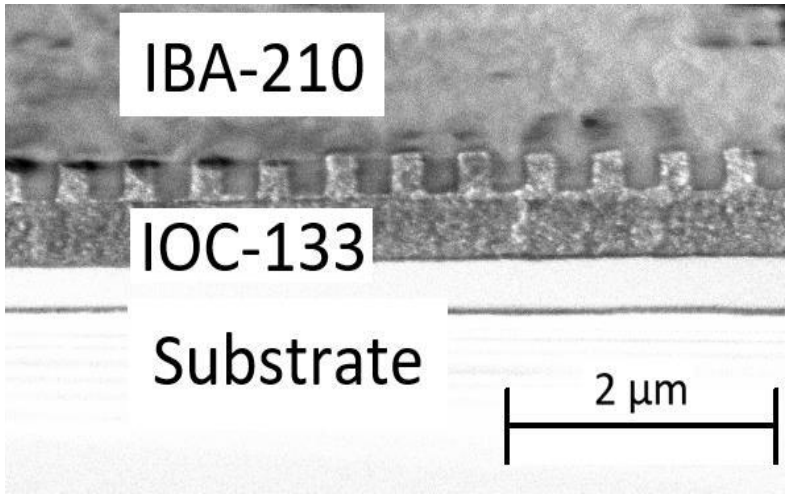
- Spin coating
- Inkjet (selected products RI 1.15-1.9)
- NIL processable (RI 1.5 -1.9x)

GAP FILLING HIGH RI



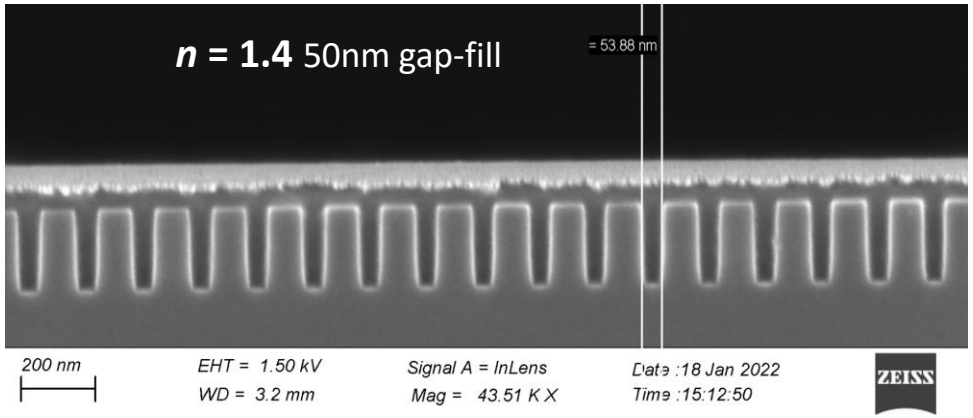
STANDARD PRODUCT LINE OF ADHESIVES

	Adhesives			
	IBA-414	**IBA-210**	**IDA-331**	**IBA-314**
RI	**1.37**	**1.40**	**1.5**	**1.60**
Solvent system	Solvent	Solvent	Solvent/S.free	Solvent
Key features	Curing: UV+temp.˚C	Curing: UV+temp.˚C	UV+temp curing ˚C	Curing: UV+ temp˚C
	Gap filling adhesive Experimental	Gap filling adhesive	Gap filling adhesive	Gap filling adhesive



MAIN PROPERTIES

- Excellent transparency, Low haze and scatter
- No nanoparticles
- Spin-coating
- Thermally stable



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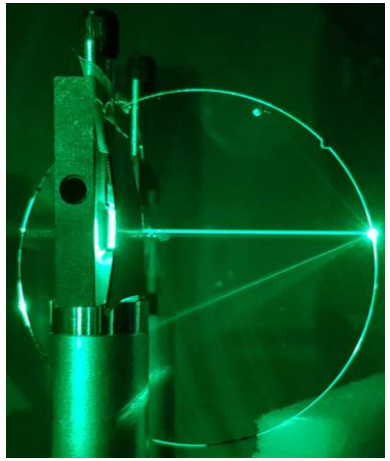
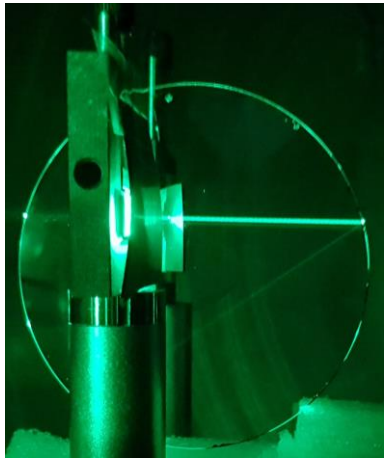
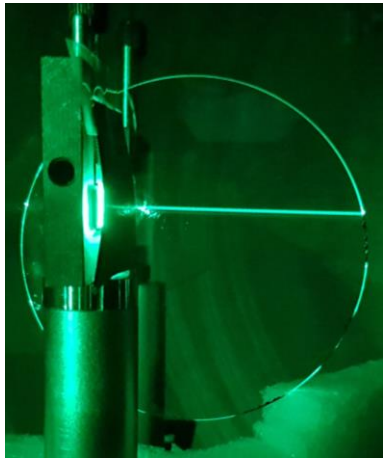
REFLECTION ELIMINATION



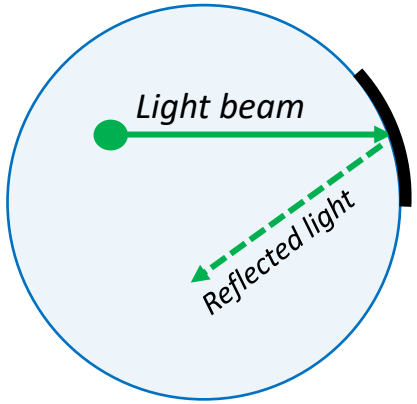
No black coating (Air)



1.5 RI black coating

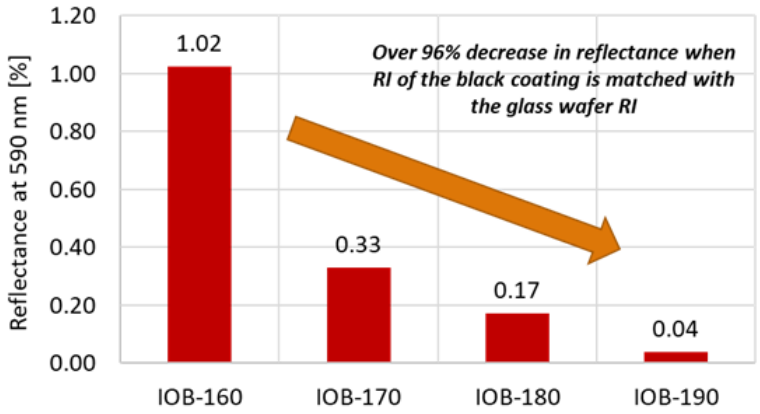


1.9 RI black coating

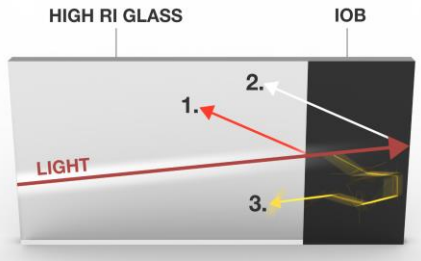


1.9 RI Glass wafer

Black edge coating



- **IOB High Index Optical black**
  - Index matching eliminates reflections caused by RI difference at the interface
  - High Optical Density (OD) absorbs light entering the blackening layer
  - Balanced formulation removes scattering
  - RI range 1.7- 1.9, both thermal cure and UV version
  - Edge coating tool may be offered

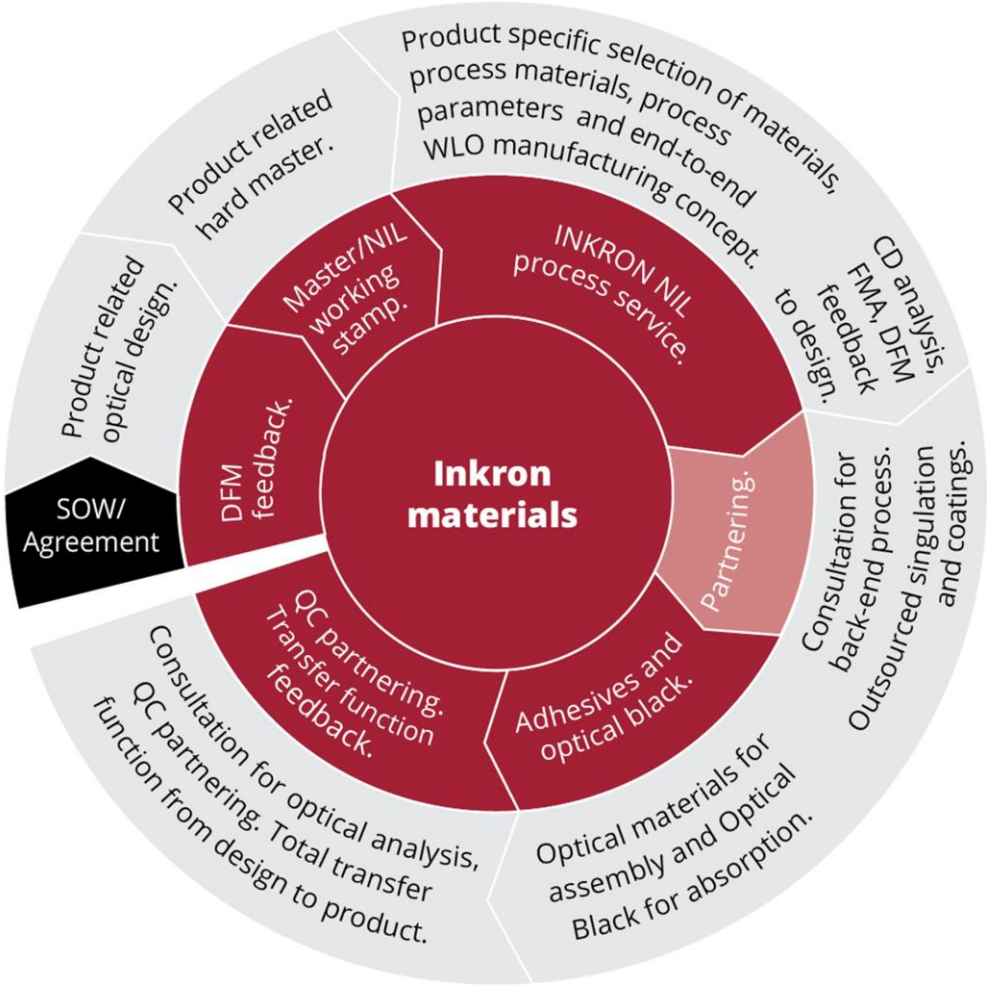


NANOIMPRINT PROCESS SUPPORT & PILOTING

OPTIMIZED MATERIALS AND PROCESS KNOW-HOW

PROCESS SUPPORT, PILOTING AND OPTIMIZATION

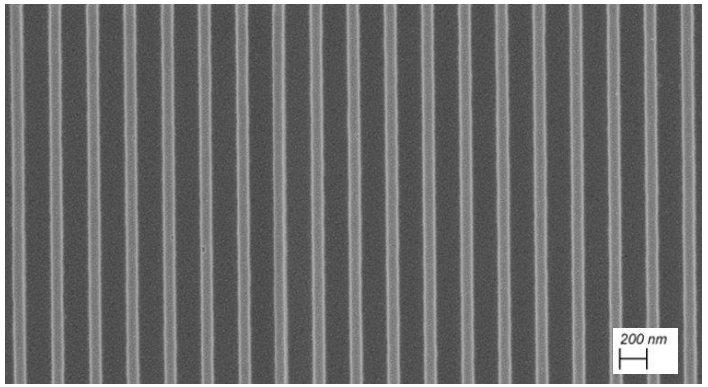
- Process support with material level optimization to fine-tune the optical designs and select the production parameters
- Master design consultancy: bilateral communication at design phase to confirm the process and material related requirements.
- Initial process tests, to confirm the basic process parameters and material selection
- If problems occur, the root cause investigation and corrective actions are proposed.
- Pilot manufacturing, edge coating
- Advice on back-end processes and product quality control are available.



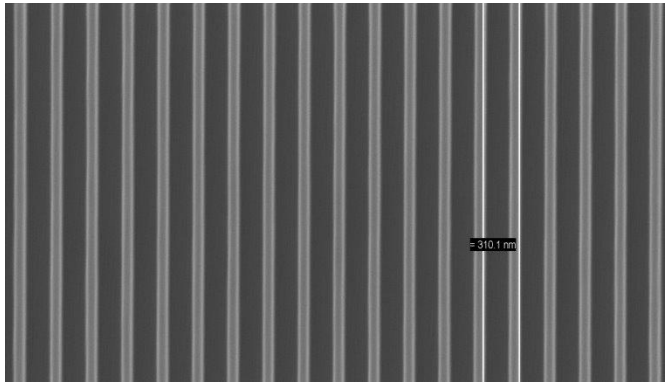
INKRON'S NIL FACILITY

NIL COATINGS' IMPRINT PERFORMANCE

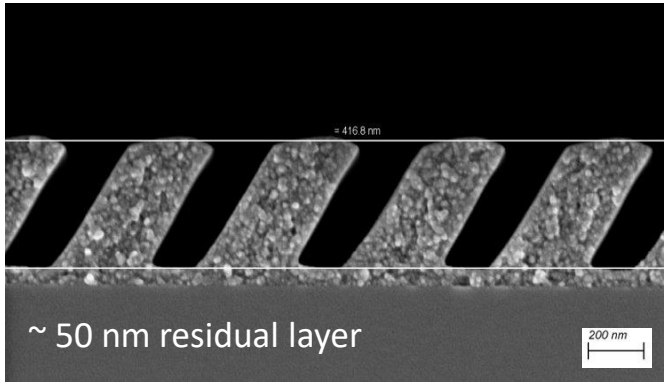
- IOC *with* ***n = 1.7 – 1.92*** shows great pattern fidelity in various stamp shapes and aspect ratios
- **Line/space** gratings with linewidths down to **75nm** with aspect ratio **>3.5**; **Bi-directional 30° slanted** gratings with **400nm** vertical height; Various pillar patterns (also non-spherical).



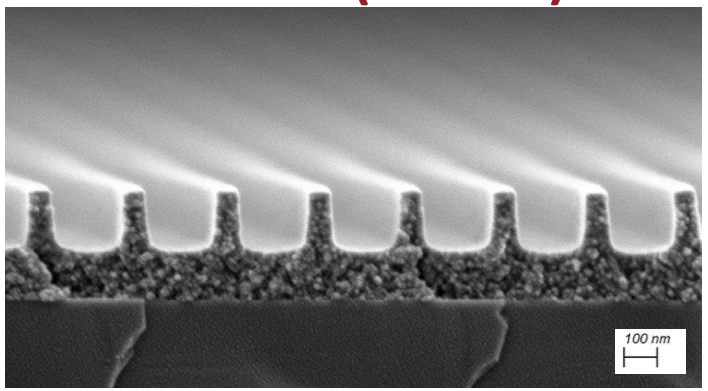
IOC 172 (n = 1.7)

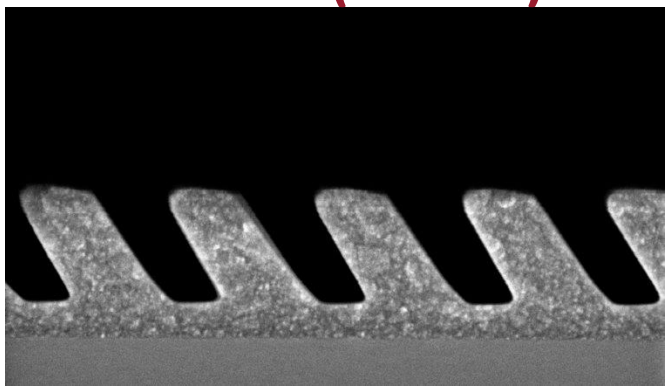


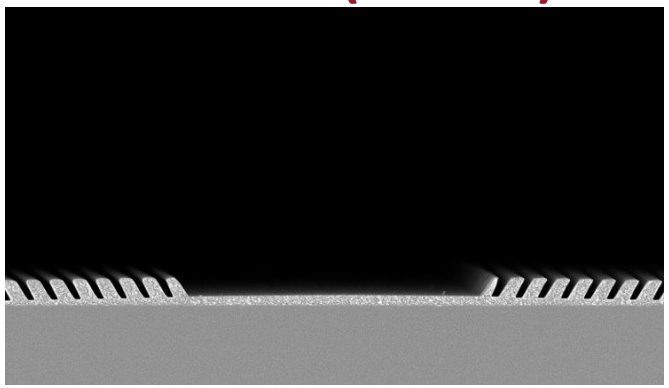
IOC 132 (n = 1.8)



IOC 133 (n = 1.9)

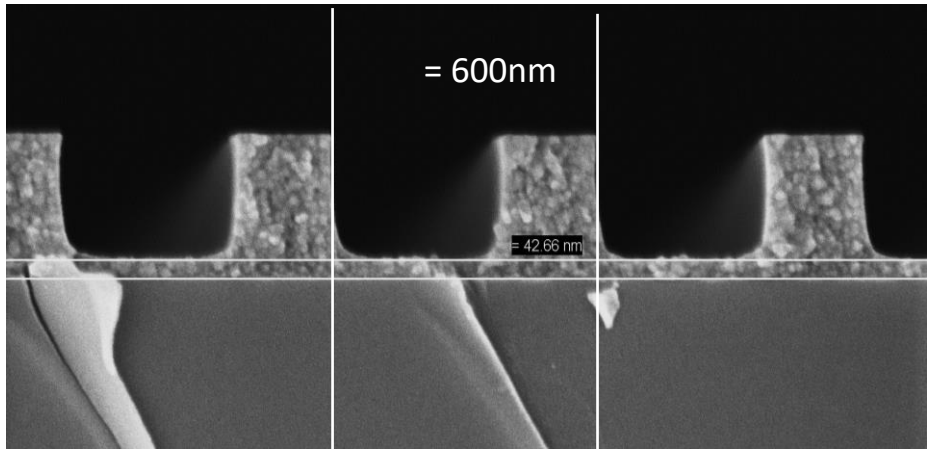




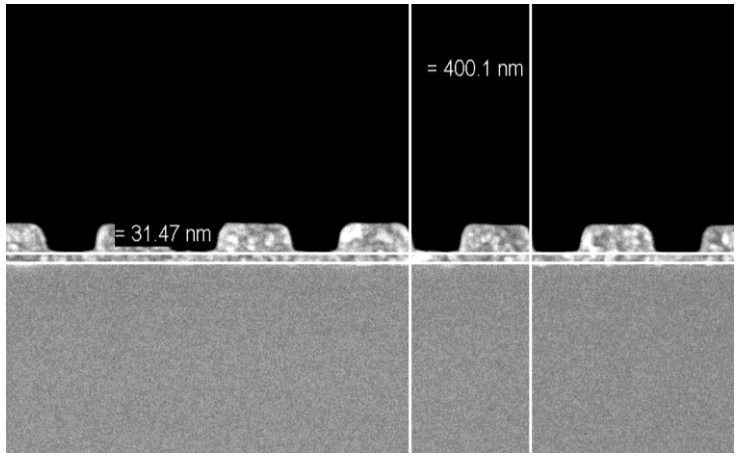


***Slanted grating master manufactured and provided by NIL Technology AsP.**

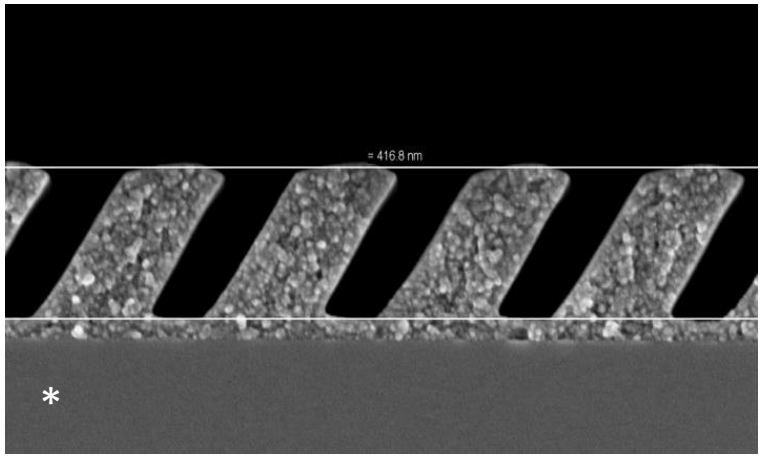
EXAMPLES OF IMPRINTS WITH IOC-133



Film thickness: 175 nm
Period: 600 nm
Height: 300 nm
Residual layer: 43 nm
Pre-bake: 60°C/60s



Film thickness: 93 nm
Period: 400 nm
Height: 100 nm
Residual layer: 31.5 nm
Pre-bake: none



Film thickness: 290 nm
Period: 502 nm
Height: 417 nm
Residual layer: 55 nm
Pre-bake: none

- Larger features are more difficult for minimizing residual layer than smaller structures.
  - 50-100 nm residual layer should be reached with a large variety of structures.
  - With small periodicities (≤600nm) even 30-40 nm residual layer is reachable

** Slanted structure provided by NILT*

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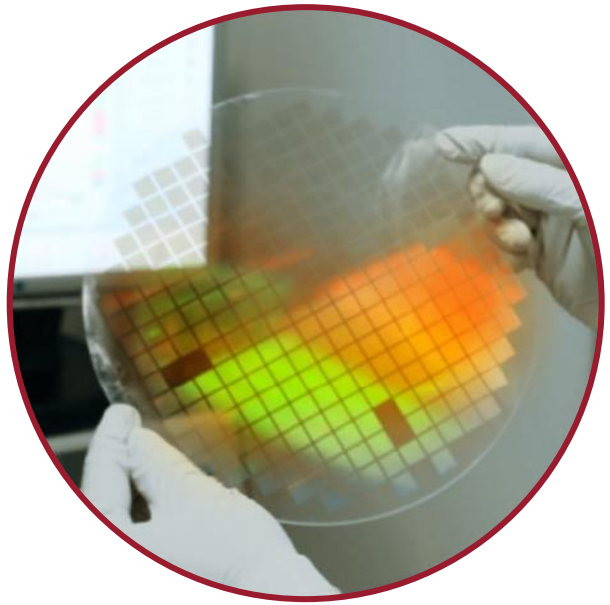

LINKING MATERIALS WITH NEW OPTICAL DEVICES

THANK YOU

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