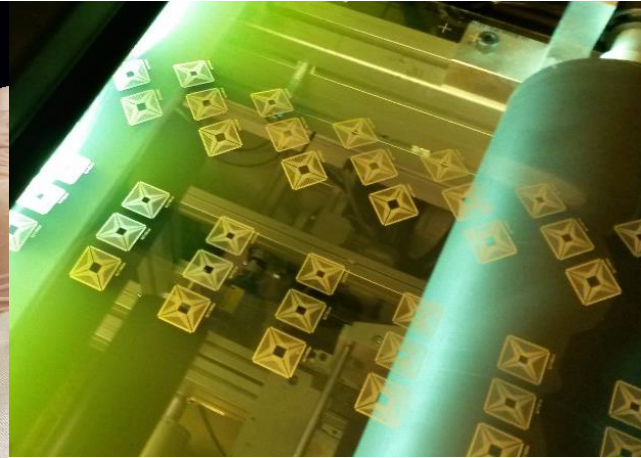
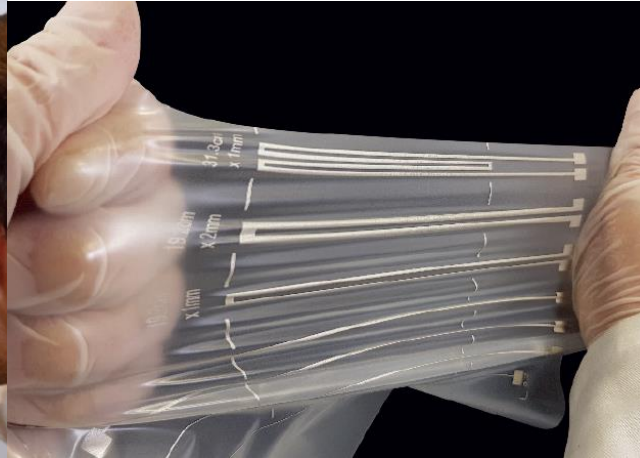




EPIC Conference
November 7 2019



The leading siloxane monomer and polymer expert

Core competence:

- Developer and manufacturer of siloxane based optical coatings, adhesives, conductive and dielectric inks
- In-house synthesis of the resins
- In-house formulation

Key attributes of Inkron products:

- Transparent and clear
- Ultimate thermal and optical stability
- Low and High Refractive Index coatings



Locations



 **INKRON**
FINLAND

 **Nagase ChemteX Corporation**

JAPAN

 **NAGASE**
NAGASE & CO., LTD.

 **Nagase ChemteX Corporation**

 **INKRON**

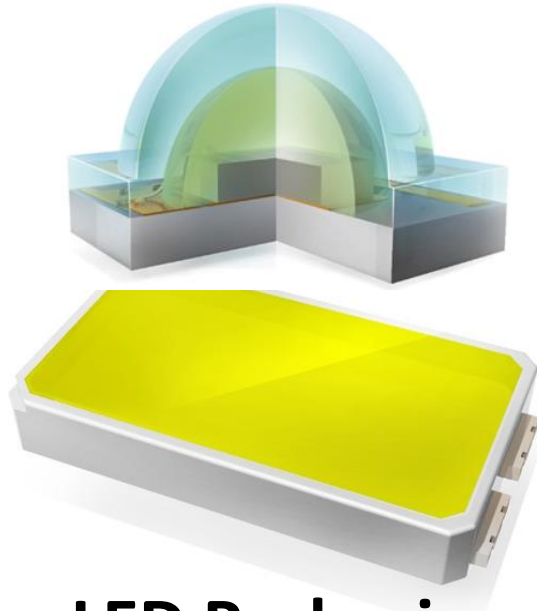
TAIWAN



- **Inkron:**
 - R&D and manufacturing operations in Espoo, Finland
 - Opto-packaging team in Taiwan
- **Nagase & Co., Ltd:** Headquarters in Tokyo and sales offices worldwide
- **Nagase ChemteX Corporation:** Factories in Harima, Fukuchiyama, Sakai Japan and Wuxi, China



Main Markets



LED Packaging Materials



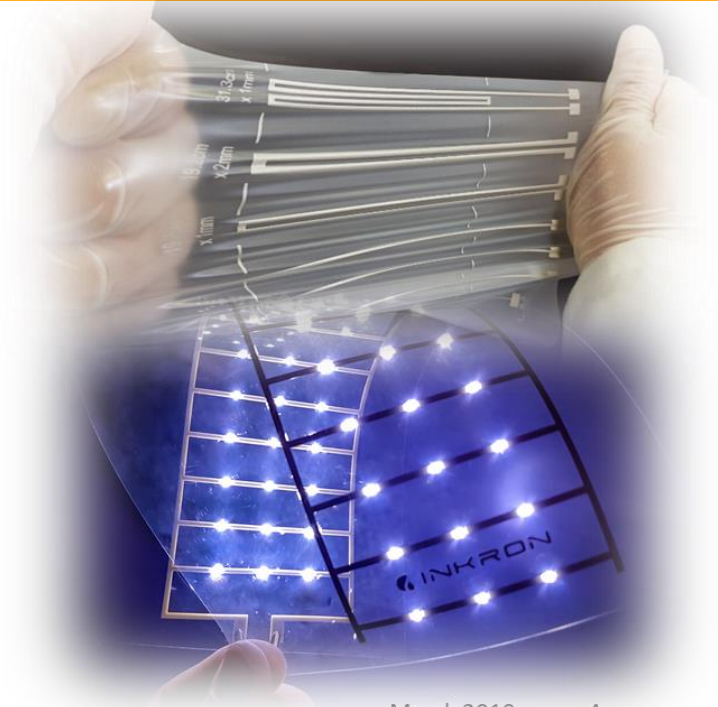
- Die attach adhesives
- LED encapsulants



Optical Devices



- Light management coatings
- Products for NIL nano-optics



Printed Electronics



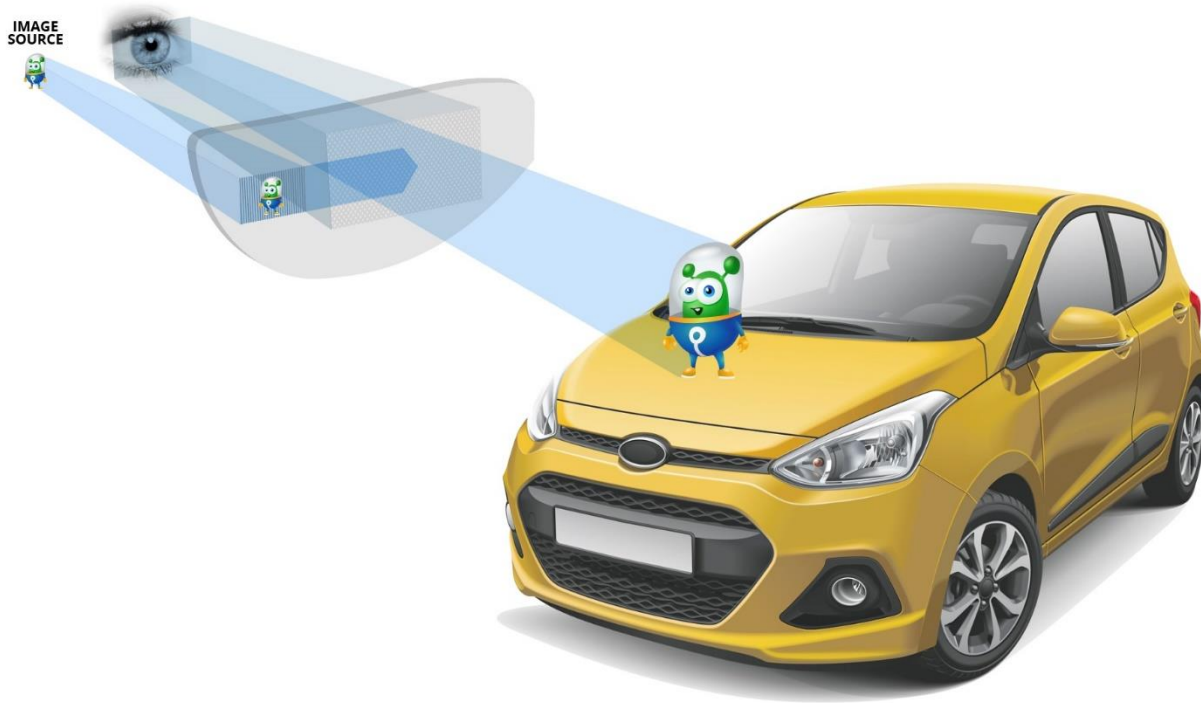
- Printable inks
- Structural adhesives

May 2019



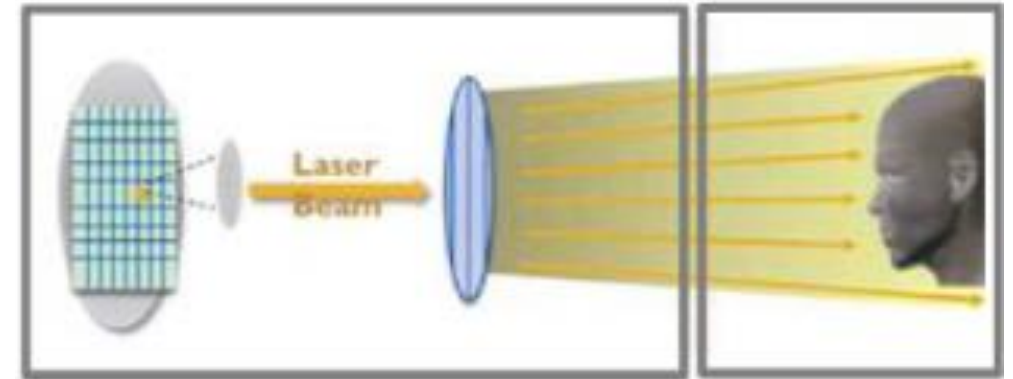
Applications of imprintable coatings

Gratings for MR & AR Devices



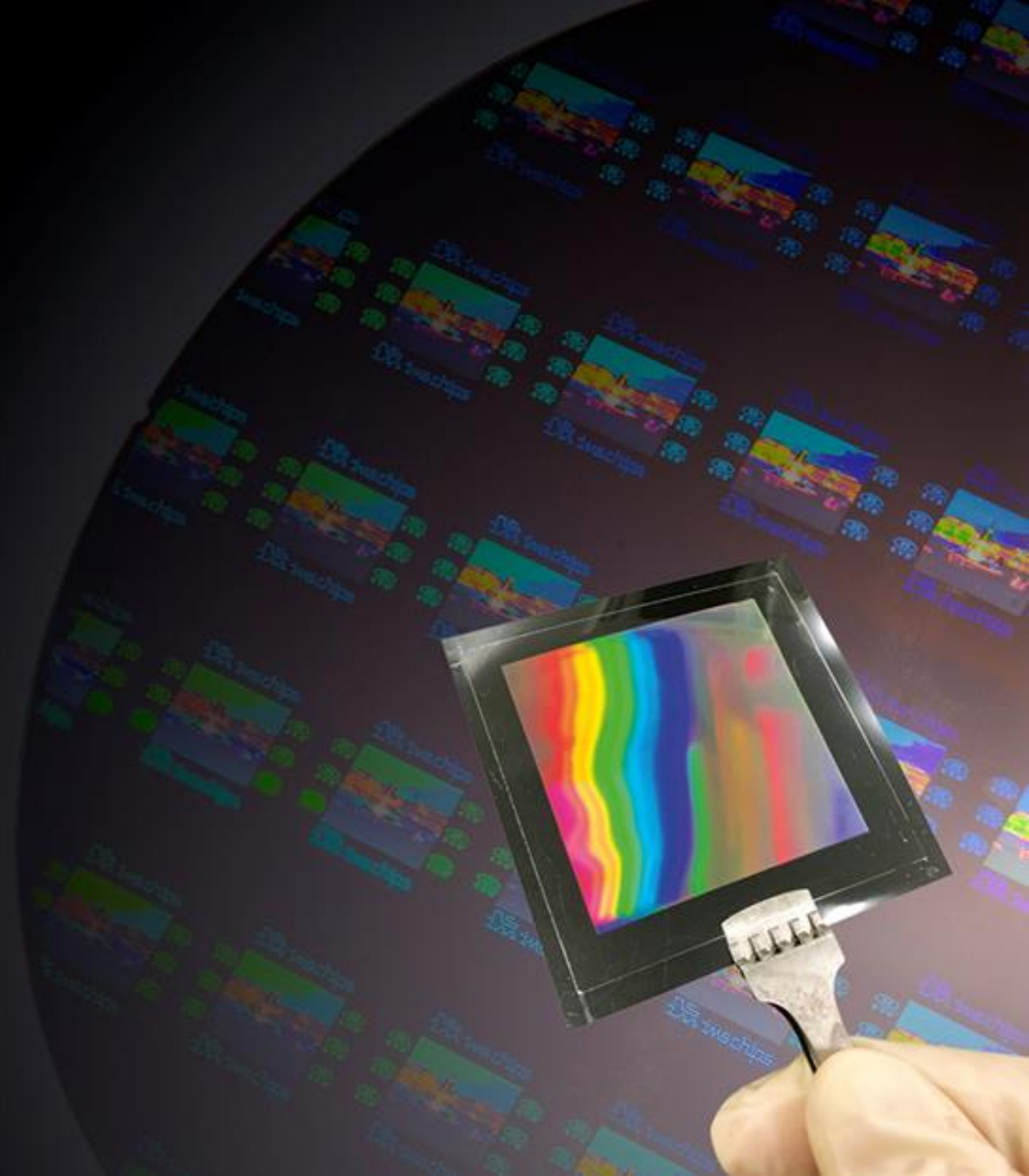
- Nanoimprinted waveguides

Diffractive Optical Elements – applications



- Sensors: ToF, Structured light sensors
- Waveguides
- Diffusers
- Beam splitters
- Wire grid polarizers
- Volumetric Displays
- Etc

SILOXANE POLYMERS IN OPTICS



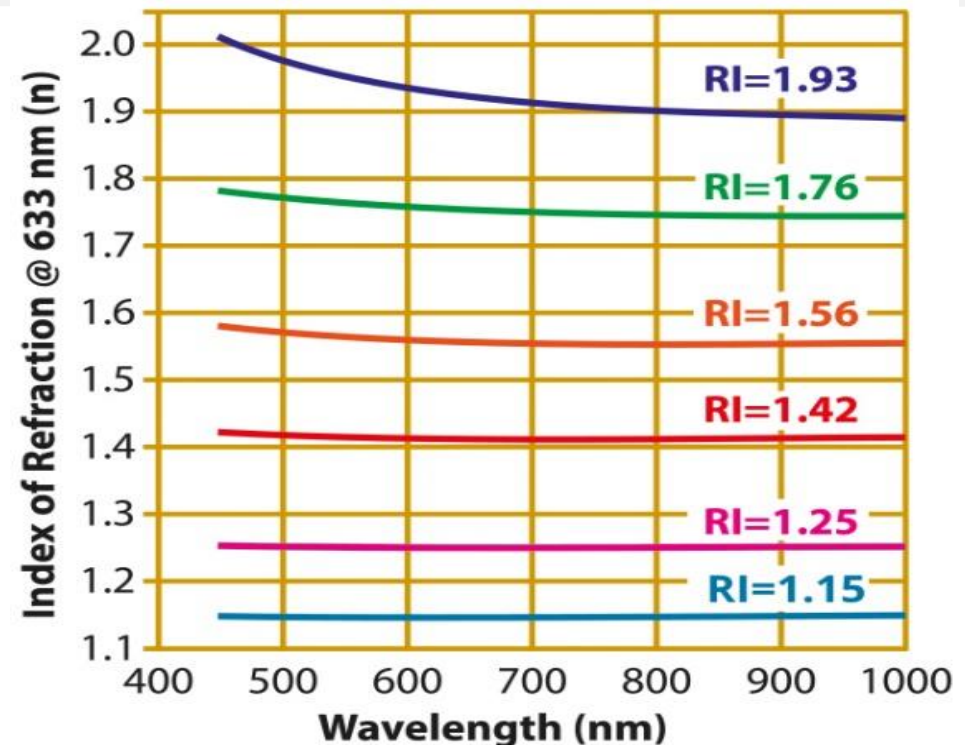


Overview of Inkron's Optical Coatings

	LOW-RI		MED-RI		HIGH-RI		
	IOC-560	IOC-501	IBA-210	IOC-110	IOC-172	IOC-132	IOC-133
RI	1.10-1.25	1.25	1.40	1.55	1.58 - 1.74	1.75 - 1.82	1.8 – 1.9
Solvent system	Solvent	Solvent	Solvent	Solvent free Solvent	Solvent	Solvent	Solvent
Key features	Curing: 180-230°C	Curing: 90-230°C	Curing: UV+150°C	UV curing Nanoimprinting	UV-curing Nanoimprinting	UV-curing Nanoimprinting	UV-curing Nanoimprinting

Principal features

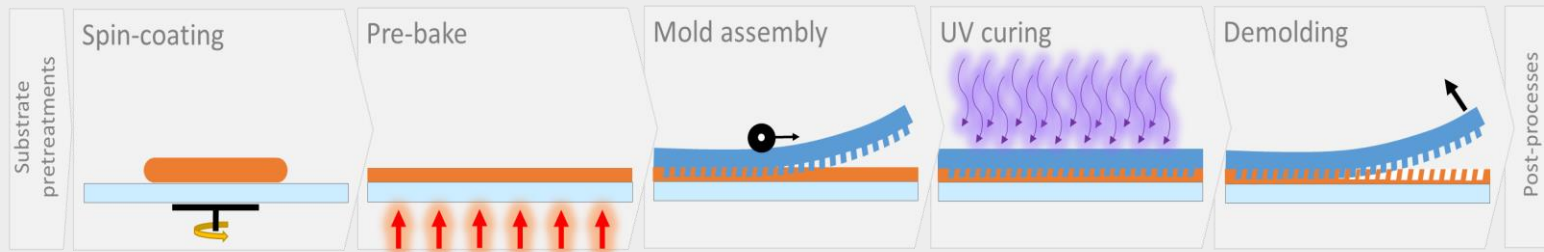
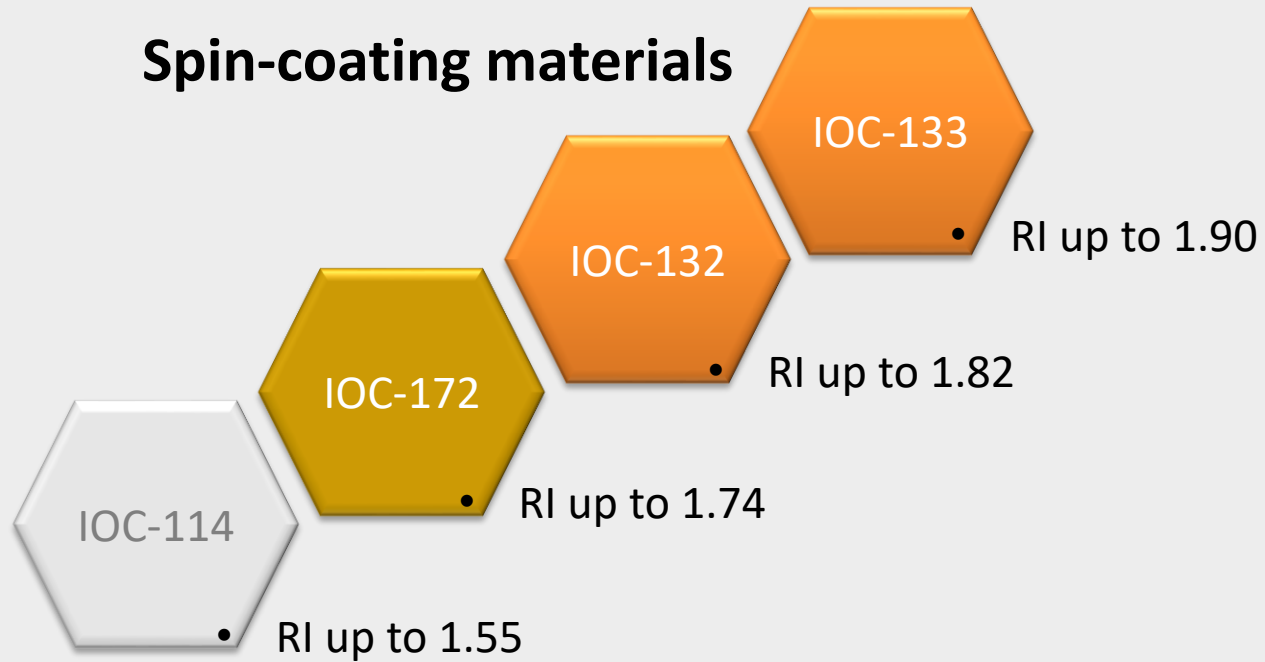
- Highly transparent
- Thermally stable
- Low haze and scatter
- Ultra Low refractive index
- High refractive index
- NIL processable grades



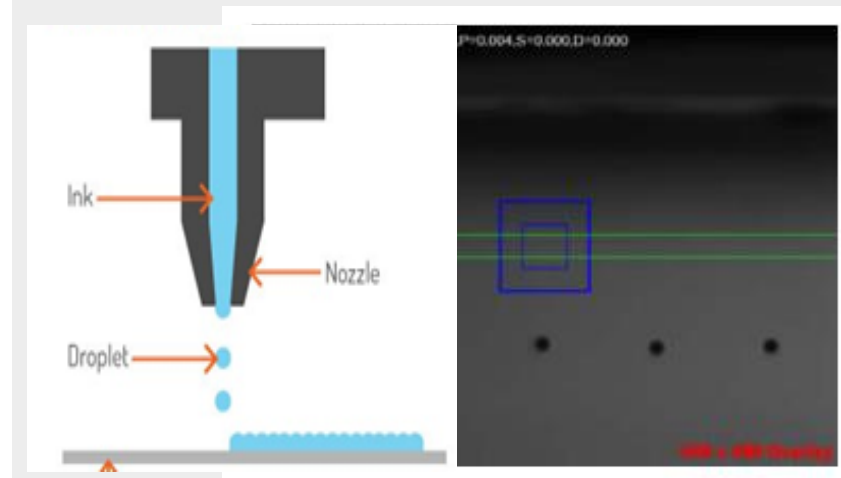
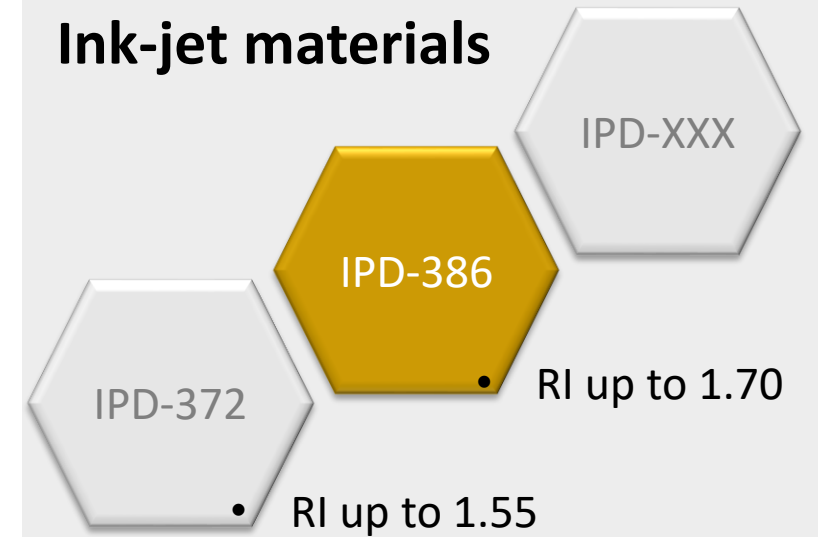


Process options: Spinning or Inkjetting

Spin-coating materials



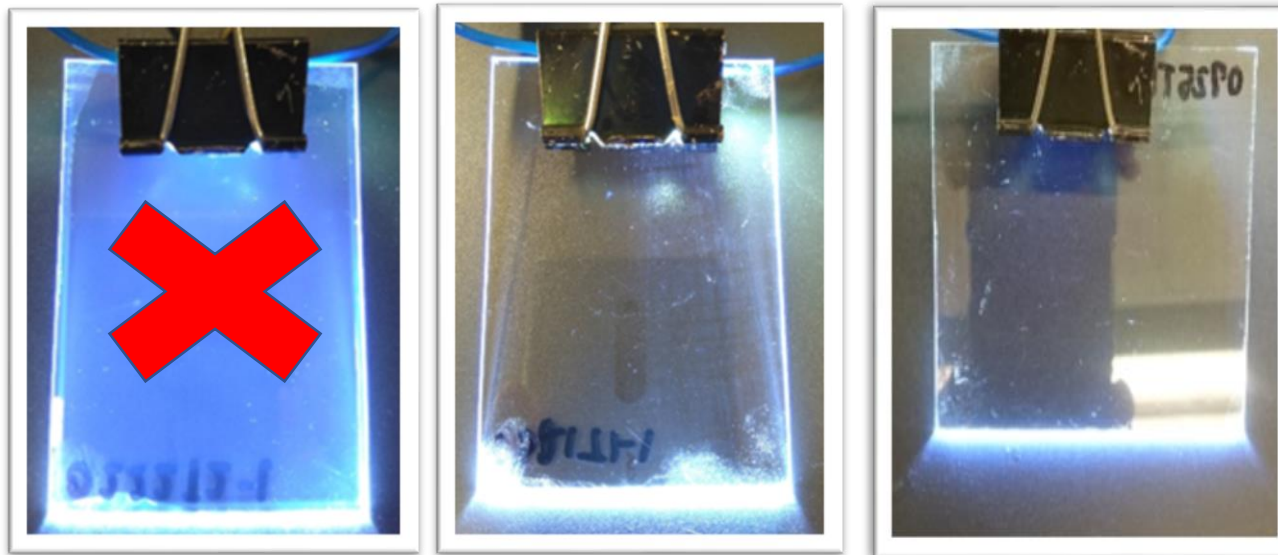
Ink-jet materials





Optical Materials for Nanoimprinting: Haze and scattering

Nanoparticles – Haze/Scattering: Optimized particle size and distribution needed



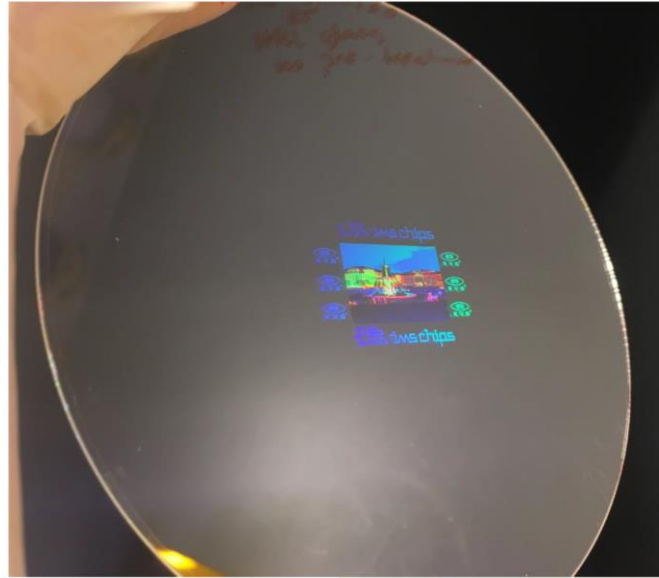
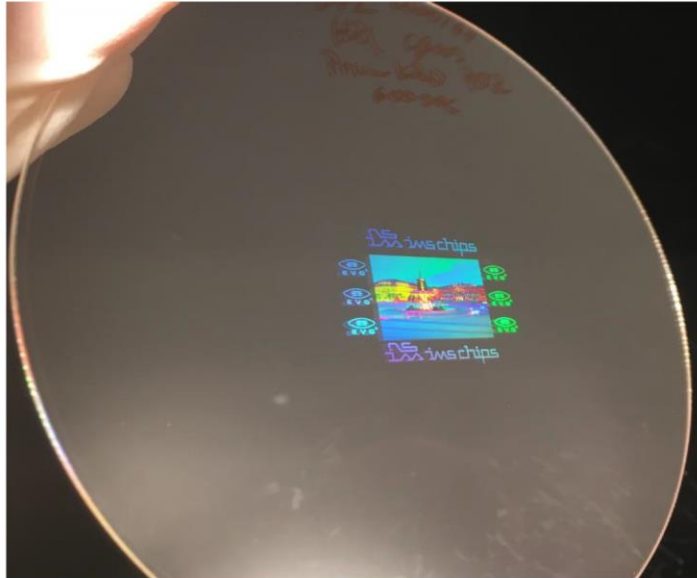
9

- Nanoparticles used for high RI material
- Scattering is clearly observed as a blue light is coming at edge of glass – visual haze observed (LEFT).



Product example: IOC-172; Nanoimprintable RI 1.7

Result IOC 172 on HRI Glass – Wafer pre-treatment

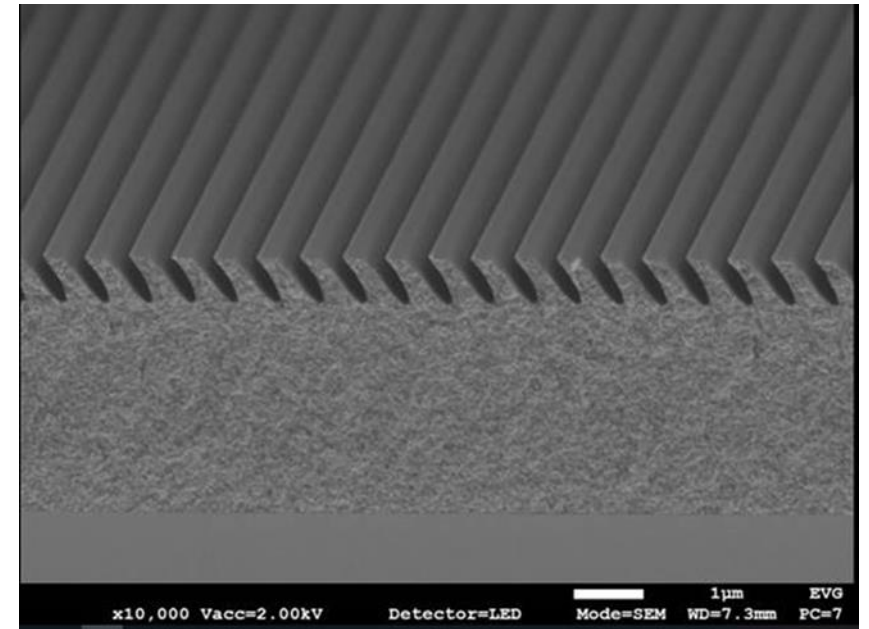


Spin coat Prim KRD:
No detachment issues

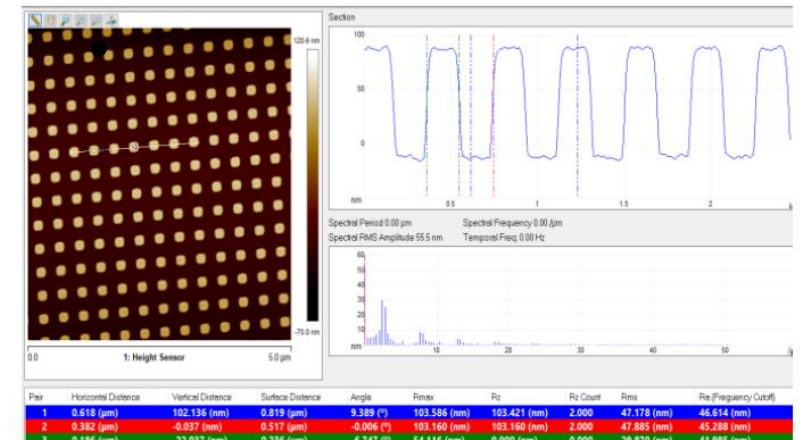
No pre-treatment:
No detachment issues



- Fully replicated
- No Detachment issues

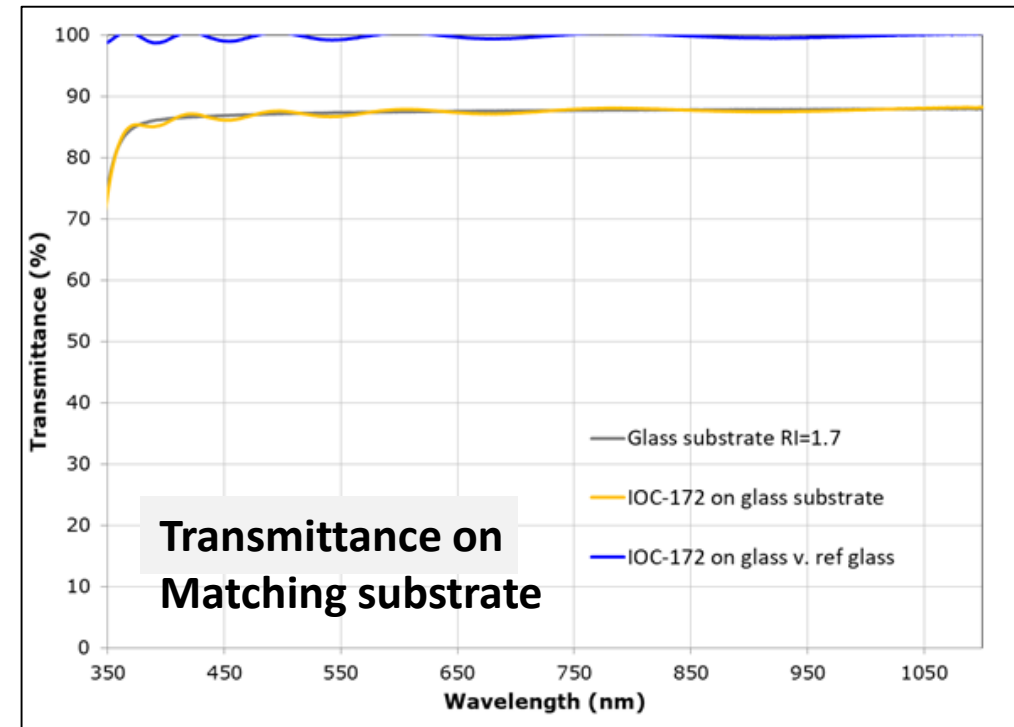
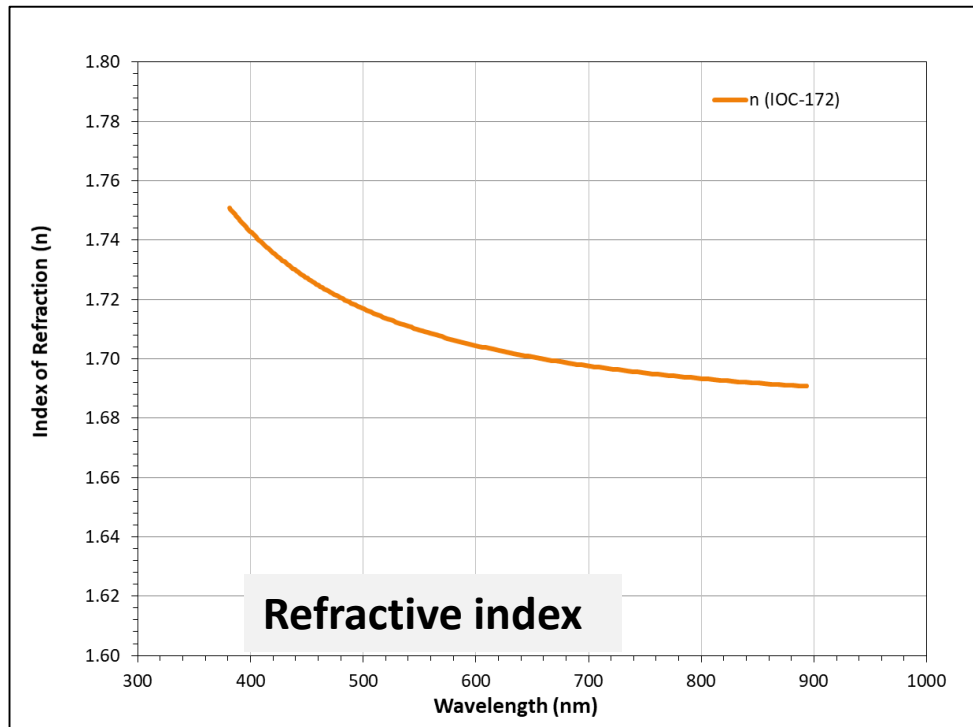


- Slanted gratings





Product example: IOC-172; Nano-imprintable RI 1.7

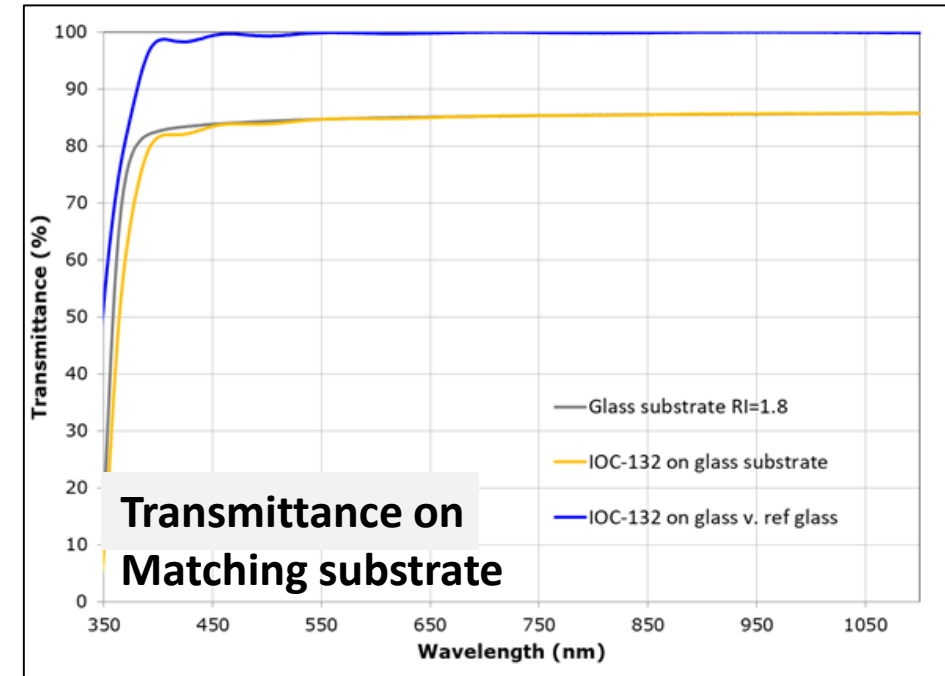
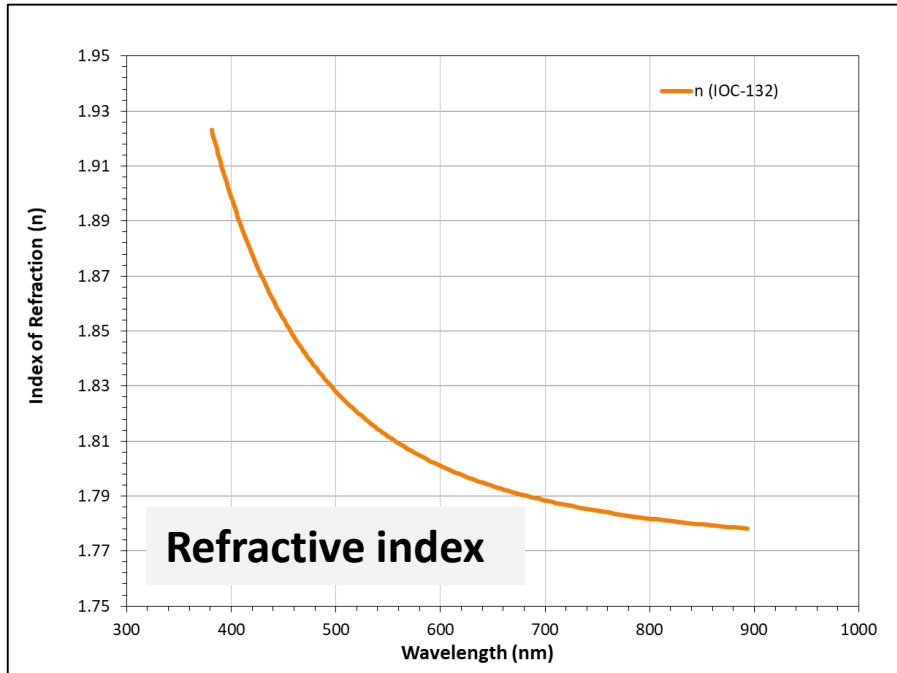


Cured film properties

Property	General Description	Result
Thickness	Spin 1000rpm	0.5 µm
Index of refraction	at 589nm	1.70
ABBE number	-	36
Transmittance	at 420nm ¹⁾	> 99%
L*, a*, b*	D65 ¹⁾	99.0, 0.04, 0.05
Haze	ASTM D1003-97 (Pros.B/A) ¹⁾	< 0.1



Product example: IOC-132; Nanoimprintable RI 1.8



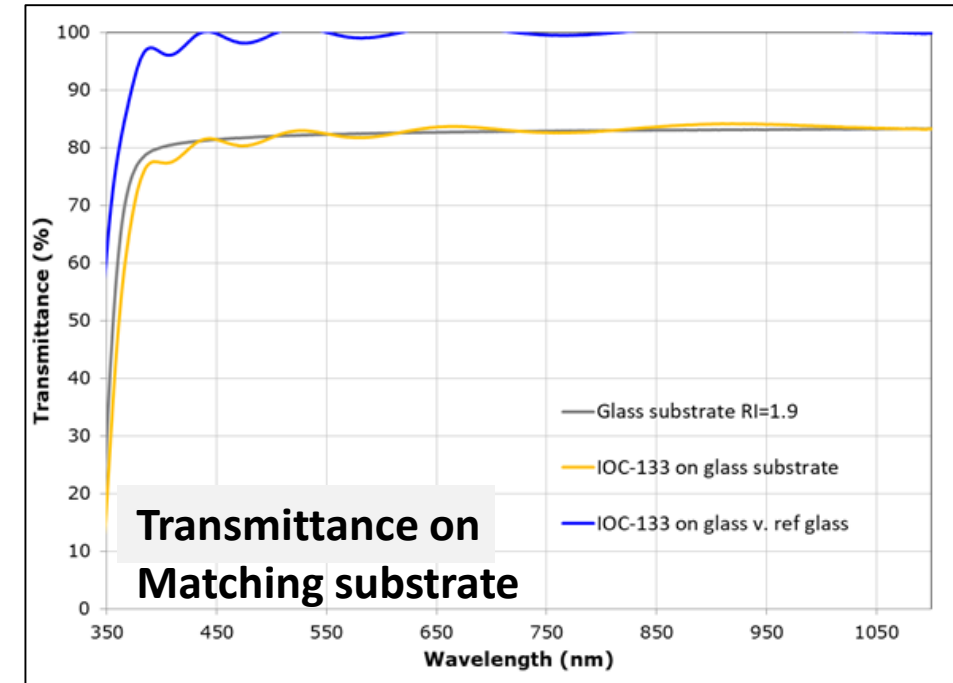
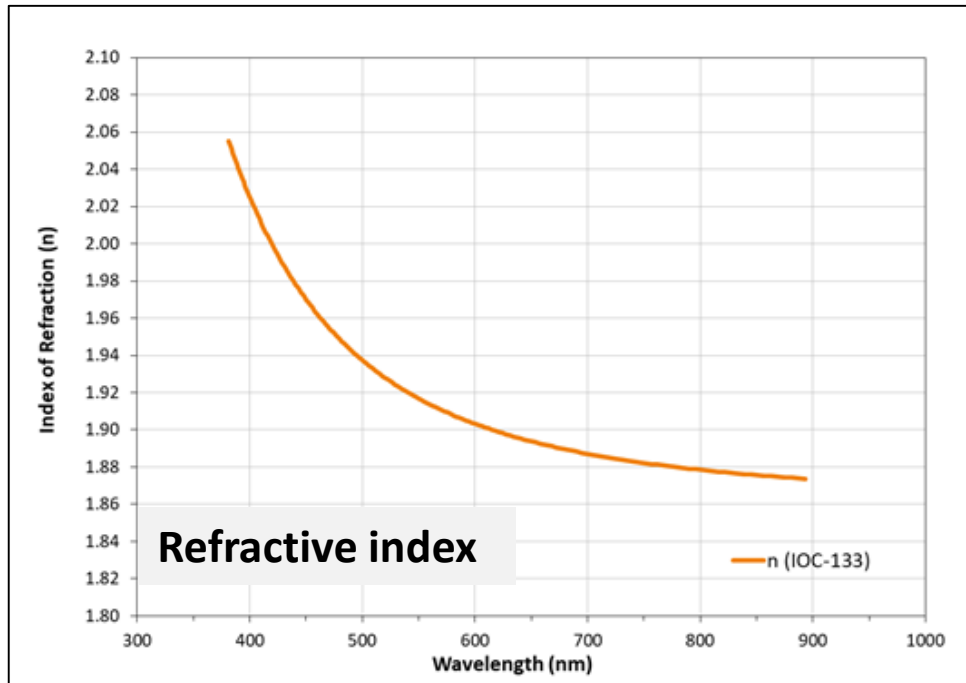
Cured film

Property	General Description	Result
Thickness	Spin 1000rpm	0.5μm
Index of refraction	at 589nm	1.80
ABBE number	-	19
Transmittance	at 420nm ¹⁾	> 99%
L*, a*, b*	D65 ¹⁾	98.8, -0.08, 0.21
Haze	ASTM D1003-97 (Pros.B/A) ¹⁾	< 0.1

Substrate SCHOTT Realview



Product example: IOC-133; Nanoimprintable RI 1.9



Cured film

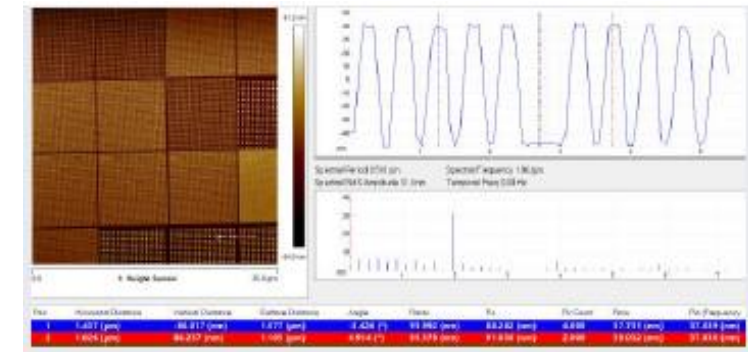
Property	General Description	Result
Thickness	Spin 1000rpm	0.5μm
Index of refraction	at 589nm	1.90
ABBE number	-	17
Transmittance	at 420nm ¹⁾	> 95%
L*, a*, b*	D65 ¹⁾	97.7, -0.3, 1.0
Haze	ASTM D1003-97 (Pros.B/A) ¹⁾	< 0.2

Substrate SCHOTT Realview



Process Testing of IOC-133 on high RI substrate

- Test prints with IOC-133, RI 1.92 @ 533 nm
 - Tool: EVG7200 , Substrate: SCHOTT's RealView 1.8
- Feature size (in this test)
 - Pillar size varies between 48-300 nm with height of 150 nm (with this stamp)
- Replication:
 - Flawless replication with the used stamp
- Repeatability:
 - No height gain observed in medium imprint series
- Process window characterization:
 - Short Exposure time (10 s) may be used, UV 365 nm
 - Softbake upto 120 C did not reduce fluidic properties
 - Dilution with no effect to RI possible with controlled soft bake





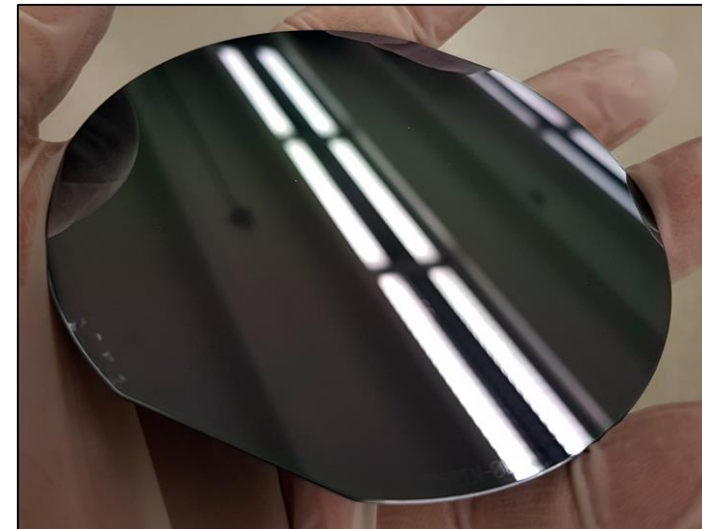
Matching Filler free (=scatter free) Low RI Coatings

LOW-RI		LOW/MEDIUM
IOC-560	IOC-501	IBA-210
1.10-1.25	1.25	1.40
Solvent	Solvent	Solvent
Curing: 180-230°C	Curing: 90-230°C	Curing: UV+150°C
Tx: 50nm-2.3µm	Tx: 50nm-1µm	Gap filling
Stable up to 400°C	Stable up to 400°C	Glass bonding

- Low refractive index 1.07....1.4
- Excellent transparency
- Excellent heat & light stability
- Low Haze and scatter



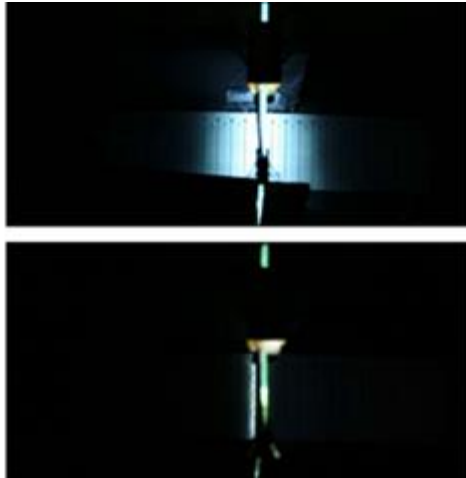
Low RI layer with particles on right, and Low RI layer without particles. Strong scatter seen with particle based formulation





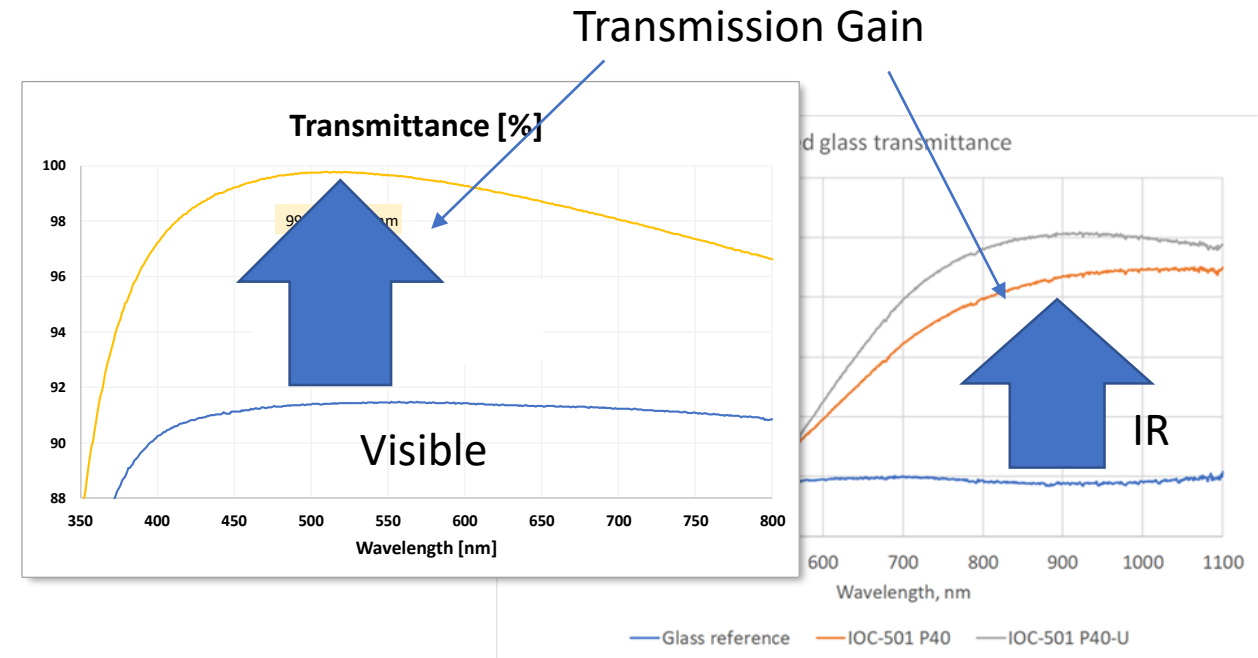
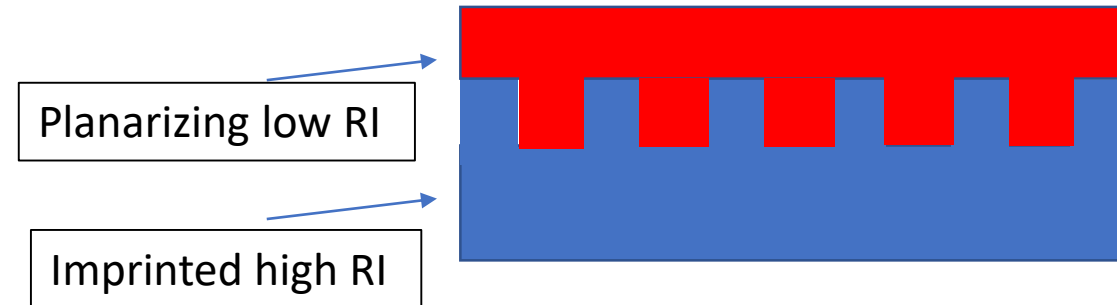
Low Refractive Index Applications

Cladding layer for light guide applications.



Dielectric mirrors and other multi stack devices

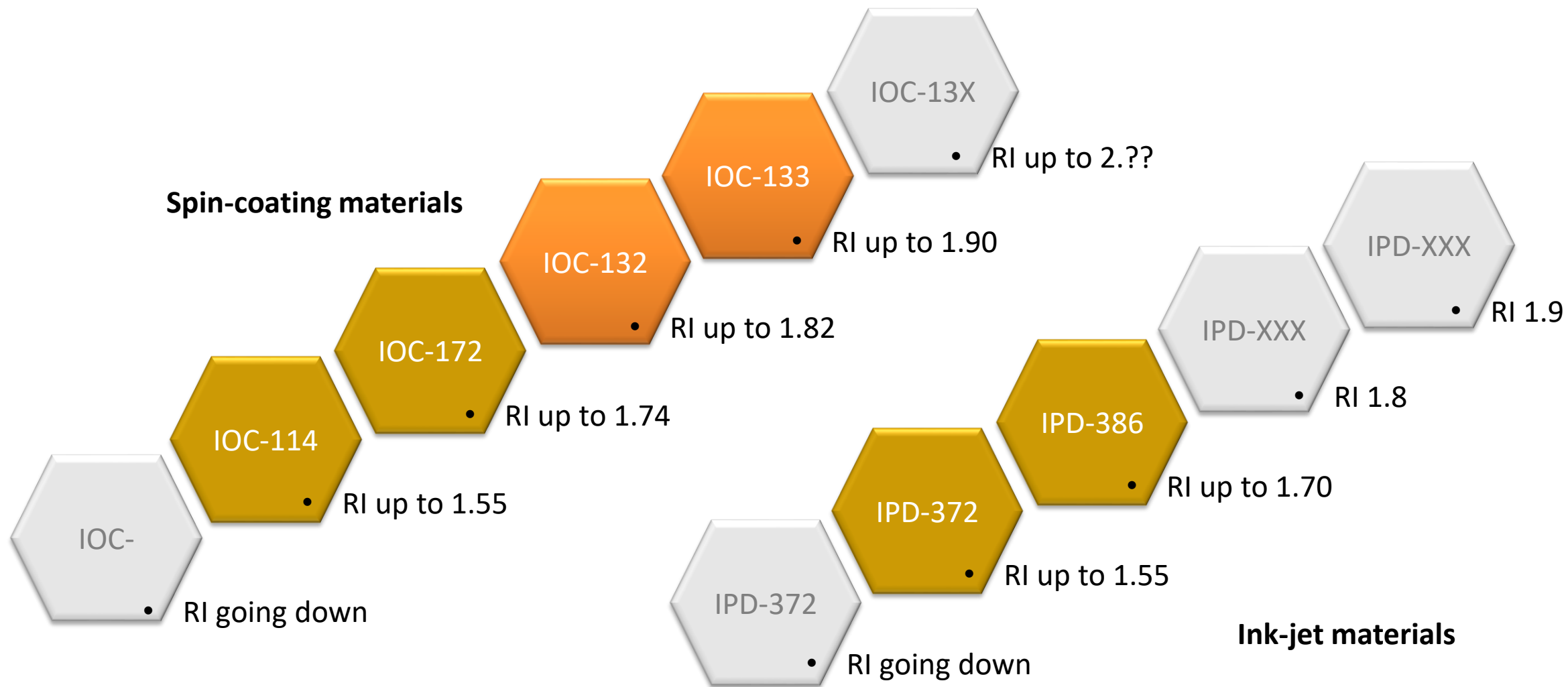
Low RI Gapping layer to create required Δn



Antireflective coatings in visible and IR area



R&D Roadmap of imprintable new products





THANK YOU!



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