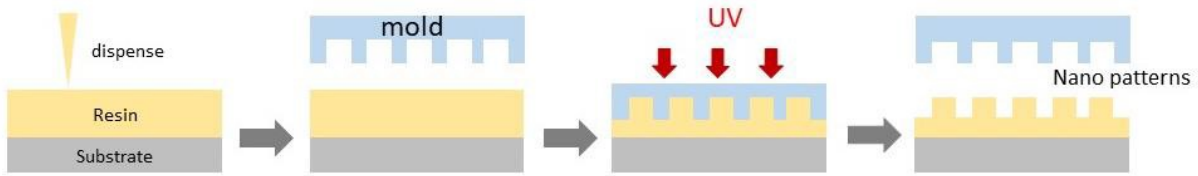
NK OPTIMER® NL series

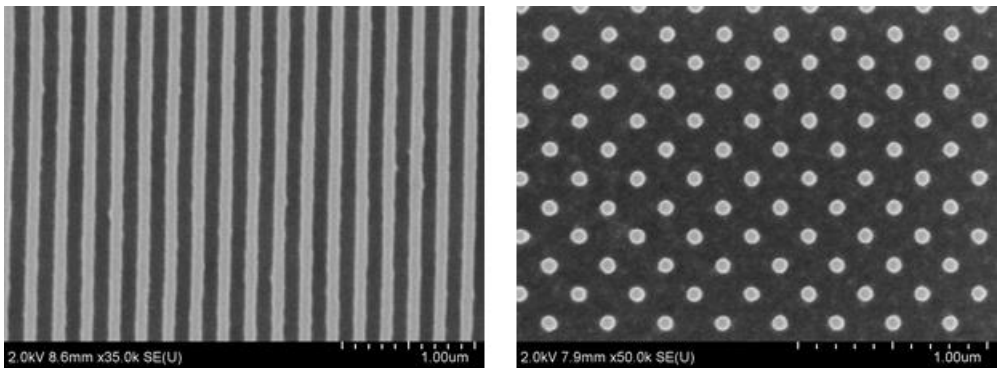
UV-Curable Composit for Micro Optical Elements

Products

		NL-S1010	NL-S1030	NL-S1040	SX003
Features		High Tg High heat resistance Solvent free	Solvent free Low Viscosity Heat resistance	High Tg High heat resistance Solvent free	Solvent free nD1.61 Non filler Heat resistance
Applications		DOE MLA WLO	Dilluent for NL-S1010	DOE MLA WLO	MLA WLO DOE
Properties before UV-curing					
Solvent-free		Yes	Yes	Yes	Yes
Viscosity (25˚C/77˚F) [mPa･s]		1800-2600	**18**	**400-600**	1800-2600
Exposure dose @365nm※1 [mJ/cm^2]		**50-200**	**100-300**	**50-200**	**100-300**
Properties after UV-curing					
Glass transition temperature (DMA, °C)		**220**	**160**	**220**	52
Curing Shrinkage [%]		8	11	**4**	7
RI (25˚C/77˚F)	486nm (F)	1.521	1.512	1.526	1.626
	589nm (D)	1.514	1.504	1.507	**1.612**
	656nm (C)	1.510	1.501	1.503	1.605
Abbe number at 25˚C/77˚F (V_D)		46	44	22	29

❖Suitable for making optical elements with nanoimprint lithography





(NK Optimer® NL-S1040 W100nm x H500nm)

❖We can customize and meet your required property.

Note: Numerical data in the table are typical and any guarantee is not provided.

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新中村化学工業株式会社
Shin-Nakamura Chemical Co.,Ltd.

2024.04.16

NL-S1010

Applications

- ❖Nano imprint Lithography
- ❖MLA ❖DOE ❖WLO ❖Lens and prism bonding

Features

- ❖Solvent free
- ❖Suitable for making optical elements with nanoimprint lithography
- ❖Suitable for solder reflow post process
- ❖High Tg, high heat resistance (Solder heat resistance 300˚C/572˚F 3min. 3times), excellent durability
- ❖High transmittance and good transparency

Typical Properties

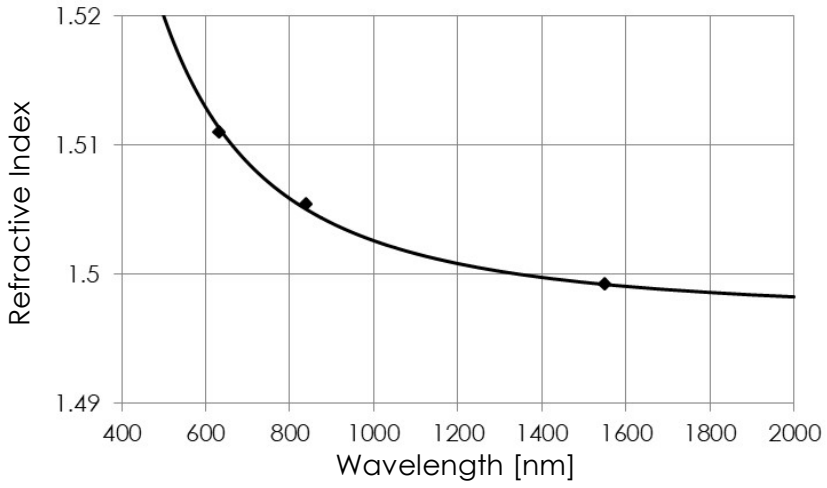
Uncured resin

Viscosity at 25 °C, mPa.s or cps	1800 to 2600
Solvent free	Yes
Density (g/mL)	1.13
Exposure dose @365nm※1 [mJ/cm²]	50 to 200

Cured film

Appearance of cured adhesive	optically clear
Shrinkage※2 (linear, %)	8
Hardness – Shore D	90
Glass transition temperature (DMA, °C)	220
Refractive index of cured film (25 °C)	@ 486 nm (F) 1.521 @ 589 nm (D) 1.514 @ 656 nm (C) 1.510
Abbe Number at 25 °C (V_D)	46

Cauchy equation



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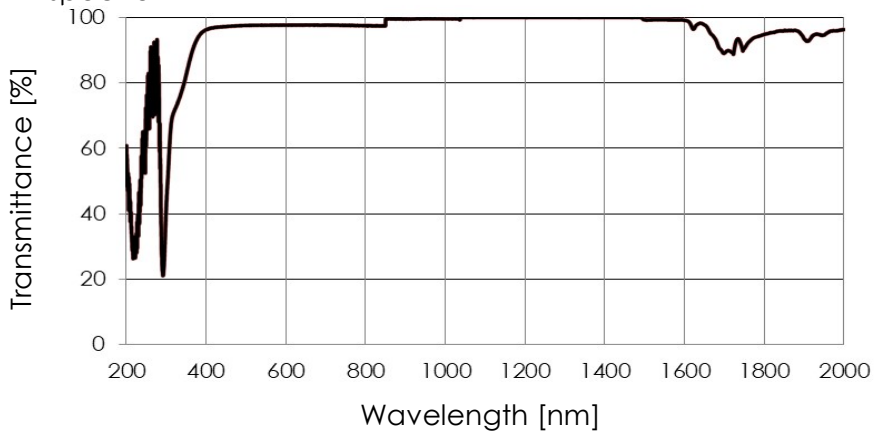
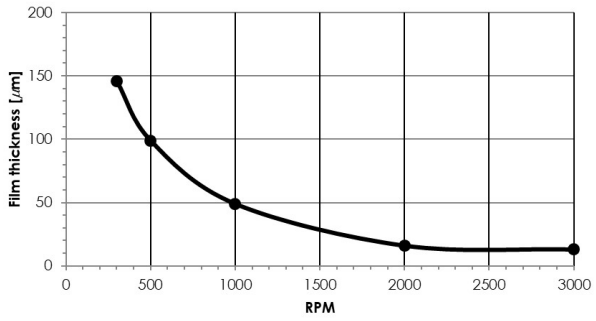
UV-Vis and NIR spectrum



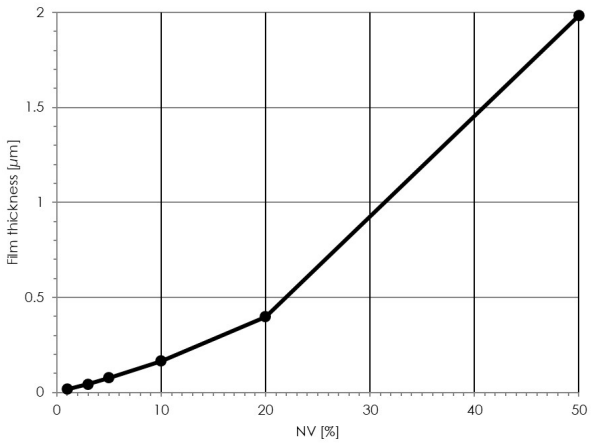
Pencil Hardness			H		
Bend test (cylindrical mandrel)			<2mm		
Heat resistance※3					
Initial Value	Tt [%]	>90	After 3min x 3 300˚C/572˚F	ΔTt [%]	<1
	Haze	<1		Δhaze	<1
	YI	3.0		ΔYI	<1
Heating loss (300˚C/572˚F, 1hr)			<-2%		

※1 Irradiate 1mm thick sample with UV-LED (365nm) 5mW/cm^2 and checked by finger
※2 Irradiate 1mm thick sample with 5times UV-LED (365nm) 1pass 5mW/cm^2 100mJ/cm^2 and measure the cured compound
※3 Measure 5 pass 1mm thick

RPM-Thickness curve



NV-Thickness curve



Coating condition: Spin-coating 1000rpm on 4" silicon wafer
Diluent: PGMEA

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NL-S1030

(Heat resistant dilluent for NL-S1010)

Applications

- Nano imprint Lithography
- MLA
- DOE
- WLO
- Lens and prism bonding

Features

- Solvent free
- Low Viscosity
- Suitable for making optical elements with nanoimprint lithography
- High Tg, high heat resistance (Solder heat resistance 300˚C/572˚F 3min. 3times), excellent durability
- High transmittance and good transparency

Typical Properties

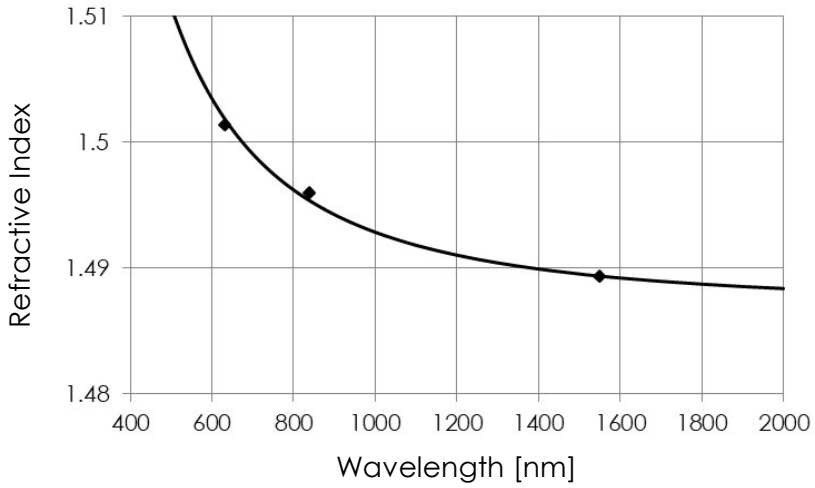
Uncured resin

Viscosity at 25 °C, mPa.s or cps	18
Solvent free	Yes
Density (g/mL)	1.08
Exposure dose @365nm※1 [mJ/cm²]	100 to 300

Cured film

Appearance of cured adhesive	optically clear
Shrinkage※2 (linear, %)	11
Hardness – Shore D	90
Refractive index of cured film (25 °C)	
	@ 486 nm (F) 1.512
	@ 589 nm (D) 1.504
	@ 656 nm (C) 1.501
Abbe Number at 25 °C (V_D)	44

Cauchy equation



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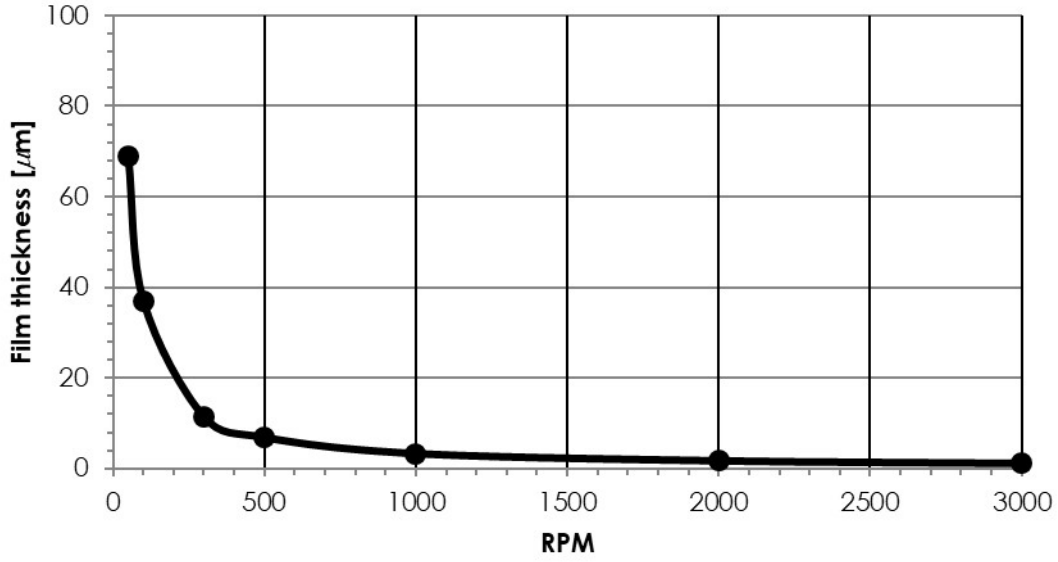
Pencil Hardness			HB		
Bend test (cylindrical mandrel)			<2mm		
Heat resistance※3					
Initial Value	Tt [%]	>90	After 3min x 3 300˚C/572˚F	ΔTt [%]	<1
	Haze	<1		Δhaze	<1
	YI	3.0		ΔYI	<1
Heating loss (300˚C/572˚F, 1hr)			<-6%		

※1 Irradiate 1mm thick sample with UV-LED (365nm) 5mW/cm^2 and checked by finger
※2 Irradiate 1mm thick sample with 5times UV-LED (365nm) 1pass 5mW/cm^2 100mJ/cm^2 and measure the cured compound
※3 Measure 5 pass 1mm thick

RPM-Thickness curve



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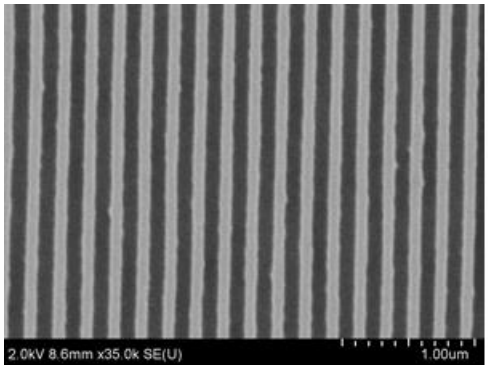
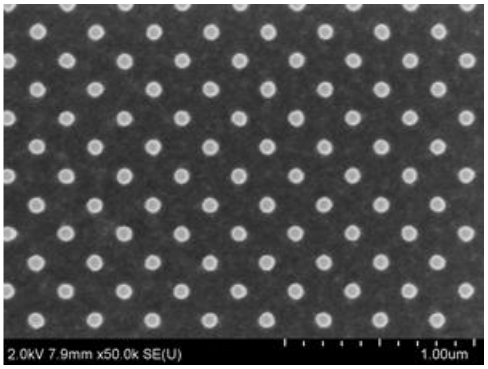
NL-S1040

Applications

❖Nano imprint Lithography





(W100nm x H500nm)

❖MLA ❖WLO ❖DOE ❖Lens and prism bonding

Features

❖Solvent free
❖Spin coat-able
❖Suitable for making optical elements with nanoimprint lithography
❖Suitable for solder reflow post process
❖High heat resistance (Solder heat resistance 260˚C/500˚F 3min. 3times), excellent durability
❖High transmittance and good transparency

Typical Properties

Uncured resin

Viscosity at 25 °C, mPa.s or cps	400 to 600
Solvent free	Yes
Density (g/mL)	1.12
Exposure dose @365nm※1 [mJ/cm^2]	50 to 200

Cured film

Appearance of cured adhesive	optically clear
Shrinkage※2 (linear, %)	4
Hardness – Shore D	91
Glass transition temperature (DMA, °C)	220
Refractive index of cured film (25 °C)	@ 486 nm (F) 1.526 @ 589 nm (D) 1.507 @ 656 nm (C) 1.503
Abbe Number at 25 °C (V_D)	22

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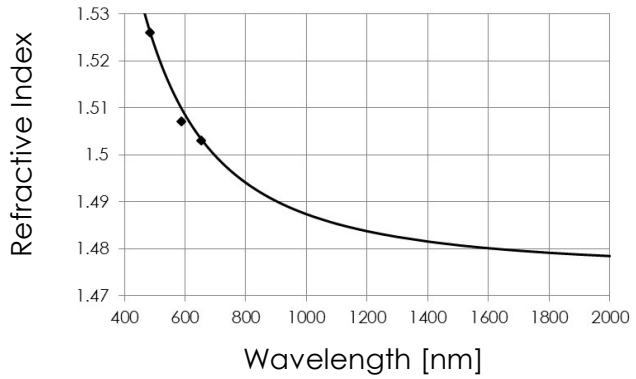
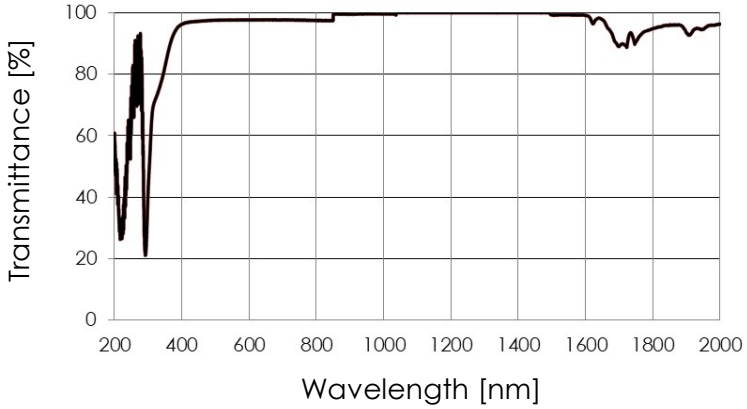
Cauchy equation



UV-Vis and NIR spectrum

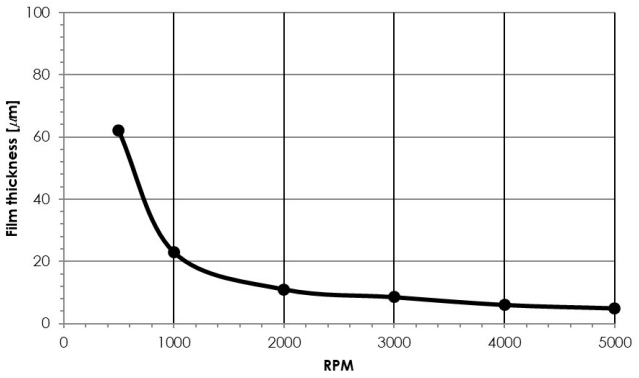


Heat resistance※3

Initial Value	Tt [%]	>90	After 3min x 3 260˚C/500˚F	ΔTt [%]	<1
	Haze	<1		Δhaze	<1
	YI	<1		ΔYI	<1

※1 Irradiate 1mm thick sample with UV-LED (365nm) 5mW/cm^2 and checked by finger
※2 Irradiate 1mm thick sample with 5times UV-LED (365nm) 1pass 5mW/cm^2 100mJ/cm^2 and measure the cured compound
※3 Measure 5 pass 1mm thick

RPM-Thickness curve



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SX003

Applications

- ❖Nano imprint Lithography
- ❖MLA ❖WLO ❖DOE ❖Lens and prism bonding

Features

- ❖Solvent free
- ❖Spin coat-able
- ❖Suitable for making optical elements with nanoimprint lithography
- ❖Suitable for solder reflow post process
- ❖High heat resistance (Solder heat resistance 260˚C/500˚F 3min. 3times), excellent durability
- ❖High transmittance and good transparency

Typical Properties

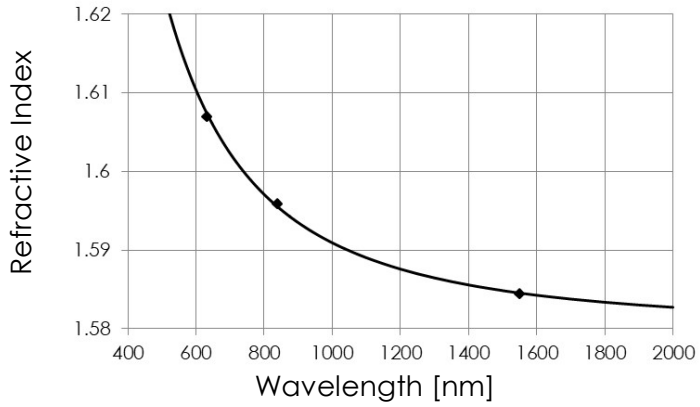
Uncured resin

Viscosity at 25 °C, mPa･s or cps	1800 to 2600
Solvent free	Yes
Density (g/mL)	1.18
Exposure dose @365nm※1 [mJ/cm²]	50 to 200

Cured film

Appearance of cured adhesive	optically clear
Shrinkage※2 (linear, %)	7
Hardness – Shore D	89
Glass transition temperature (DMA, °C)	52
Refractive index of cured film (25 °C)	
	@ 486 nm (F) 1.626
	@ 589 nm (D) 1.612
	@ 656 nm (C) 1.605
Abbe Number at 25 °C (V_D)	29

Cauchy equation



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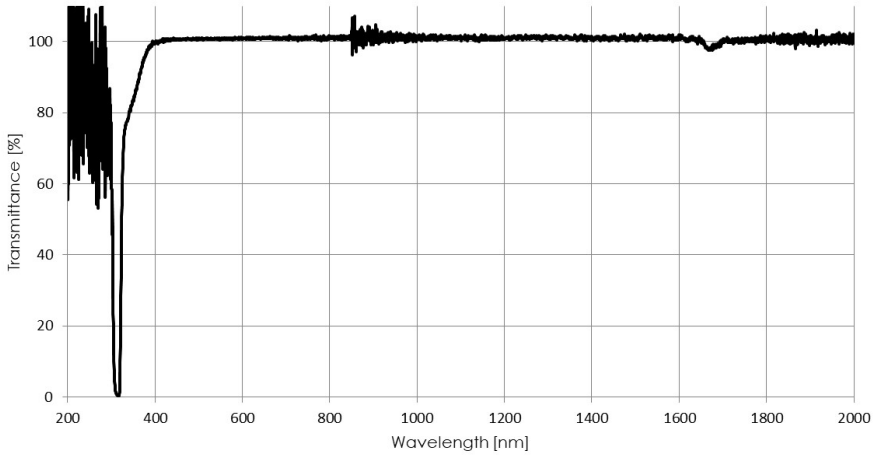
UV-Vis and NIR spectrum



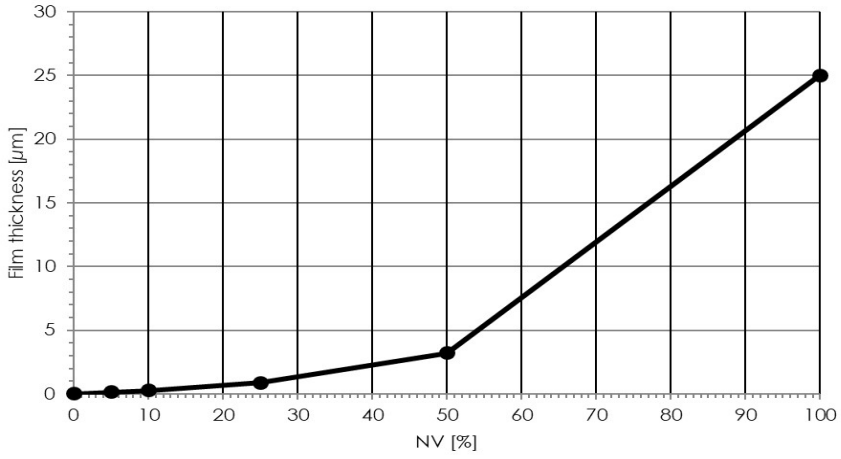
Heat resistance※3

Initial Value	Tt [%]	>90	After 3min x 3 260˚C/500˚F	ΔTt [%]	<1
	Haze	<1		Δhaze	<1
	YI	1.0		ΔYI	<1

Heating loss (260˚C/500˚F, 1hr) <13%

※1 Irradiate 1mm thick sample with UV-LED (365nm) 5mW/cm^2 and checked by finger
※2 Irradiate 1mm thick sample with 5times UV-LED (365nm) 1pass 5mW/cm^2 100mJ/cm^2 and measure the cured compound
※3 Measure 5 pass 1mm thick

NV-Thickness curve



Coating condition: Spin-coating 1000rpm on 4" silicon wafer
Diluent: PGMEA

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NK OPTIMER® NL series

Nanoimprintable
Adjustable Refractive Index UV-Curable Composit

NL-N series

Adjustable refractive index based on various wavelength

Applications

- ❖Nano imprint Lithography
- ❖AR/MR waveguides
- ❖Displays
- ❖Imaging & Sensing
- ❖MLA
- ❖WLO
- ❖DOE
- ❖Meta Optics
- ❖Silicon Photonics

Features

- ❖Suitable for making optical elements with nanoimprint lithography
- ❖Quick cure
- ❖High transmittance and good transparency
- ❖Spin coat-able

Products

		NL-N3432	NL-N4646NF	NL-N6226NF	NX003	NL-N81X	NL-N93X
Properties before UV-curing							
NV		~20	**100**	~50	**100**	~30	~20
Contains filler		✓			✓	✓	✓
Filler size [nm]		50-80	-	-	10-15	< 10	< 10
Viscosity [mPa･s] (25˚C/77˚F)			135		2700		
Exposure dose @365nm※1 [mJ/cm^2]		1000-2000	1000-2000	100-300	50-100	100-300	100-300
Applications		**Non-PFAS** AR/VR Sensors DOE	MLA WLO Silicon Photonics Cladding Encupsulant	Silicon Photonics Photonic circuit	MLA WLO	AR/VR Sensors DOE	AR/VR Sensors DOE
Properties after UV-curing							
Curing Shrinkage [%]			12	1	2	2	3
RI (25˚C/77˚F)	588nm (d)	**1.339**※2	**1.456**※2	1.616※2	**1.688**※2	**1.812**	**1.926**
	632nm	1.336	1.453	1.612	1.683		
	839nm	1.333	1.449	1.600	1.674		
	1550nm	1.326	1.443	1.587	1.661		
Abbe number at 25˚C/77˚F (V_d) ※2		32	46	26	34		
Total Transmittance (360-830nm) (ISO 13468-1)		>99	>99	>99	98		
Haze (ISO 14782)		0.02	0.01	0.03	0.3		
YI (ASTM E313)		0.31	0.01	0.31	0.4		
85˚C 85%RH [hours]		✓ 1000	✓ 1000	✓ 1000	✓ 1000		
Cross-cut test (vs D263Teco) (ISO2409)		4	4	4	5		

※1 365nm UV-LED in nitrogen
※2 Calculated value by Cauchy equation

$$n(\lambda) = A + \frac{B}{\lambda^2} + \frac{C}{\lambda^4} + \frac{D}{\lambda^6} + \cdots$$

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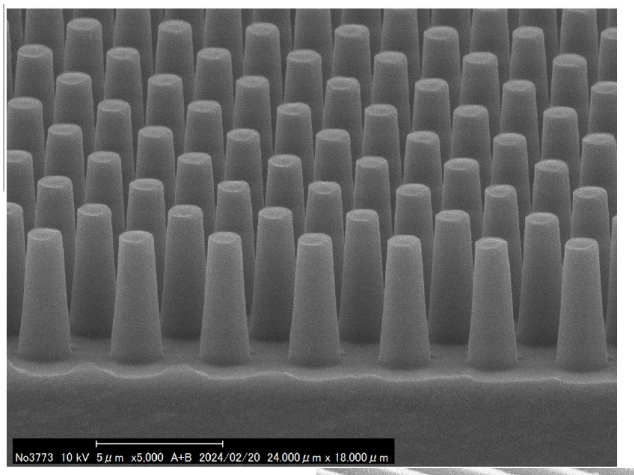
NX003

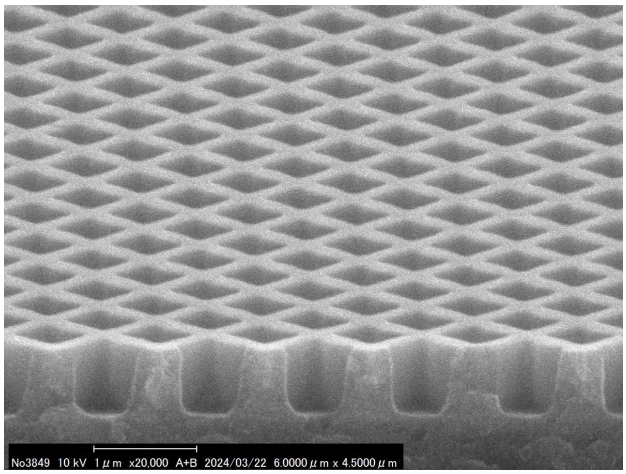
Applications

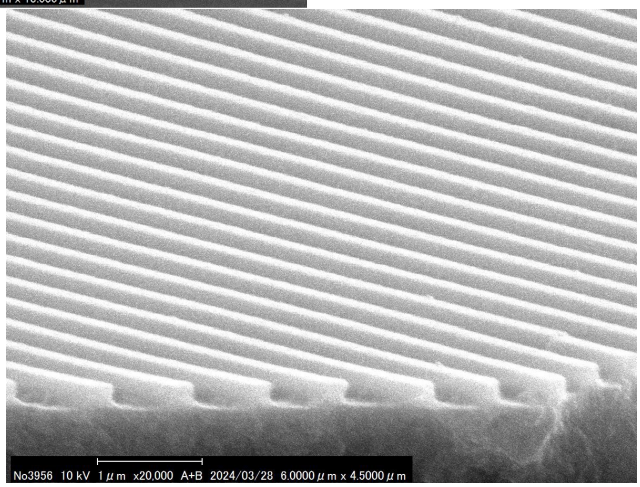
- WLO
- MLA
- DOE
- AR/MR waveguides
- Displays
- Meta Material (Meta Optics)

Features

- Solvent free
- High RI
- The viscosity is high (Approx. 3000 mPa･s), so it can be applied thickly.
- Suitable for solder reflow post process
- High heat resistance (Solder heat resistance 260˚C/500˚F 10sec. 3times), excellent durability
- High transmittance and good transparency
- Imprintable







We imprinted NX003 using OEX-028-X433-3-4.0 / OEX-080-X1, manufactured by AUTEX Inc., as the replica mold.

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Typical Properties

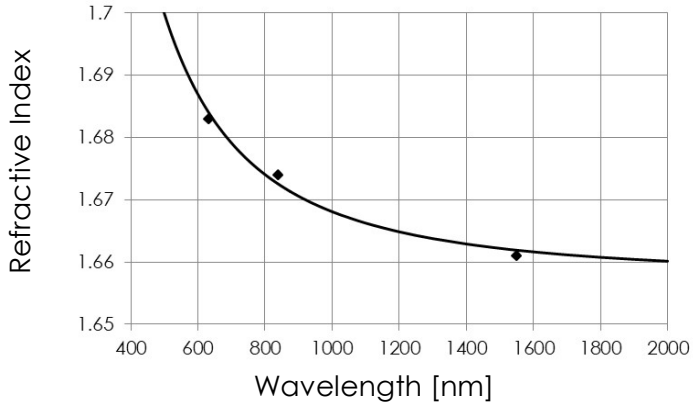
Uncured resin

Viscosity at 25 ℃, mPa･s or cps	2700
Solvent free	Yes
Density (g/mL)	2.2
Exposure dose @365nm※1 [mJ/cm2]	50 to 100

Cured film

Appearance of cured adhesive	optically clear
Refractive index of cured film (25 ℃)	
	@ 588 nm (d) 1.688
	@ 632 nm 1.683
	@ 839 nm 1.674
	@1550nm 1.661
Abbe Number at 25 ℃ (V_D)	34

Cauchy equation



Durabirity (85 ˚C/185˚F, 85%RH)※2

Initial Value	Tt [%]	98	After 1000h	ΔTt [%]	<1
	Haze	0.3		Δhaze	<1
	YI	0.4		ΔYI	<1

Solder heat resistance 260˚C/500˚F 10sec. 3times ✓

※1 Irradiate 1mm thick sample with UV-LED (365nm) 5mW/cm2 and checked by finger
※2 Measure 25μm thick

❖We can customize and meet your required property.

Note: Numerical data in the table are typical and any guarantee is not provided.

Wakayama : TEL +81-73(423)3256 Tokyo sales office : TEL+81- 3(3256)2671
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ありがとうを化学する
新中村化学工業株式会社
Shin-Nakamura Chemical Co.,Ltd.

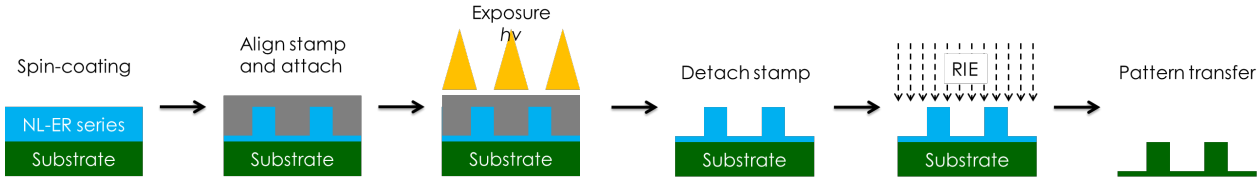
2024.04.16

Resists for UV-NIL (via RIE)

NL-R series

Applications

❖Nano imprint Lithography process scheme



Features

❖Primer free

❖Spin coat-able. Excellent performance at film thickness uniformity. Easy to form a thin film which has a good uniformity in thickness at spin-coating.

❖Decompression resistance. Hard to volatilize at decompression defoaming process (thin film on the wafer).

❖Baking resistance. Hard to volatilize at hot-air drying process (thin film on the wafer)

Typical Properties (NL-R1020)

Uncured resin

NV [%]	50
Viscosity at 25 °C, mPa.s or cps	390
Density [g/mL]	1.029
Exposure dose @365nm※1 [mJ/cm²]	50 to 200

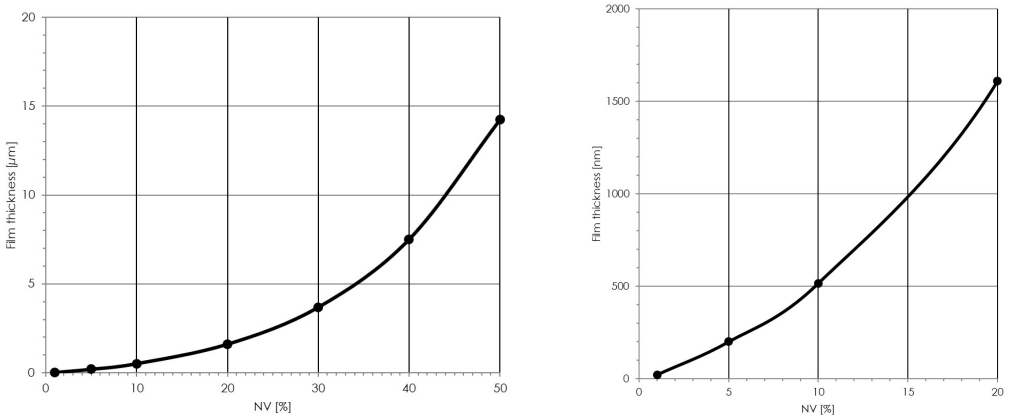
Cured film

Appearance of cured adhesive	optically clear	
Shrinkage※2 [%]	3	
Etching selectivity	1.0 (Al_2O_3)	0.6 (TiO_2)

※1 Irradiate 1000nm thick sample with UV-LED (365nm) 5mW/cm² and checked by finger

※2 Irradiate 1000nm thick sample with 5times UV-LED (365nm) 1pass 5mW/cm² 100mJ/cm² and measure the cured compound

NV-Thickness curve



Coating condition: Spin-coating 1000rpm on 4" silicon wafer

Diluent: PGMEA

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