Technical data sheet of optical waveguide resin :

Exguide™ WIR30-RI

ChemOptics Inc

Application

WIR30-RI series are photo-active UV curable fluorinated resins based on acrylate. They are optimized for UV embossing or UV imprinting procedures. These UV embossing process are useful for optical multimode waveguide device and various optical elements such as micro lens array, deflective optics applications. The main applications are as follows:

- Multi-mode waveguide devices
- Optical Multi-mode splitter
- Optical interconnections
- Micro lens arrays
- Deflective optics elements

Features

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These resins have highly optical transparency at visible and near infrared region, small birefringence, and excellent environmental stability. They are useful for various multimode waveguide fabrication using UV-embossing and imprinting technique. Especially, these WIR30-RI materials are not require the expensive equipment such as ICP dry etcher, e-beam evaporator for waveguide fabrication.

- UV curable type (solvent free)
- Low optical propagation loss
- Low optical birefringence
- Excellent gap filling ability
- High environmental stability
- Excellent adhesion on substrate
- Easy removing to master mold
- Easy control of film thickness

Performance specifications

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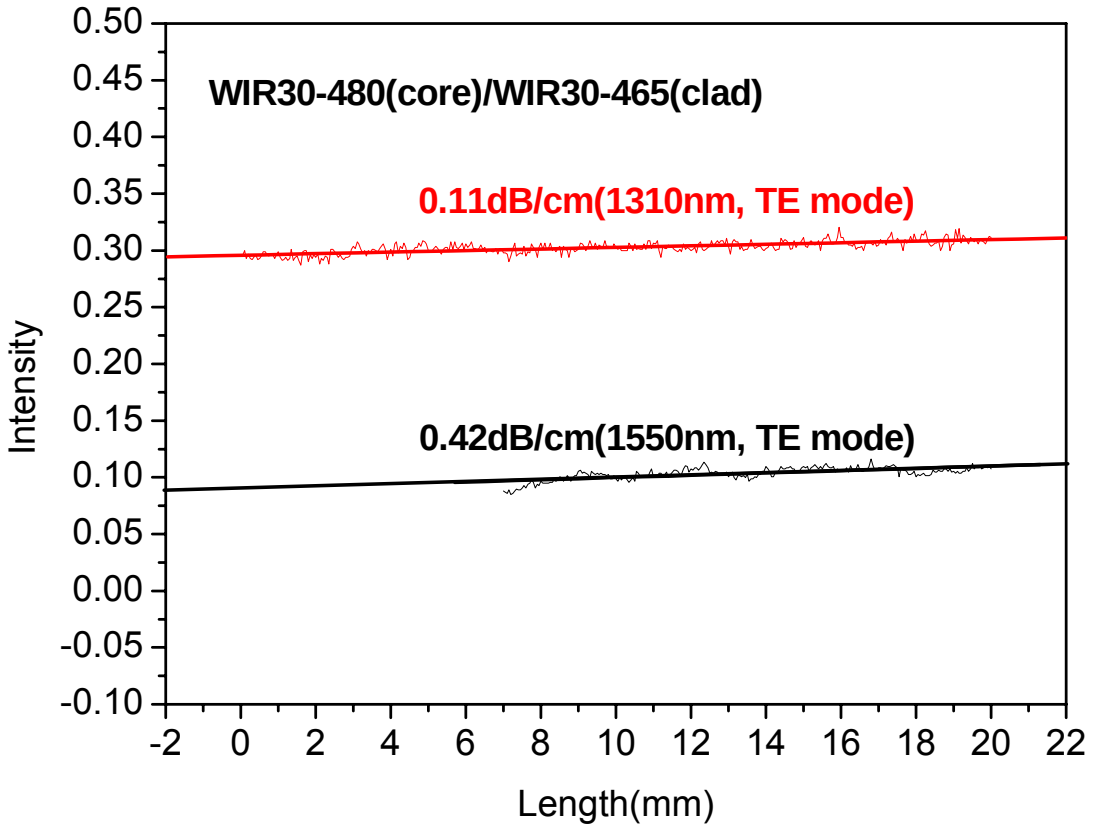
Exguide™		WIR30-RI		
		WIR30-500	WIR30-480	WIR30-450
Liquid	Composition	Perfluorinated acrylate		
	Solvent	Solvent free, 100% reactive liquid		
	Viscosity (+/- 15cps @25 °C)	160	214.4	242.9
	Filtration	0.1 ~ 0.2 μm absolute PTFE filter		
	UV-exposure (N_2 atmosphere)	> 2500 mJ/cm^2 (160 °C/30 min, post baking)		
Film	Propagation loss (measured from slab waveguide)	**0.05 dB/cm @ 0.83 μm**		
		0.11 dB/cm @ 1.31 μm		
		0.42 dB/cm @ 1.55 μm		
	Refractive Index (@ 850 nm)	1.500	1.480	1.450
	Birefringence ($n_{TE} - n_{TM}$)	0.001 ± 0.0005		
	Linear shrinkage (ASTM D-2566)	Less than 5 %		
	Glass Transition Temp. (Tg)	Not detectable		
	Degradation Temp. (1 wt%)	300 ± 20 °C		
	Adhesion (on Si wafer)	50 hr pass with treatment of promoter		

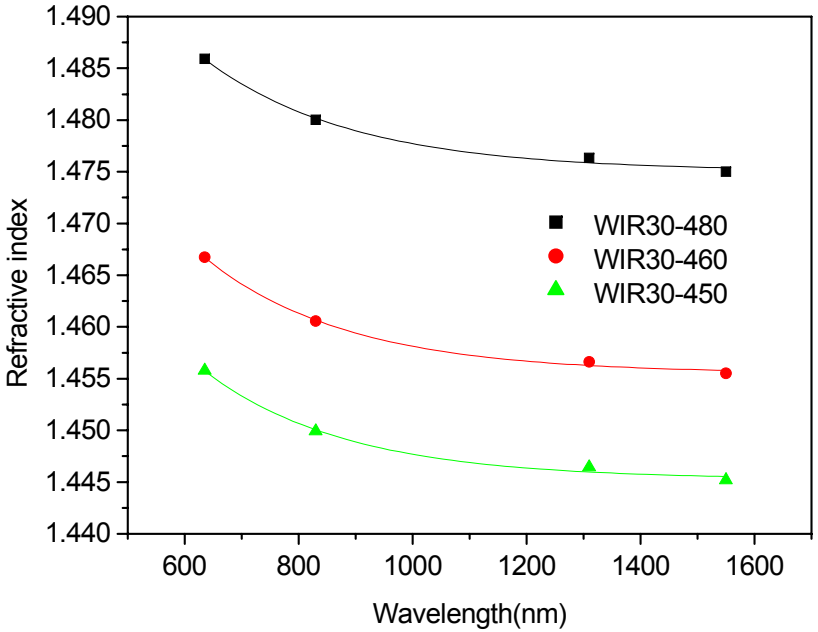
Optical Loss (slab waveguide)

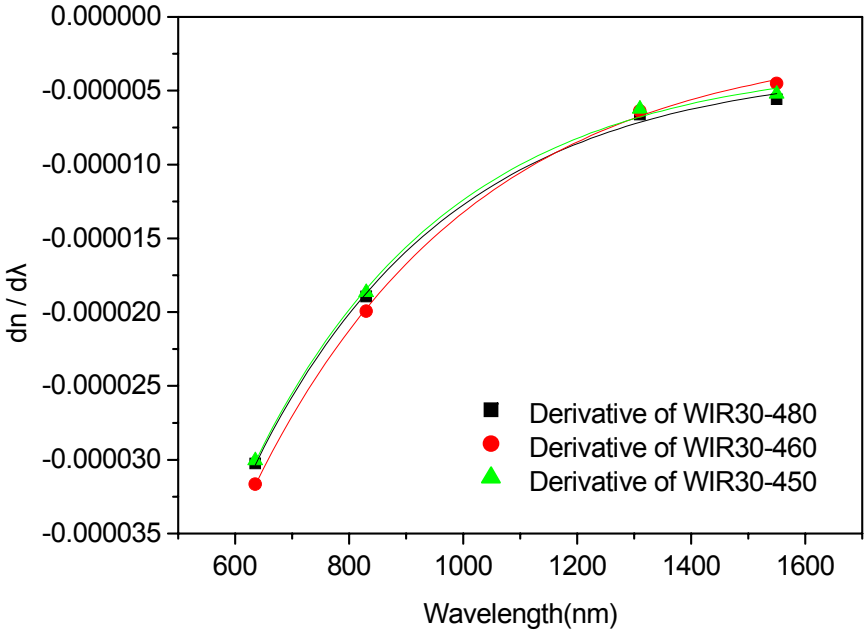


Sample name	Loss (dB/cm)		
	830nm	1310nm	1550nm
WIR30-480	ND	0.11	0.42

***Measured by immersion technique of slab waveguide**

Dispersion of Refractive Index

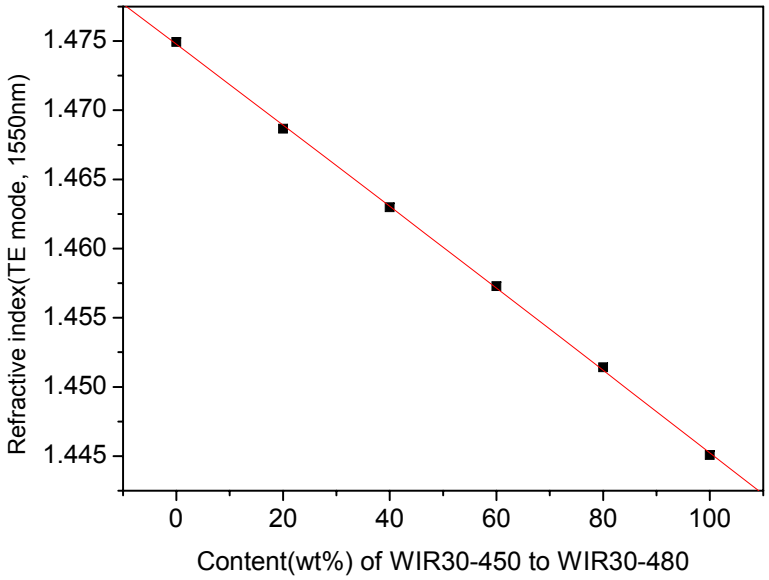


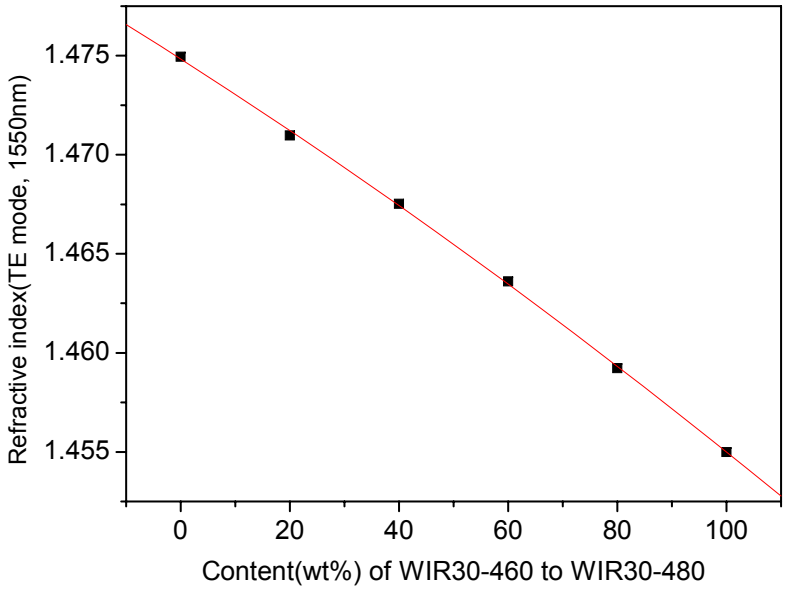


Sample name	dn / dλ (10^{-6} nm^{-1})			
	635nm	830nm	1310nm	1550nm
WIR30-480	-30.26	-18.95	-6.61	-5.58
WIR30-460	-31.64	-19.94	-6.36	-4.50
WIR30-450	-30.05	-18.66	-6.24	-5.21

Continuous Control of Refractive Index

The precise control of refractive index can be achieved by simple blending of two polymers. The blended polymers exhibit intermediate properties of original polymers according to blending ratio.





Tuning of refractive index

n_{TE} (RI, mix) = 2 x 10^{-4} (wt%) + 1.48 or 1.45(1.46)

So, wt% = 1/(2x10^{-4}) x {n_{TE} – 1.48 or 1.45(1.46)}

Blending ratio **Target refractive index**

example) If you want RI(n_{TE}) = 1.4600 tuning?

Blending ratio (wt%)

=1/ (2×10^{-4}) × (1.4600–1.45) = 50

∴ blending of WIR30-450 50 wt%

& WIR30-480 50 wt%

Film Forming Procedure

The followings provide a general overview of the processing procedure associated with WIR30-RI series optical resins.

Surface Treatment

Substrates to be coated with WIR30-RI should be free of all organic impurities and other contaminants prior to the coating application. Use of an adhesion promoter, such as trialkoxy silane derivatives or ZAP1020 (manufactured by ChemOptics), is highly recommended for many applications. A typical application procedure for adhesion promoter is outlined below:

- Dispense adhesion promoter: Dynamically dispense the adhesion promoter solution (ZAP1020) onto the center of the substrate (3~5 ml in case of 4-inch substrate).
- Spinning: Spin the substrate at 300~500 rpm/5sec and then immediately increase spinning speed to 2000~3000 rpm/20~30sec , or until dry.
- Baking: Bake the substrate on a hotplate at 110℃ for 1 to 5 minutes.

Coating

WIR30-RI series solutions are spin cast onto the substrate directly after the adhesion promoter application. The precise conditions used to deposit the resins will depend on the desired final film thickness. A typical application procedure is outlined below:

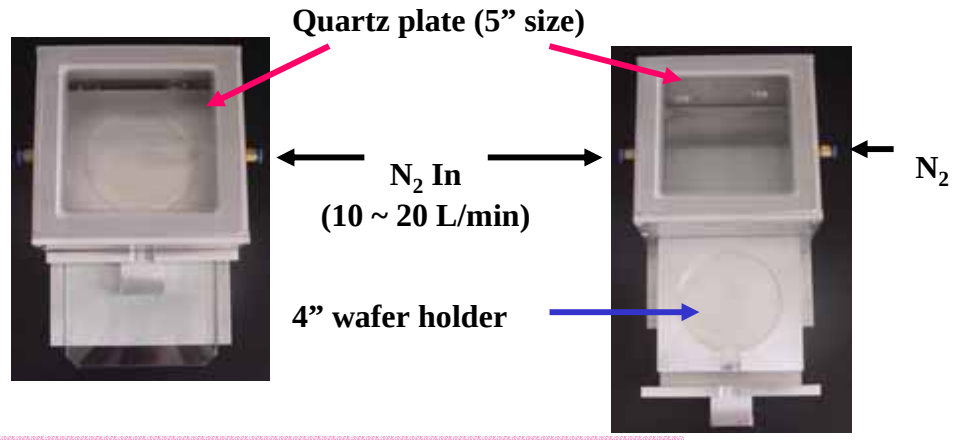
- Dispense resin: Dispense the polymer solution onto the center of the substrate (approximately 3~5 ml in case of 4-inch substrate).
- Spinning: Spin at 300~500rpm/5sec and then immediately increase spinning speed to 700~2500rpm/20~30sec to achieve the desired film thickness.

Note: Film thickness made of WIR30-RI series depends on coater equipments and spinning procedures. Following figure shows the film thickness according to spin rate.

UV curing

After coating, the polymer film is cured to ensure stability during the subsequent processes such as multi-layer over coating, photolithography and metal deposition. The UV curing is performed in an UV light irradiation chamber with an optical intensity higher than 15 mW/cm^2 for 2 ~ 10 minutes. Curing of films must be carried out in the absence of oxygen (<100 ppm). This environment can be easily achieved by flowing nitrogen through the chamber (about 20 L/min). For better stability, a final thermal baking at 160 ~ 200 ºC is necessary for 30 ~ 60 min after the UV curing.

Photograph of UV curing box



Curing box size : L x W x H = 150 x 150 x 100 mm

a) Closed curing box

b) Opened curing box

Waveguide fabrication using RIE or ICP

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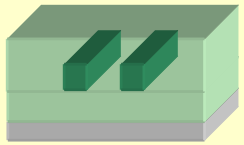
1) Lower clad coating

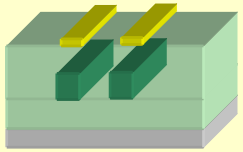
2) Core coating

3) Waveguide patterning

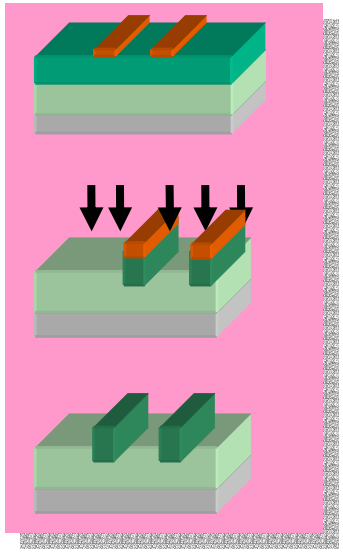
4) Upper clad coating

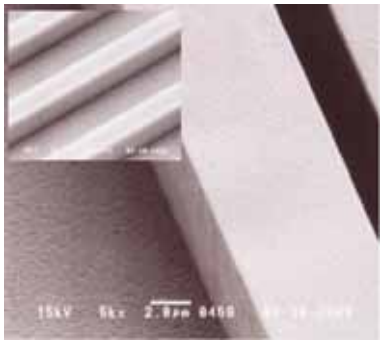


5) Electrode



Dry Etching





Dry etching of the waveguides patterns on the film is accomplished by ICP or RIE in a gas containing oxygen etc. Various etching masks like photoresist, metal or inorganic oxide could be used as long as the materials have enough selectivity in the oxygen plasma etch. Commonly used etching masks are Si based photoresist and Au/Cr metal. The ultimate etching rate is a function of gas composition, system power, and chamber pressure.

Etching Mask	Si PR
Etching gas :	O_2
Working pressure :	5 mtorr
O_2 Gas flow :	20 sccm
RF power :	80 W
Etching rate :	2.0 μm/min

Waveguide fabrication using imprinting

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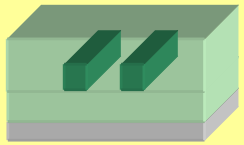
1) Lower clad coating

2) Core coating

3) Waveguide patterning

4) Upper clad coating



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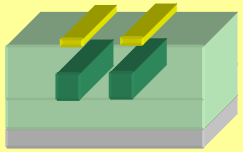
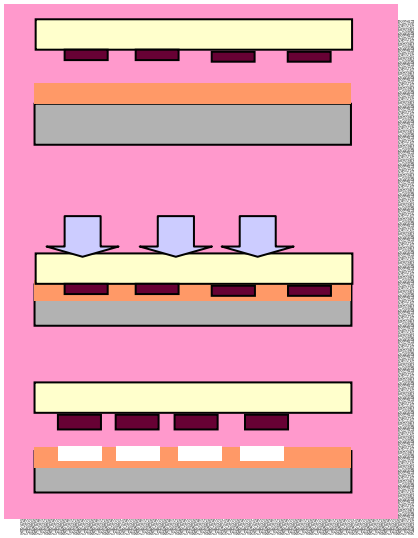


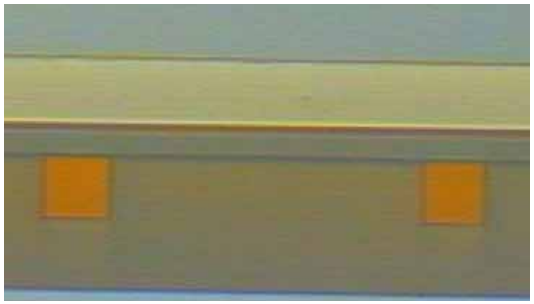
UV Imprinting



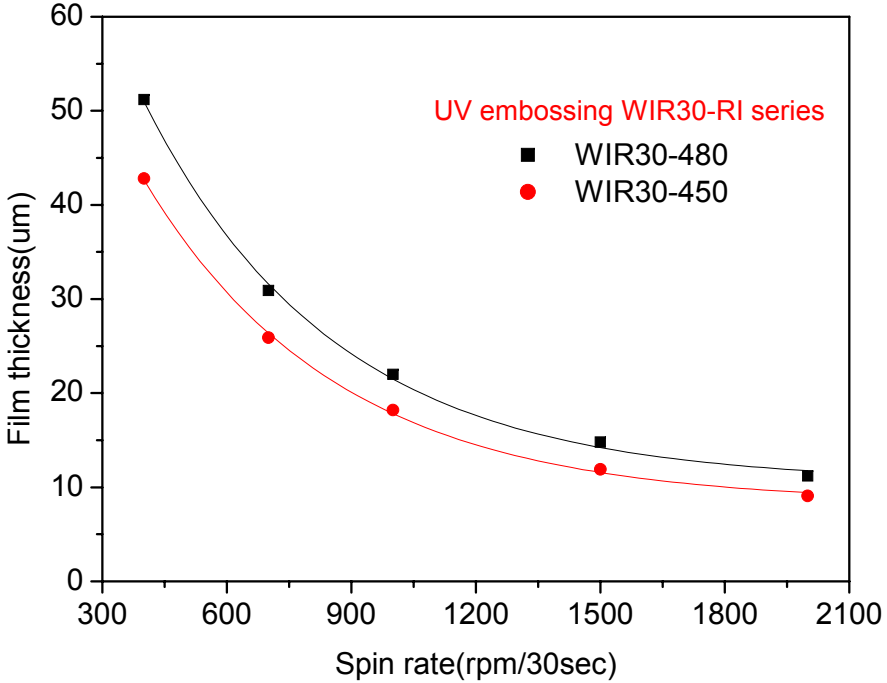
UV imprinting method for waveguides patterning is accomplished by various master such as hard Si or silica master or soft PDMS master.

Typical procedures are as follows;

1. Dispense of WIR30-RI on core patterned master
2. Cover the low clad layer coated glass wafer
3. UV curing and de-molding the glass substrate from the master
4. Upper clad coating & UV curing



Film Thickness



Spin rate (rpm, 30 sec)	WIR30-480 (thickness)	WIR30-450 (thickness)
400	51.2 μm	42.8 μm
700	30.9 μm	25.9 μm
1000	22.0 μm	18.2 μm
1500	14.8 μm	11.9 μm
2000	11.2 μm	9.1 μm

Note: Film thickness depends on coating equipment and spinning procedures.
Measured by a stylus surface profiler.

Storage & Precaution

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Storage

The WIR30-RI series should be stored under dark and cool place 10 ~ 25 ° C. Moisture can affect the product performance thus should be avoided. Keep bottles be capped when not in use. The recommended shelf life for the product is at least three months since the formulation date denoted in the information sheet.

Precaution

These solutions may cause skin and eye irritation to a sensitive person. Avoid direct skin and eye contact. In case contact does occur, immediately wash the exposed area with water and then wash thoroughly with soap and water once again.

Availability

These solutions are available in clean PP bottles by 100 g and 250 g.

Contact

For further information, please feel free to contact us.

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