

**LIGHTSPAN®** Materials Selection Guide



## Silicone for Photonics

### Maximize Light Output and Minimize Signal Loss

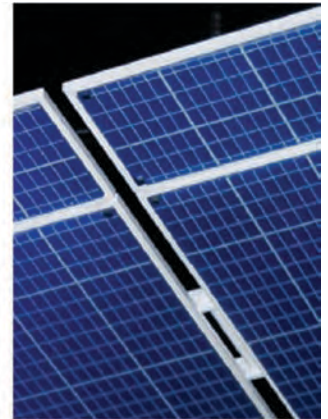
From LEDs to fiber optics, NuSil Technology's LightSpan™ brand product line delivers the most comprehensive line of refractive index matching adhesives, encapsulants and thermosets available. NuSil also offers testing services for optical materials characterization, including UV-Vis-NIR spectrophotometric transmission and refractive index vs. wavelength and temperature. No matter how large or small the batch, NuSil guarantees the same high-quality care and commitment to excellence - that's a promise.

If a feature or requirement is not available in an existing product line, NuSil will work toward formulating a unique silicone system for your specialized application while keeping critical regulatory considerations in mind.

ISO-9001 certified since 1994, NuSil operates state-of-the-art laboratories and processing facilities in North America and Europe, providing on-site, in-person application engineering support worldwide.

The benefits of silicone include the following:

- Thermal Stability
- Low Ionic Species
- Maintain Optical Clarity (90% minimum @ 400nm)
- Low Moisture Absorption (<0.4%)
- Optimization for UV Resistance
- Adjustable Cure
- Low Outgassing
- Low Shrinkage, <1%
- Low Modulus: Stress reduction for bonding materials with different coefficients of thermal expansion



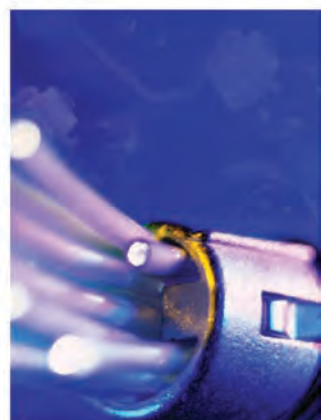
## Applications

### Optoelectronics

- Gel encapsulants for phosphor dispersion and protection
- Silicone lens material for overmolding or curing individually

### Displays and Other Optical Interfacing

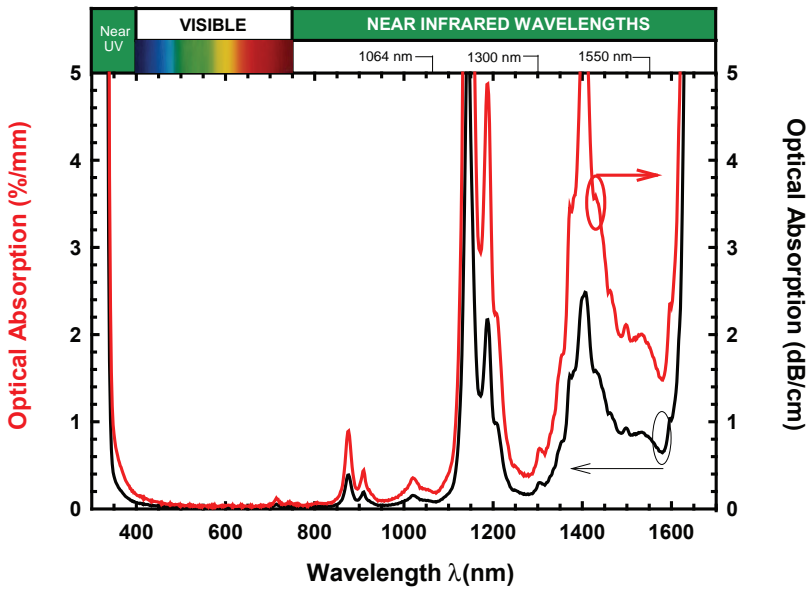
- Fluids
- Gels at various refractive indices and hardness
- Clear, tough encapsulants



## Operating Temperature

The operating temperature range of a silicone in any application is dependent on many variables, including but not limited to: temperature, time of exposure, type of atmosphere, exposure of the material's surface to the atmosphere, and mechanical stress. In addition, a material's physical properties will vary at both the high and low end of the operating temperature range. Silicone typically remains flexible at extremely low temperatures and has been known to perform at -140 °C as well as resist breakdown at elevated temperatures up to 315 °C. The user is responsible to verify optical and mechanical performance of a material in a specific application.

Each product undergoes optical characterization that is provided on LightSpan™ product profiles.

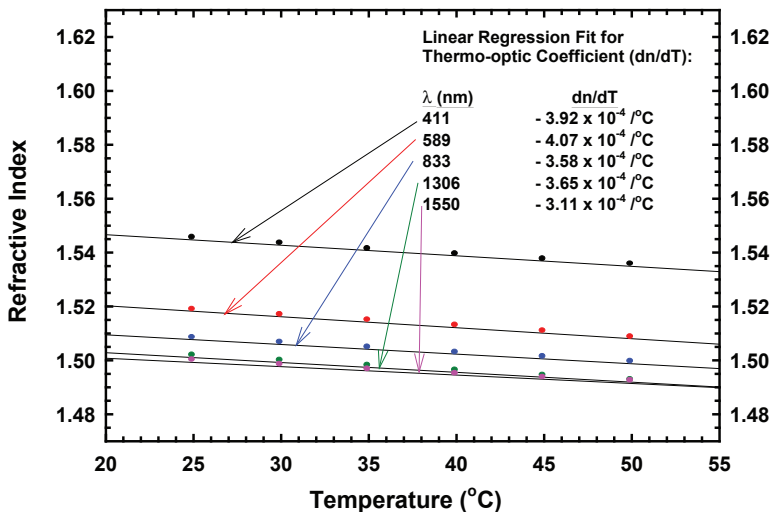
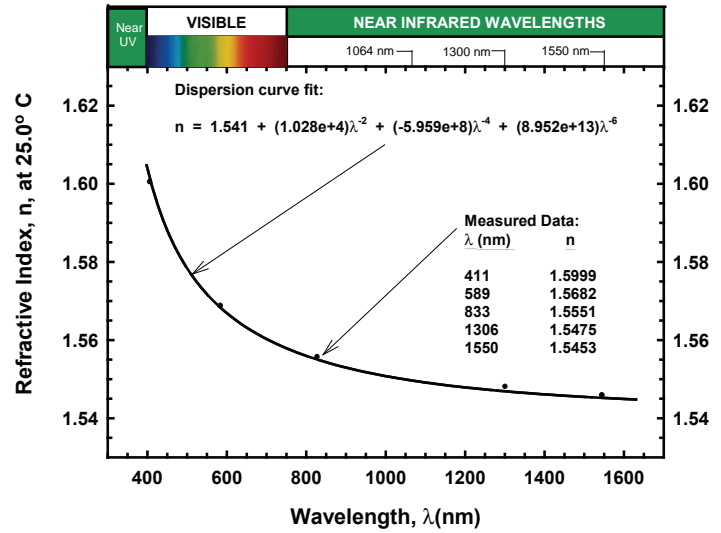


### Optical Absorption

Absorption spectrum for our optical materials, displaying low optical absorption in the visible region.

### Refractive Index vs. Wavelength

Shows how light is directed at various wavelengths.



### Refractive Index vs. Temperature

The Thermo-Optic Coefficients (dn/dT) is represented for each LS material allowing the engineer to incorporate into the design if needed.

## Product Name Legend

The key properties of NuSil Technology's LightSpan™ Materials can easily be distinguished by the product name.

The first digit of the product name represents the hardness of the optical silicone.

Optical Gels (Soft to 00 Durometer): LS-3XXX  
 Optical Thermosets (Type A and D durometer): LS-6XXX  
 Optical Fluids (do not cure): LS-5XXX

For all materials, excluding primers, the last 2 digits of the product name are the last 2 digits of the refractive index measured at 589 nm.

*For example: LS-3351 is an optical gel when cured and the refractive index is 1.51.*

## Index Matching

LightSpan™ materials are very effective for index matching of common materials used in Optical Applications. Some common materials, shown in the table below, use the following LS products for index matching.

Material Type	Acronym	Refractive Index	LS Products
Magnesium Fluoride	MgF <sub>2</sub>	1.38	LS-3238
Fused Silica	SiO <sub>2</sub>	1.46	LS-3246
Acrylate	PMMA	1.49	LS-3249
Borosilicate	BK	1.52	LS1-3252
Cyclic Olefin	COC, COP	1.52	LS1-3252
Polycarbonate	PC	1.59	LS-3357, LS-6257

General Purpose	NuSil Product Number	Comments	Refractive Index 589 nm	Work Time	Durometer	Viscosity cP/mPa-sec	Cure Time/Temp °C	Tensile psi (MPa)	Elongation %	CTE ppm/°C	Mix Ratio	Application
OPTICAL GELS	LS-3238	"Resistant to Hydrocarbon Solvents"	1.38	11 h	'00' / '000'	1,500	30 m / 150	-	-	-	1:1	Index Matches MgF2, AR Coating
	<del>LS-3140</del>	<del>Low Volatility, Penetration 0.4 mm, non-phenyl containing</del>	<del>1.40</del>	<del>&gt;24 h</del>	<del><sup>*34)</sup> MBP</del>	<del>A:16,000 / B:8,500</del>	<del>30 m / 150</del>	<del>-</del>	<del>-</del>	<del>411</del>	<del>1:1</del>	<del>Encapsulant, Potting</del>
	LS-3440	Very Soft, Penetration 9.0 mm, non-phenyl containing	1.40	>24 h	<sup>*32)</sup> MBP	535	60 m / 100	-	-	300	1:1	Encapsulant, Potting
	LS-3441	Firm and Tacky Gel, Penetration 0.4 mm, non phenyl containing	1.41	-	<sup>*31)</sup> MBP	14,500	30 m / 150	-	-	-	1:1	Encapsulant, Potting
	LS-3443	Soft and Tacky Gel, Penetration 5 mm	1.43	-	<sup>*31)</sup> MBP	A:500 / B:650	30 m / 100	-	-	300	1:1	Encapsulant, Potting
	LS-3246	Index matches to glass such as fused silicates (Glass, Quartz)	1.46	8 h	10 / NA	1,000	60 m / 65	-	-	-	1:1	Index Matches Silica, Optical Fiber, Glass. LCD Bonding
	LS-3249	Index matches to acrylates such as PMMA	1.49	48 H	60	-	60 M / 75	-	-	-	1:1	Bonding, Encapsulant
	LS-3351	"Use with Phosphor, Index matches to Crown Glass such as BK7 Index matches to plastics such as COC"	1.51	160 m (1.2xVi)	NA / 55	6,000	60 m / 100	-	-	-	1:1	Excellent for Dispersing Phosphor
	LS1-3252	"Low Viscosity and 1.52 RI, Index Matches BK7, Glass Use with Phosphor, Index matches to plastic such as COC"	1.52	-	25	360	30 m / 150	-	-	-	1:1	Excellent for LCD Display and LED Encapsulation
	LS-3354	Use with Phosphor	1.54	90 m (2xVi)	NA / 64	5,400	60 m / 70	-	-	-	1:1	Excellent for Dispersing Phosphor
	LS2-3354	Contains adhesion promoter, use with Phosphor	1.54	2 h min (2xVi)	15 / 53	6,000	60 m / 70	-	-	-	1:1	Excellent for Dispersing Phosphor
	LS3-3354	Contains adhesion promoter, use with Phosphor	1.54	80 m (2xVi)	NA / 60	5,200	60 m / 70	-	-	-	1:1	Excellent for Dispersing Phosphor
LS4-3354	Longer work time for dispensing applications, 80 °C minimum cure	1.54	-	60	4,200	60 m / 70	-	-	-	1:1	Excellent for Dispersing Phosphor	
LS-3357	100 °C minimum cure	1.57	>10 d	10 / NA	200	60 m / 150	-	-	-	1:1	Very high RI Encapsulant, LED Encapsulation	
OPTICAL ADHESIVES AND ELASTOMERS					Type 'A'							
	LS-6140	Low Volatility, non-phenyl containing	1.40	3 h	50	A:3,700 / B:2,550	15 m / 150	850 (5.9)	90	400	1:1	Bonding, Encapsulant, Dispersing Phosphor
	LS1-6140	LS-6140 with longer work time for dispensing, 80 C minimum cure	1.40	-	50	A:3,450 / B:2,500	60 m / 150	900 (6.2)	90	-	1:1	Bonding, casting or injection molding
	LS-6941	Non-phenyl containing	1.41	4 h	50	5,300	15 m / 150	1300 (9.0)	95	500	10 :1	Bonding, Encapsulant
	LS1-6941	Tough, Tensile 750 psi, Tear 80 ppi	1.41	>24 h	50	A:75,000 / B:50,000	30 m / 150	750 (5.2)	305	-	1:1	Lenses made by Injecting or Compression Molding
	LS2-6941	Low viscosity, non-phenyl containing	1.41	5-5 h	30	A:1,200/B:800	15 m / 150	120 (0.83)	400	337	1:1	Lower durometer where stress is concerned
	LS-8941	High Durometer to reduce tackiness, non-phenyl containing	1.41	>24 h	80	A:27,500 / B:25,000	30 m / 150	1,250 (8.6)	65	-	1:1	Lenses made by Injecting or Compression Molding
	LS-6143	Low Volatility	1.43	2 h	40	A:3,600	4 h / 65	600 (4.1)	125	490	10:1	Bonding, Encapsulant
	LS-6943	Broad operating temperature range	1.43	-	40	5,400	60 m / 100	900 (6.2)	120	-	10:1	Bonding, Encapsulant
	LS-6946	Primed Lap Shear 510 psi, Youngs Modulus 425 psi	1.46	2 h	30	A:40,000 / B:35,000	30 m / 150	675 (4.7)	275	360	1:1	Bonding, Molding
LS-6257	100 °C minimum cure, Low Viscosity,	1.57	3 d	39	150 cSt	1 h / 150	122	49	-	1:1	Bonding, Coating	
OPTICAL GREASES	LS-1246	Flows Under Pressure, Non-Slumping, Non-Curing	1.46	-	-	-	-	-	-	-	-	Index Matches POF, PMMA
	LS-1249	Flows Under Pressure, Non-Slumping, Non-Curing	1.49	-	-	-	-	-	-	-	-	Index Matches POF, PMMA
OPTICAL PRIMERS	LS1-3200	All Purpose Primer for Optical Applications	1.4 to 1.425	-	-	1.0	-	-	-	-	-	Adheres to various substrates
	LS2-3200	Improves Adhesion to Difficult Substrates	1.4 to 1.425	-	-	1.0	-	-	-	-	-	Adheres to difficult substrates
	LS3-3200	Maintains Transparency at 400nm	1.4 to 1.425	-	-	1.0	-	-	-	-	-	Improves Adhesion to Difficult Substrates

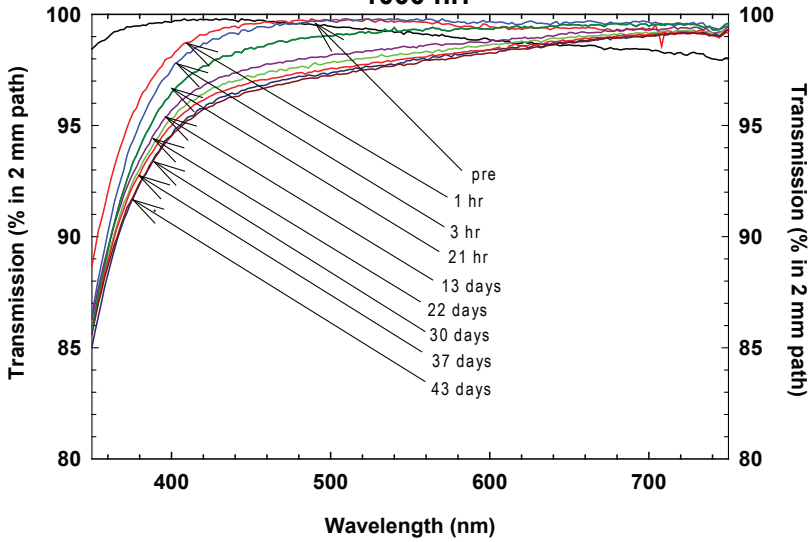
h = Hours  
 m = Minutes  
 d = Days

MBP = Measured by Penetration  
<sup>\*31)</sup> Tested per NuSil TM017  
<sup>\*32)</sup> Tested per NuSil TM036

RTV = Room Temperature Vulcanization

\*The operating temperature range of a silicone in any application is dependent on many variables, including but not limited to: temperature, time of exposure, type of atmosphere, exposure of the material's surface to the atmosphere, and mechanical stress. In addition, a material's physical properties will vary at both the high and low end of the operating temperature range. Performance of a material in a specific application should be verified by the user.

**Optical Transmission vs. Wavelength of LS-6140**  
1000 hr.

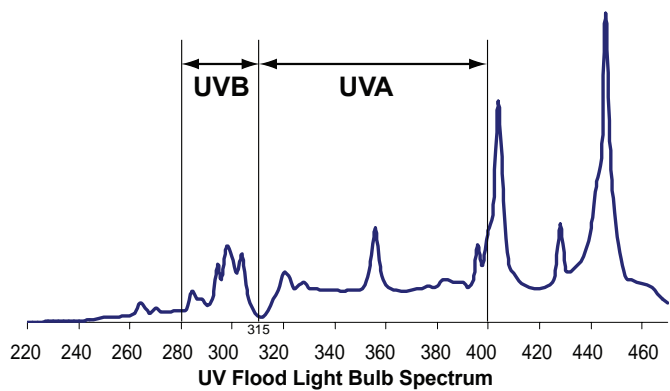


### UV Resistance

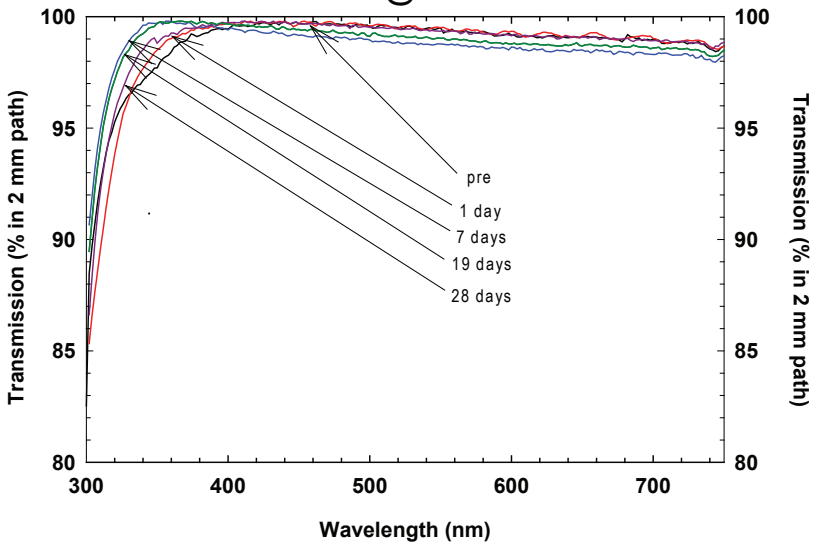
Compared to other materials used in photonics applications, silicone can be formulated to resist optical degradation after exposure to UV light.\*

### \* UV Exposure Testing Conditions

UV-Vis	61 mW/cm <sup>2</sup>
UV-A	52 mW/cm <sup>2</sup>
UV-B	23 mW/cm <sup>2</sup>
UV-C	0 mW/cm <sup>2</sup>



**Optical Transmission vs. Wavelength of LS-6140**  
672 hr. @ 150°C

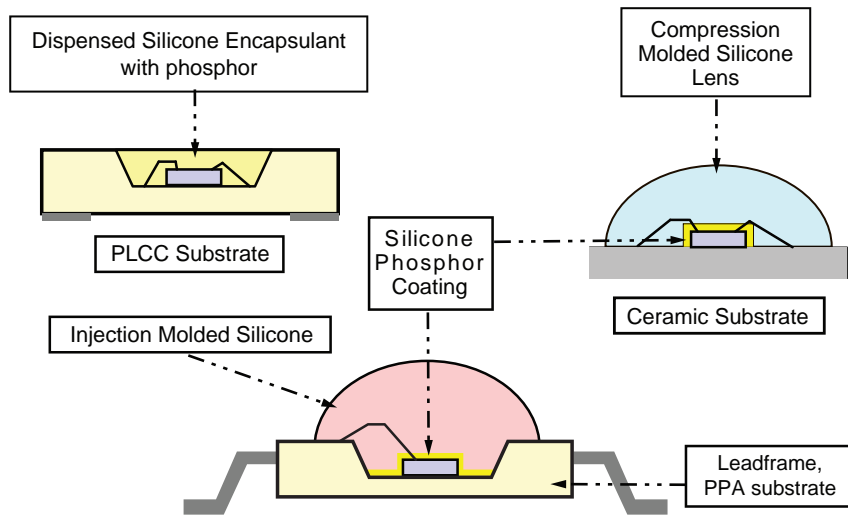


### Temperature Resistance

In addition to optical stability after exposure to UV radiation, silicone can also be formulated to minimize or resist optical degradation due to prolonged exposure to high temperature.



## General LED Footprint



## Lenses

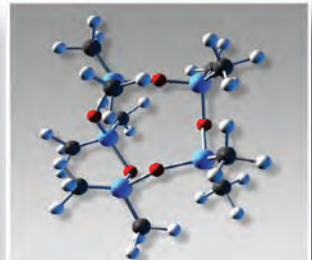
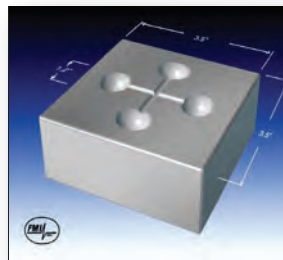
Silicone lenses offer photonic device packagers unparalleled compatibility with softer silicone encapsulants. They resist degradation in high temperatures, yellowing under UV exposure and can be molded into unique optical shapes. NuSil and FMI Inc. have teamed up to provide silicone lenses to the photonics industry. NuSil's LightSpan™ line of high quality, optically characterized silicone materials offer different choices for lenses. FMI's molding experience with silicones, particularly small intricate parts, can provide customers with quality optical lenses. Acronym Refractive Index LS Products

## Phosphor Coatings

NuSil Technology has specifically designed higher viscosity silicone Optical Gel Encapsulants in order to keep the dense phosphor powders suspended for extended periods of time during dispensing. They are excellent for low to high power LED applications and are available in refractive indices ranging from 1.51 to 1.54.

## Application Notes

- Avoiding Cure Inhibition and Bubbles with LightSpan™ Optical Materials
- Choosing a Silicone Primer / Adhesive System
- Converting a Two-part LightSpan™ Optical Gel or Thermoset to a One-part Material
- Curing LightSpan™ Optical Gels – the Relationship between Temperature, Viscosity, Durometer and Cure
- Improving Light Extraction from LEDs Using LightSpan™ Optical Gels & Thermosets
- Index Matching Using Optical Polymers



For more details and to view the above Application Notes or for additional technical resources please see our website at: [www.nusil.com/whitePapers/resources](http://www.nusil.com/whitePapers/resources).





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