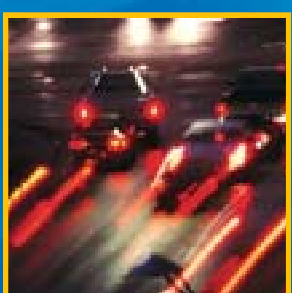
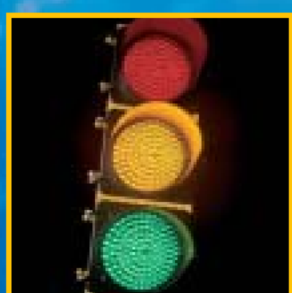
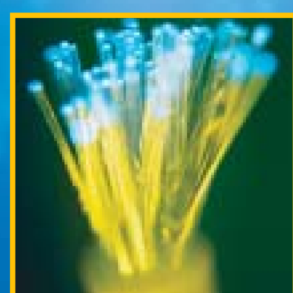
Nye®

SmartGel®

Optical Coupling Technology







Answers to frequently asked questions about SmartGels and how they improve the performance of optical devices.

SmartGel®

Improving the reliability and efficiency of optical devices.

SmartGel® is an enabling technology developed by Nye Lubricants in the 1980s to eliminate reflection and signal loss within fiber connectors in optical networks. Today, SmartGels are used in an expanding array of applications — from LEDs and flat panel displays to CCD cameras and experimental solar light-gathering systems.

A rule of thumb: SmartGels can improve reliability and efficiency whenever light must pass through mated plastic or glass within a device designed to transmit, deflect, amplify, or detect light. If you think SmartGels may enhance the performance of your product, call us. We look forward to helping you make the light shine through.

What is SmartGel?

SmartGel consists of a low viscosity optical fluid and optical thickening agents. When combined, they become a viscoelastic solid with a specific refractive index, high optical clarity, and low absorption loss.

Are there different types of SmartGels?

There are two types of SmartGels: thixotropic and curing. Thixotropic SmartGels are pre-mixed and ready-to-use. When motion is introduced to a thixotropic gel, its viscosity decreases. For example, depressing the plunger of a syringe filled with thixotropic gel makes the gel more fluid-like, allowing it to be pumped into an assembly. Once a thixotropic SmartGel is dispensed, it doesn't migrate out of the assembly. The consistency of thixotropic SmartGels ranges from toothpaste to putty.

Curing SmartGels consist of an optical fluid and a soluble optical catalyst that are mixed by the customer. Mixing the two components produces a cured viscoelastic solid. Heat may be used to accelerate the curing process. Both components have a low pre-cure viscosity, which makes it easy to inject them into tight spaces. A two-cartridge dispenser allows for automated high-volume, or convenient hand operated, dispensing of curing SmartGels in controllable measures.

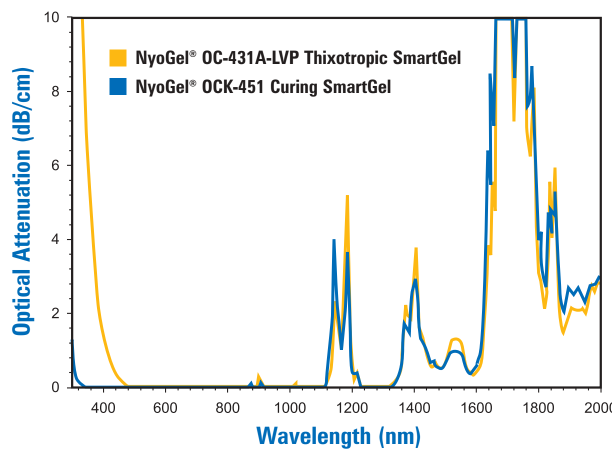
Why are SmartGels used?

SmartGels improve the efficiency of photonic and telecommunication devices when light inside a device must travel through mated plastic or glass. Air gaps between mated materials cause reflection. Filling the gap with SmartGel virtually eliminates reflection and optimizes light transmission. For example, SmartGel is used to fill the micron-sized gaps between fibers in optical cable connectors, or the gap between a back-light and the TFT-LCD screen on personal digital assistants or cell phones.

How do SmartGels work?

Air gaps between mated plastic and glass cause reflection because the refractive index of air is lower than the refractive index of the mated materials. Filling the gap with an index-matching SmartGel displaces the air and eliminates the difference in refractive indices that causes reflection and reduces efficiency.

Optical Clarity vs. Wavelength



Are SmartGels like optical epoxy?

SmartGels offer advantages over epoxy. Epoxy is rigid, so it can trap stress, fracture, and delaminate. SmartGels absorb shock, minimizing fracture and delaminating. Epoxy can crack when cold and soften when hot. SmartGels are designed to withstand wide temperature excursions (–65°C to ≥ 200°C), including soldering temperatures during device assembly. Unlike epoxies, SmartGels are non-yellowing under typical conditions and virtually unaffected by x-ray, ultraviolet, or sunlight exposure. Generally, SmartGels are precisely engineered materials. They have extremely low outgassing and volatility characteristics. Optical absorption is typically <0.001% per micron of light path length. They are ultraclean, chemically stable, non-toxic, synthetic materials suitable for designs that require high reliability and long service life.

Why are they called "SmartGels?"

SmartGels "know" how to make the light shine through because they are designed for specific products. The refractive index of a SmartGel is matched to the refractive index of the mated materials (±0.005). A SmartGel's temperature service range, cleanliness levels, and evaporation rate can be matched to product requirements. For thixotropic SmartGels, apparent viscosity can be specified. For curing SmartGels pot life, cure rate, and Shore hardness can be specified. SmartGels can also be formulated to resist water, ionizing radiation, and reactive chemicals.

Where are SmartGels currently used?

SmartGels are now used in fiber optic splices and connectors (Bellcore GR-2919-CORE), high-brightness LEDs, CCD cameras, light therapy technology, and flat panel displays. They are also being tested in a broad range of photonic and telecommunications designs, including personal digital assistants, avionic displays, vision systems, fiber light guides, accent lighting, multiplexors, photodiodes, optical transceivers, optical attenuators, and ultrasonic welding equipment.

How are SmartGels packaged?

SmartGels are typically available in 1cc, 10cc, 30cc, and 55cc syringes; in 20cc and 50cc cartridges; and in 200g and 600g Semco® cartridges.

How do I start experimenting with SmartGels?

Nye's Optical Coupling Kit is a great way to explore how SmartGels can enhance the efficiency of your product. The kit includes two thixotropic SmartGels (NyoGel OC-431A-LVP and NyoGel OC-462) and one curing SmartGel (NyoGel OCK-451).

To order a kit or to consult with an engineer about a SmartGel for your application, please call Nye at 508-996-6721.

Thixotropic SmartGels

Thixotropic gels are ready-to-use, non-migrating, viscoelastic materials with a high apparent viscosity. The consistency of thixotropic gels ranges from that of toothpaste to hard putty, so they are unsuitable for applications where the material must wick into very tight spaces under surface tension alone. Once a thixotropic gel is dispensed, it won't migrate out of the optical assembly. They are stable to >200°C.

Property	Test Method	NyoGel OC-431A-LVP*	NyoGel OC-440	NyoGel OC-459	NyoGel OC-462
Color in bulk	Visual	Crystal Clear	Translucent Milky	Translucent Ivory	Translucent Ivory
Refractive Index at 589.3nm	ASTM D-1218	1.46	1.51	1.59	1.62
Refractive Index temp. coeff., 25°C to 60°C	ASTM D-1218	$-3.5x10^{-4}$/°C	$-3.4x10^{-4}$/°C	$-3.5x10^{-4}$/°C	$-3.6x10^{-4}$/°C
Refractive Index vs. Wavelength, Cauchy fit	ASTM D-1218	$1.4332+10{,}526\lambda^{-2}$	$1.4831+10{,}474\lambda^{-2}$	$1.5573+10{,}561\lambda^{-2}$	$1.5899+12{,}524\lambda^{-2}$
Optical Attenuation (dB/cm)	Custom	<0.25 (450-750nm)	1.80 (1550nm)	5.11 (1550nm)	9.83 (1550nm)
		1.34 (400nm)	14.47 (589nm)	29.86 (589nm)	28.95 (589nm)
		1.21 (1550nm)	30.23 (400nm)	35.07 (400nm)	34.74 (400nm)
Penetration, unworked	ASTM D-1403	243	301	217	235
Apparent Viscosity (poise)	ASTM D-1084	11,000	7,000	12,000	11,000
Oil Separation, 24 hrs at 100°C	FTM 791(321.2)	<0.2%	4%	1.6%	3.0%
Evaporation, 24 hrs at 100°C	ASTM D-972	<0.2%	<0.1%	<0.1%	<0.1%
Coefficient of Thermal Expansion	ASTM D-1903	$6x10^{-4}$ cc/cc/°C	$4x10^{-4}$ cc/cc/°C	$5x10^{-4}$ cc/cc/°C	$6x10^{-4}$ cc/cc/°C
Specific Gravity	ASTM D-1217	1.06	1.15	1.19	1.20
Microscopic Particulate Contamination	FTM 791B(3005.3)	<300 particles/cc (≤ 34 microns)	<500 particles/cc (≤ 34 microns)	<300 particles/cc (≤ 34 microns)	<300 particles/cc (≤ 34 microns)

Curing SmartGels

Curing gels consist of an optical fluid and soluble optical thickening agents. When mixed they cure and harden into a viscoelastic solid, stable to >200°C. Curing gels can be injected into tight spaces to cure in place, or premolded and cured into shapes like washers, gaskets, or spacers.

Property	Test Method	NyoGel OCK-433		NyoGel OCK-451	
Property of Uncured Mixture					
Color in bulk	Visual	Crystal Clear		Crystal Clear	
		Part A	**Part B**	**Part A**	**Part B**
Kinematic Viscosity (cSt)	ASTM D-445	1270	1483	200	600
Specific Gravity	ASTM D-1217	1.04	1.05	1.06	1.08
Property of Cured Mixture (50:50 mix, ±2%)					
Color in bulk	Visual	Crystal Clear		Crystal Clear	
Refractive Index at 589.3 nm	ASTM D-1218	1.46		1.51	
Refractive Index temp. coeff., 10°C to 65°C	ASTM D-1218	$-3.2x10^{-4}$/°C		$-3.6x10^{-4}$/°C	
Refractive Index vs. Wavelength, Cauchy fit	ASTM D-1218	$1.4429+10{,}489\lambda^{-2}$		$1.4954+8{,}022\lambda^{-2}$	
Optical Attenuation (dB/cm)	Custom	<0.001 (320-900nm)		<0.001 (350-850nm)	
Cure Time at 25°C	Custom	24 hours		24 hours	
Hardness, Shore 00	ASTM D-2240	38		35	
Coefficient of Thermal Expansion	TMA	$1.2x10^{-3}$ cc/cc/°C		$1.9x10^{-3}$ cc/cc/°C	

*Properties at 25°C unless otherwise noted. Test results are typical values. *Specified by Bellcore GR-2919-CORE for fused silica fiber splice/connectors. λ=nm*

The SmartGrease Company®

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ISO 9001:2000
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ISO 14001