Nye® LUBRICANTS

LubeLetter

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Lifetime Solutions With Synthetic Lubricants

Nye Takes Optical Coupling Gels Into The Next Millennium

In 1988, Nye Lubricants introduced a breakthrough to the fiber optic industry: index-matching gels. Now, 10 years later, as engineers explore new frontiers for light pipes and opto-electronic components — ones that may eventually replace incandescent lamps — Nye remains on the crest of the optical couplant development wave.

A brief history. With the advent of fiber optics, light waves traveling through glass or plastic could be used to speed the transmission of digital data. The technology was quickly adopted by the telecommunications industry. Unlike old metal wire systems, where splicing in the field was a relatively easy mechanical task, connecting strands of glass or plastic wasn't as simple. Fiber optic cables must be precisely aligned and fused, an equipment-intensive process that was neither efficient nor economical in the field. Consequently, a fiber optic connector was invented. Strands were inserted into either end of the connector and locked in place. A short gap was designed into the center of the connector to prevent one fiber from rubbing against the end of the other.

The gap between the fibers, however, posed the problem of attenuation, light losses through reflection, absorption, or scattering, due to the large differential optical impedance between air in the gap and the signal carrying wave guides. If the gap could be filled with a medium with a Refractive Index that matched the fiber, the loss could be reduced to a minimum. (Refractive Index is a measure how much a light ray will bend when it passes from a vacuum into a material) Index-matching fluids were the first gap-filling materials. A fluid's plasticity ensured the gap would be filled. However, because of potential leakage and evaporation, fluids were not the optimal solution to "closing the gap" in the connector.

Seeing the light. *Dr. David Stone, Nye's Engineering Manager for New Products, and Lab Technician Linda Gouveia review spectrograph results on Nye's new high-index coupling gels. For information about Nye's optical coupling gels, call Dave at (508) 996-6721.*

Filling the gap. Nye overcame the inherent disadvantage of optical coupling fluids with the introduction of an experimental index-matching gel in the mid-1980s. The gel structure offered stay-in-place capability as well as the self-healing plasticity of a fluid. Crystal clear and transparent, the gel neither scattered nor absorbed light. Oxidatively stable over the usual optical cable operating temperature range of -25°C to 80°C, it was also filtered to eliminate impurities that might cause additional attenuation and minute distortion of the light signal.

After several early refinements, Nye formulated NyoGel OC 431A, an optical couplant with a Refractive Index at 25°C of 1.46. It quickly became and remains a standard material used in fiber optic connectors. It is also being used for a variety of light piping applications, which distribute light from a single source through linked "pipes" to remote locations for illumination, rather than data transmission.

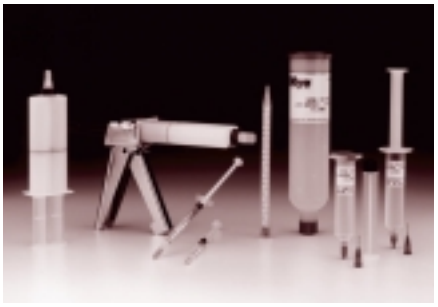
Finding a cure. Unlike relatively stationary fiber-optic connectors, some applications required an index-matching gel that offered more mechanical support than a non-curing gel like NyoGel OC 431-A could provide, for example, a light pipe application where inertial or shock forces may cause the gel to be dislodged. For such applications, Nye developed custom-formulated curing gels. NyoGel

OC 433 has a Refractive Index of 1.46 and cures in 10 minutes at 25°C.

A curing gel system consists of three major components: a polymer, a "crosslinker," and a catalyst. The polymer, the major component by weight, determines the mechanical properties and Refractive Index of the gel. The crosslinker, in the presence of the catalyst or curing agent, links polymer molecules to each other. When these three components are mixed together in the proper ratio, the polymer undergoes a transition to a much higher molecular weight, as the crosslinker molecules graft separate polymer molecules together into a solid matrix. The amount of crosslinker determines the rigidity of the cured material, while the quantity and type of catalyst effects the speed and completeness of the cure. Rigidity of the gel and speed of cure can be matched to specific application requirements. Once cured, the gel has the same mechanical characteristics as any soft elastomer.

For a coupling gel, Nye typically uses a straightforward measure of hardness or stiffness. The soft, self-healing gels register zero when tested on a Shore A Durometer, but can be quantified in hardness by a measurement of half-scale penetration, a measurement commonly used at Nye to quantify the stiffness of grease. For the harder materials, Shore A hardness is measured. Other more conventional mechanical properties like tensile strength, shear strength, and bulk modulus can also be measured when these properties are critical to an application.

Encapsulation Gels. Applications for cured gels fall into three categories. A "low-tech" application, where the typical Refractive Index is approximately 1.40 and not a critical parameter, is encapsulation. Nye has formulated "see-through" gels that enable economical potting and encapsulation of assemblies that are sensitive to moisture, dust, water, and other atmospheric intrusions. These materials pour easily and have low viscosity prior to cure. Both before and after cure, these materials are crystal clear, allowing non-intrusive inspection of the encapsulated assembly. The consistency of the cured material is similar to Jello®, and it can be easily excavated for localized re-work operations without disturbing the remainder of the encapsulated assembly. Typical applications for these gels are outdoor plant circuit board assemblies, patch panels, and severe service industrial control electronics.



***A new 3M® EPX Applicator**, with duo-pak cartridge which can mix the proper ratio of crosslinker and catalyst for Nye's cured index matching gels, has recently been added to the selection of other standard dispenser containers offered by Nye.*

Heat-triggered Gels. While the rate of cure for all conventional curing gels can be accelerated by raising ambient temperature (standard cure temperature is 25°C), Nye has developed a "heat triggered" curing technology for special applications where complete cure at elevated temperatures is required, but the mixed components **must not cure** at ambient temperature. These gels are useful in assemblies which are simultaneously heated for other purposes, such as heat-shrinking, plastic molding, and soldering, and where the gel must not harden until other components have cooled and assumed their final mechanical tolerances. Nye has formulated gels which remain fluid and uncured at 100°C, but which cure completely within minutes or hours at 150°C.

High Index Gels. A new breakthrough, Nye recently developed cured index-matching gels. These gels have a Refractive Index well above 1.40 and are suitable for use with clear engineering plastics and glasses. Nye's new high index gels, which are formulated with a Refractive Index from 1.46 (NyoGel OC 433) to values as high as 1.54, are ideally suited for applications where optimal light transmission efficiency through a light pipe, a lens, or other photonic component is paramount.

Seeing in the future. As research and development engineers continue to explore how to convert electricity more efficiently to visible light, index matching gels will play an increasingly important role in illumination. The more light pipes and lenses are used to transfer light from discrete electronic sources, high index coupling gels become to opto-electronic devices what tungsten filaments have been to the incandescent bulb. At Nye, the vision is clear. Continued development of optical coupling gels will literally help light the future.

Important Performance Parameters For Curing Optical Coupling Gels

Refractive Index	Selected for optimizing light transmission; critical applications require 1.46 and higher.
Optical Clarity	"Haziness," measured in intensity absorption, in %/cm of path length, at wavelength of interest. Acceptable value dependent on device geometry in the application.
Viscosity before Cure	Low viscosity (<1000 cP) usually desirable for high-speed automated dispensing. Not critical for manual dispensing or for automated dispensing through large orifices.
Cure Temperature	Standard is 25°C. Temperatures above nominal serve to accelerate the cure. Heat-triggered gels remain uncured at 25°C, but cure at the design temperature, up to 150°C.
Set-Up Time	Time delay between mixing of fluid gel components, and time that gel becomes semi-solid (>300,000 cP). Can be varied from minutes to hours. Cure usually complete within 24 hours.
Hardness after Cure	Can be varied from soft, self-healing, Jello® consistency to hardness of a pliable elastomer. Measured as half-scale penetration.

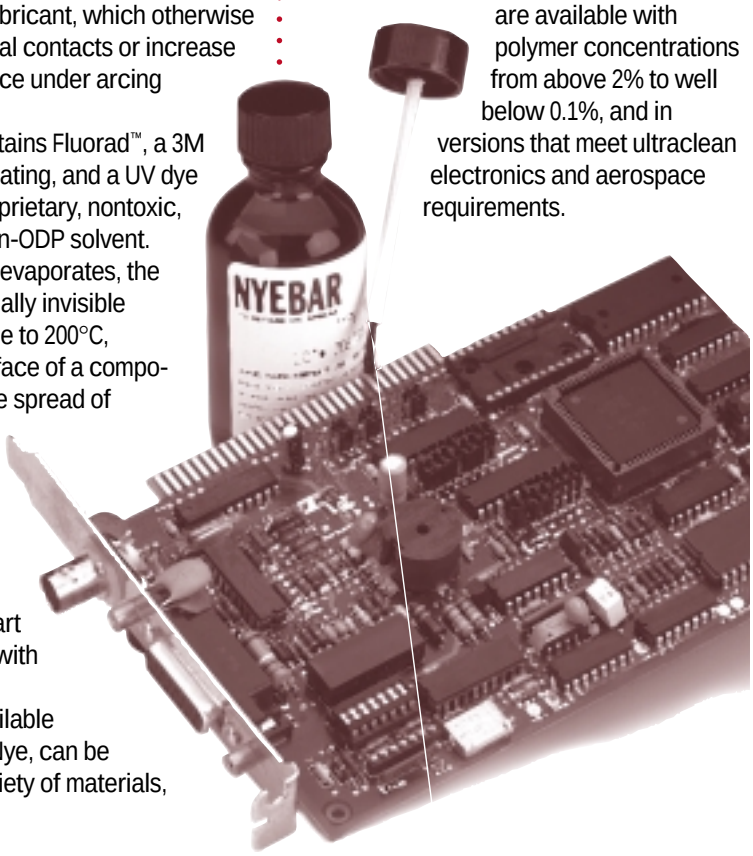
3M Promotes Benefits of Nye Barrier Coating To Automotive Industry

3M™ recently agreed to promote NyeBar® UV, a new barrier coating by Nye Lubricants that helps automotive manufacturers meet demanding quality control requirements.

In typical automotive applications, small amounts of oil or grease may be used to lubricate rolling element bearings, motor shafts, or sensitive electrical devices. A thin coating of NyeBar UV prevents migration of the lubricant, which otherwise could foul electrical contacts or increase electrical resistance under arcing conditions.

NyeBar UV contains Fluorad™, a 3M fluorochemical coating, and a UV dye dispersed in a proprietary, nontoxic, nonflammable, non-ODP solvent. When the solvent evaporates, the UV dye and a virtually invisible polymer film, stable to 200°C, remain on the surface of a component to prevent the spread of lubricants. Under ultraviolet light, the UV dye fluoresces, confirming for quality control purposes that a part has been treated with NyeBar.

NyeBar UV, available exclusively from Nye, can be used to coat a variety of materials, including copper, aluminum, steel, tin, plastic, and glass. It can be applied by dipping, spraying, or brushing. The standard formulation contains 0.2% fluoropolymer solids. For applications requiring a solids content other than 0.2% or a different rate of evaporation, Nye offers custom formulations based on different polymer concentrations or solvent mixtures. Custom formulations are available with polymer concentrations from above 2% to well below 0.1%, and in versions that meet ultraclean electronics and aerospace requirements.



NyeBar® UV prevents oil creep by acting as a dam around the lubricated area on sliding and rotating parts. The addition of a UV dye makes it ideal for manufacturing settings that use automated UV cameras in the QC process.

Nye Expands Production Facilities

Less than a year after opening an 18,000 square foot facility for its specialty packaging services, Nye Lubricants purchased in September another 33,000 square foot building, adjacent to its headquarters in Fairhaven, Massachusetts, "to improve production capacity and efficiency," Nye Vice President George B. Mock, III, said.

"Within the next year we will install a Class 10K Clean Room dedicated to the ultrafiltration of our own and other manufacturers' lubricants, to meet the growing need for ultra-clean oils and greases used in precision bearings," George added.

With a new Wiped Film Evaporator, Nye's current Clean Room will become a distillation lab for ultra-clean oils, primarily for aerospace and disk drive applications.

The new plant is scheduled for operation by the end of 1997.

Materials Manager Receives CPIM

Nye Materials Manager Alden "Skip" Pierce successfully completed the last in a series of national exams in September, and was awarded the American Production and Inventory Control Society's (APICS) Certification in Production and Inventory Management (CPIM).

Skip took six intensive courses and exams over the last 18 months to earn the CPIM. The curriculum consisted of Inventory Management, Just-In-Time, Master Planning, Production Activity Control, Supply Chain Management, and MRP/CRP.

"The program makes clear how all aspects of manufacturing relate, how we all affect each other by what we do," Skip observed. "The training will improve our efficiency and, in turn, help ensure customers get the lubricants they need, when they need them."

In November, Skip will begin another program of study leading to certification in Integrated Resource Management (CIRM), a designation held by only 2,300 people worldwide. He plans to complete CIRM training by early 1999.

Alden Pierce, CPIM

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ISO 9002 In Hand, Nye Eyes QS-9000

Nye Lubricants received its ISO 9002 certificate from the British Standards Institute in August, a distinction Nye's Quality Manager Tom Gray says is the first step in a plan to meet Automotive Standard QS-9000.

"ISO 9002 is the benchmark in the lubricant and chemical industry," Tom explained, "so we decided to begin with that certification. Our plan now is to upgrade our ISO certification to 9001 by the end of 1998, which will open the door to QS-9000, the standards set by Chrysler, Ford, and GM, who now rely on Nye for more than 100 different synthetic lubricants."

Of note, more than 85 percent of the Nye's employees were directly involved in the 18-month ISO certification process.

"We got a 'buy-in' up front," Tom said, "by inviting those who would be responsible for carrying out the ISO procedures to help develop them. ISO at Nye is really a company-wide commitment."

Pennzane Update: New Low Vapor Pressure, Low-Temp Grease

Nye recently introduced Fluorocarbon Gel 2000F, a new low vapor pressure synthetic lubricant formulated from Pennzane SHF-X2000, a proprietary multiply-alkylated cyclopentane base fluid from Pennzoil, thickened with high-efficiency PTFE solids to an NLGI Grade 1 consistency.

Fluorocarbon Gel 2000F offers improved vapor pressure over Rheolube 2000, Nye's first version of a Pennzane-based grease. Rheolube 2000, thickened with a sodium soap, has a 25°C Vapor Pressure of 1.09 x 10^{-7} Torr. Fluorocarbon Gel 2000F has a 25°C Vapor Pressure of 4.2 x 10-9 Torr — almost 100 times better than Rheolube 2000.

Fluorocarbon Gel 2000F also offers better low temperature performance. At -40°C, it has an apparent viscosity at low shear of 20,000 poises. Under similar conditions, Rheolube 2000's apparent viscosity is 170,000 poises.

"Because of trace chemical contaminants in the raw materials, Rheolube 2000 has some residual impurities present in the organic soap, so the vapor pressure is higher than if these impurities were not present," Nye Technical Director Paul Bessette said. "Because Fluorocarbon Gel 2000F uses PTFE, these are not an issue, and vapor pressure improves significantly."

"Volatile constituents don't necessarily rule out a grease when a customer needs very low vapor pressure," Paul explained. "Rheolube 2000, for example, may be quite suitable for bearings in a gyro. But if, for example, the gyro is located near a lens that could become fogged when the impurities are baked out, then there is cause for concern. Fluorocarbon Gel 2000F addresses this concern."

Pennzoil partnered with Nye more than two years ago to develop commercial applications for Pennzane SHF-X2000, an unformulated base oil with a 25°C Vapor Pressure of 3.5 x 10-11 Torr.

"Nye's goal is to take advantage of the low vapor pressure of the Pennzane base fluid, and continuously work toward a grease with the properties of the base oil itself," Paul added.

Currently, about 20 customers in the aerospace industry use Pennzane-based products from Nye.

E-Grease by E-Mail: Do Web Sites & Web Browsing Really Pay Off?

Following the publication of a cover story on electrically conductive greases in Nye's spring Lubeletter, one of our applications engineers received an E-Mail from a Canadian branch of an international manufacturer of printers and copiers which requested a sample of a custom formulated, electrically conductive grease for bearings and grounding straps, used to dissipate static electricity.

http://www.nyelubricants.com.

The samples from Nye were tested in Canada. Test results were presented to the Company's US corporate headquarters, which queried, again by E-mail, whether specialty packaging services were available from Nye. The Company needed 100,000 small tubes of the custom grease, packed with instructions, in bar-coded, shipping-ready boxes, that would be sent to its field maintenance personnel throughout North America.

When Nye confirmed, by E-Mail, that it could meet the specialty packaging requirement in-house, the order arrived for preliminary production quantities of custom-formulated NyoGel 755G, a new electrically conductive, silicone-based grease with a proprietary carbon filler — Nye's first major sale of an "E-Grease" by E-Mail.

For application information, inquiries, sample requests — and orders — Nye's Web address is http://www.nyelubricants.com.

Nye® LUBRICANTS

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