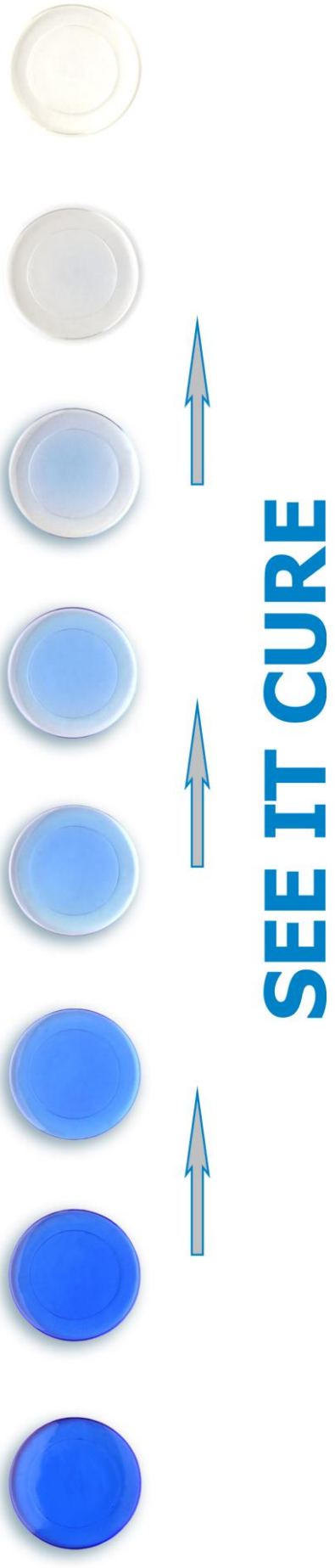
See-Cure Adhesives Selector Guide



DYMAX®

About DYMAX

DYMAX is an ISO 9001 certified leading manufacturer of solvent-free, UV/Visible light-curable adhesives and light-curing systems that are supplied to the medical, electronic, appliance, transportation, and alternative energy markets worldwide.

DYMAX was founded in January 1980 as the *American Chemical and Engineering Company*. Our first products, a patented line of structural adhesives that combined high bond strength with fast fixturing speed, offered significant productivity improvements to electric motor manufacturers and were widely used in OEM environments. Eventually, formulations were developed that offered faster processing speeds for a larger segment of the industrial market. This led to the development of ultraviolet light-curable adhesives and compatible UV light-curing equipment.

Today our product line includes light-curable adhesives and coatings, temporary masking resins, one and two-part epoxy resins, activator-cured adhesives, cyanoacrylates, and form-in-place gaskets.

Our complete line of light-curing systems, which are perfectly matched to our adhesive chemistry, includes light-curing spot lamps, flood lamps, conveyor systems, and radiometers for measuring light intensity. Our equipment can be configured as stand-alone units or integrated into existing manufacturing assembly lines for fast processing.

DYMAX Corporation, which employs more than 200 people globally, is headquartered in Torrington, CT, with additional facilities in Germany, China, Hong Kong, and Korea.

The DYMAX Edge – Making our Customers More Efficient

At DYMAX, we're committed to making our customers more capable and efficient. Our solutions help manufacturers increase throughput, enhance quality and performance, conserve energy, improve safety, and reduce environmental impact. We offer complete technical solutions that optimize the speed and yield of their assembly processes:

- **Light-curable materials** (LCMs) that are environmentally friendly and maximize process throughput.
- **Curing equipment** that is optimized to our LCM formulations for the fastest, most thorough cure.
- **Dispensing systems** that are robotically or manually integrated into the assembly process.
- **Technology consulting services** from DYMAX Applications Engineering and R&D groups enable selection of the best combination of bonding materials, curing equipment, and process parameters for the most efficient and robust assembly process.

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See-Cure Technology

DYMAX light-curable adhesives with patented See-Cure technology have built-in cure validation that makes it easy for operators, or simple automated inspection equipment, to confirm cure without investing in additional specialized equipment. See-Cure technology is an indicator of cure that intentionally transitions the color of the adhesive after it has cured and builds a visible safety factor into the assembly process. The color transition is directly linked to the photoinitiator in the adhesive.

See-Cure technology answers the two most often asked questions about light-curable products:

- How do I know that I've dispensed a sufficient amount of adhesive in the prescribed area?
- How do I know when the adhesive is cured?

See it Dispense!

DYMAX adhesives that are formulated with See-Cure technology are bright blue in an uncured state. This makes them easy to see on the surface of substrates, in deep wells, or when placed between two layers of materials, while enabling simple confirmation of the quantity and location of placement. The adhesives' blue color will not permanently stain or affect the biocompatibility of the component surfaces they contact. Because the blue color is extremely visible, simple vision systems can be incorporated into automated assembly processes prior to curing in order to easily identify adhesive coverage and profile.

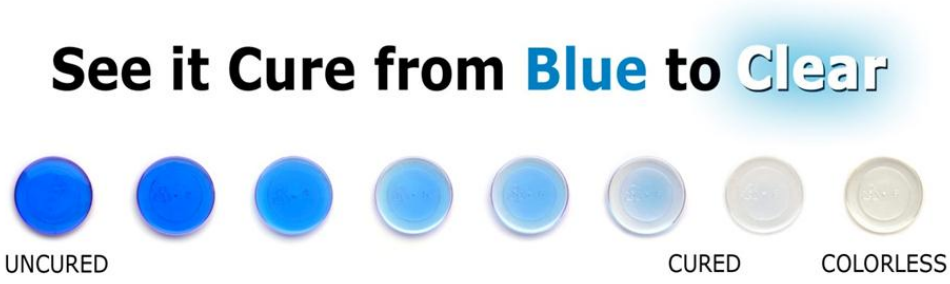
See it Cure!

As the adhesive begins to cure, its blue color begins to fade and ultimately turns clear after full cure. See-Cure adhesives are specifically formulated to ensure that this visually obvious, blue-to-clear color change occurs ***only after the adhesive is cured***. This serves as a visible confirmation that the adhesive has received a sufficient dose of energy to cure. See-Cure technology that transitions the adhesive from blue to pink is also available. These products are ideal for applications in which post-cure confirmation of adhesive cure and placement is critical.

DYMAX adhesives with patented See-Cure technology improve manufacturing processes and help increase profitability by streamlining cure validation, reducing line stoppages, and increasing throughput.

See-Cure technology offers manufacturers many key advantages over competing technologies including:

- Easy confirmation of adhesive placement, quantity, and cure
- The adhesive's transition to clear is indicative of cure - from top to bottom
- Validation of cure for the entire bond line, not just for select areas
- Validation of cure without the expense of purchasing and maintaining specialized equipment
- Production-proven technology
- No additional floor space required
- No additional employee training needed
- No language translation needed for cure confirmation



Frequently Asked Questions

Q. What is See-Cure?

A. See-Cure is an unique patented technology that enables visual confirmation of cure for DYMAX light-curable adhesives.

Q. Do See-Cure products require any special equipment?

A. No. The See-Cure color change can be easily detected with only the human eye or with inexpensive AOI equipment.

Q. Is See-Cure available for all DYMAX chemistries?

A. The majority of DYMAX's light-curable adhesive platforms have See-Cure versions available.

Q. How does See-Cure work?

A. Upon exposure to light of the correct intensity and wavelength, photoinitiators in the See-Cure adhesive will fragment and form highly-reactive free-radicals. These free-radicals initiate a rapid polymerization reaction of the adhesive's oligomers and monomers. As the polymerization reaction progresses to completeness, the available free-radicals react with the blue See-Cure additive and irreversibly convert it to a colorless form that results in colorless, cured adhesive.

Q. How reliable is See-Cure as an indication of cure?

A. All See-Cure products are formulated such that the color change to clear occurs when the material is cured.

Q. Does See-Cure color change guarantee the performance of the DYMAX adhesive?

A. All adhesives should be thoroughly tested in the customer's specific application to ensure that the final bond performance properties can be achieved on the customer's specific substrates and under the customer's specific process conditions. See-Cure provides a visual confirmation that the adhesive has been cured. The customer must determine that all performance requirements have been met.

Questions about See-Cure?

DYMAX's Application Engineering team is available to answer your questions and assist you in choosing the correct light-curable material for your application. Assistance from our Application Engineers is available by phone, email, or by scheduling a visit to DYMAX's Applications Engineering laboratory. The lab is fully equipped to perform mechanical testing under a variety of environmental conditions including shear strength, adhesion strength between substrates, compression set, and humidity aging per ASTM standards. The lab also has fully automated and industry-proven X, Y, Z application systems and manual spray or dispense valves to demonstrate conformal coating technology, cure-in-place gaskets, or to provide conceptual test samples for evaluation.

See-Cure Products Selector Guide

Product	Applications	Description	Nominal Viscosity cP (20 rpm)	Durometer Hardness	Tensile at Break, MPa [psi]	Elongation at Break, %
Catheter Bonding Medical Device Adhesives						
211-CTH-SC	▪ Y-Connector Assembly ▪ Tubing Connectors ▪ Balloon Bonding ▪ Catheter Assembly ▪ Needle Bonding	LED-curable plastic-bonding adhesive. Tack-free cure in 4 seconds; adhesion to a wide variety of plastics; UV/Visible light cure.	450	D70	16 [2,300]	140
Multi-Purpose Medical Device Adhesives						
1201-M-SC	▪ Tube Sets ▪ Reservoir Bonding ▪ Catheter Assembly ▪ Bonding of Rigid and Flexible Plastics	Flexible plastic-bonding adhesive. UV/Visible light cure.	600	D60	14 [2,000]	170
1201-M-GEL-SC	▪ Tube Sets ▪ Reservoir Bonding ▪ Catheter Assembly ▪ Bonding of Rigid and Flexible Plastics	Flexible, high-viscosity plastic-bonding adhesive. UV/Visible light cure.	38,000	D50	14 [2,000]	170
1201-M-T-SC	▪ Tube Sets ▪ Reservoir Bonding ▪ Catheter Assembly ▪ Bonding of Rigid and Flexible Plastics	Flexible, medium-viscosity plastic-bonding adhesive. UV/Visible light cure.	8,000	D55	14 [2,000]	170
1202-M-SC	▪ Tube Sets ▪ Reservoir Bonding ▪ Catheter Assembly ▪ Metal-to-Plastic Bonding	Flexible adhesive for multiple substrates. UV/Visible light cure.	200	D55	11 [1,600]	230
1204-M-SC	▪ Tube Sets & Fittings ▪ Face Mask Bonding ▪ Tracheal Tubes	Flexible PVC-bonding adhesive. UV/Visible light cure; silicone-like softness with the toughness of acrylic.	12,000	A60	6.9 [1,000]	380
1205-M-SC	▪ Tube Assembly ▪ Face Mask Bonding ▪ Doming	PVC-bonding adhesive. UV/Visible light cure; tack-free surface; strong bonds to PVC with the ability to resist plasticizer migration.	900	D70	3,650 [529,388]	50
1206-M-SC	▪ Tube Sets ▪ Reservoir Bonding ▪ Catheter Assembly ▪ Needle Bonding	Multi-purpose adhesive for plastics and metal. UV/Visible light cure.	300	D70	16 [2,300]	100
Industrial Assembly Adhesives						
3220-SC	▪ Plastic Housing Assembly ▪ Plastics Lamination ▪ Plastic Window Bonding ▪ Appliance Assembly	Flexible plastic-bonding adhesive. UV/Visible light cure; rapid bonding and laminating of plastics.	450	D60	15 [2,200]	180
3220-GEL-SC	▪ Plastic Housing Assembly ▪ Plastics Lamination ▪ Plastic Window Bonding ▪ Appliance Assembly	High-viscosity plastic-bonding adhesive. UV/Visible light cure.	38,000	D55	15 [2,200]	180

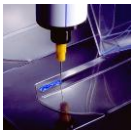
Continued on page 8

Adhesion Chart for See-Cure Products

● = Recommended adhesive ○ = Limited applications
ST = Surface treatment required in addition to adhesive (plasma, corona, UV, chemical, etc.)

Bonds These Substrates	See-Cure Products									
	211-CTH-SC	1201-M-SC	1201-M-T-SC	1201-M-GEL-SC	1202-M-SC	1204-M-SC	1205-M-SC	1206-M-SC	3220-SC	3220-GEL-SC
Plastic										
ABS	●	●	●	●	●	●	●	●	●	●
CAP	●						●			
COPE								●		
EVA						●				
PA	●	○	○	○	●			●	○	○
PC	●	●	●	●	●	●	●	●	●	●
PC/PCTG						●				
PEBA		●	●	●	○		●		●	●
PEEK						●				
PET					●	○	●	●	●	●
PETG							●	●		
PI								○		
PMMA		○	○	○	●	○		●	○	○
PP								ST		
PS						○	●	●		
PU		●	●	●	●	●		●	●	●
PVC	●	●	●	●	●	●	●	●	●	●
SAN	●									
TPU	●					●				
Other (metals, ceramics, glass)										
FR-4	●									
GLASS								●		
STAINLESS STEEL					○			●		

Typical Applications

Medical Device Adhesives		Industrial Adhesives		Masking Resins	Edgebond Adhesives	Form-In-Place Gaskets
						
Face Mask Bonding	Catheter Bonding	Plastics Assembly & Lamination	Appliance Assembly	Surface Protection During Chemical Processes	Leadless Component Ruggedization	Sealing Automotive Door Handles

See-Cure Products Selector Guide

Product	Applications	Description	Nominal Viscosity cP (20 rpm)	Durometer Hardness	Tensile at Break, MPa [psi]	Elongation at Break, %
Industrial Assembly Adhesives						
3221-SC	▪ Plastics Assembly ▪ Plastics Lamination ▪ Metal-to-Plastic Bonding ▪ Appliance Assembly	Flexible adhesive for multiple substrates. UV/Visible light cure; multi-substrate adhesion.	300	D55	12 [1,700]	220
3223-SC	▪ Plastics Assembly ▪ Plastics Lamination ▪ Metal-to-Plastic Bonding	Flexible plastic-bonding adhesive for PMMA (Acrylic). UV/Visible light cure; multi-substrate adhesion; low shrinkage.	150	D75	20 [2,900]	170
3224-SC	▪ Industrial Plastics Bonding ▪ Film Laminating ▪ Strain Relief ▪ Connectors and Hoses	Highly flexible PVC-bonding adhesive. UV/Visible light cure; very flexible; low shrinkage.	12,000	A60	8.3 [1,200]	400
3225-T-SC	▪ Plastics Assembly ▪ Plastics Lamination ▪ Metal-to-Plastic Bonding ▪ Appliance Assembly	Medium viscosity plastic-bonding adhesive for multiple substrates. UV/Visible light cure; multi-substrate adhesion.	9,500	D65	17 [2,400]	150
3227-SC	▪ Plastics Assembly ▪ Plastics Lamination ▪ Appliance Assembly ▪ Sealing Plastic Components	LED-curable PVC and PET-bonding adhesive. UV/Visible light cure; low viscosity; rapid sealing, bonding, and lamination of PET, PVC, and other substrates.	110	D70	14 [2,100]	80
SPEEDMASK® Resins for Surface Protection						
726-SC	▪ Plating ▪ Decorative Etching and Anodizing ▪ Powder Coating ▪ Part Handling ▪ Air Plasma Spray ▪ Grit Blasting	Surface treatment and protection mask. Moderate adhesion; UV/Visible light cure; fast curing; easy peel-off after exposure to heat.	45,000	D40	6.8 [980]	160
Edgebond Reinforcement Adhesives						
9422-SC	▪ Reinforcing Fine Pitch or Leadless Components on PCB ▪ Shock Absorption ▪ Underfill Replacement	Light-curable BGA, CSP reinforcement adhesive. No VOCs; fast, room-temperature cure.	37,500	D50	16 [14,000]	170
9422-T-SC	▪ Reinforcing Fine Pitch or Leadless Components on PCB ▪ Shock Absorption	Light-curable reinforcement adhesive. No VOCs; fast, room-temperature cure.	8,000	D50	16 [14,000]	170
Form-in-Place Gasket						
GA-140-SC	▪ Fuel Cells ▪ Automotive Door Handles ▪ Appliance Housings ▪ Critical Electronic Assemblies	Light-curable, form-in-place gasket. Moisture and chemical resistant; tack tree; low outgassing.	45,000	A30	0.8 [126]	187

Adhesion Chart for See-Cure Products

● = Recommended adhesive ○ = Limited applications
ST = Surface treatment required in addition to adhesive (plasma, corona, UV, chemical, etc.)

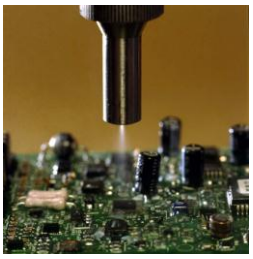
Bonds These Substrates	See-Cure Products								
	3221-SC	3223-SC	3224-SC	3225-T-SC	3227-SC	726-SC	9422-SC	9422-T-SC	GA-140-SC
Plastic									
ABS	●	●	●	●	●				●
CAP		●		●					
EVA			●						
PA	●	●		●					●
PBT		●							
PC	●	●	●	●	●				●
PC/ABS		●		●					
PC/PCTG		●	●	●					
PCTG		●		●					
PE		ST							
PEI		●	●						
PET	●	●	○		●				
PETG				●					
PI		●							
PMMA	●	●	○	●					●
PP		ST							
PS		○	○	○					
PSU		○		●					
PU	●		●	●	●				
PVC	●	●	●	●	●				●
SAN		○		●					
TPU		○	●	●					
Other (metals, ceramics, glass)									
ALUMINUM		○		●		●			
BRASS				○					
CERAMIC				○			○	○	
COBALT						●			
FR-4									
GLASS		●		○		●			
LEAD FRAME							●	●	
NICKEL ALLOYS						●			
PCB							●	●	
SILICONE							●	●	
STAINLESS STEEL	○	○		○		●			
STEEL						●			
TITANIUM						●			

Types of Applications for DYMAX Products

DYMAX is a major manufacturer of both light-curable materials (LCMs) and light-curing equipment. This focus on light-curing technology, coupled with the synergy produced by designing both the materials and equipment, uniquely positions DYMAX as the technical leader in light-curing technology. The primary DYMAX products are:

Adhesives	
Application Use	Bonding glass, plastic, metal, and ceramic
Industries	Appliance, aerospace, automotive, solar, alternative energy
Chemistries	Light-curable adhesives, Multi-Cure® adhesives, activator-cured acrylics, 2-part epoxies

Coatings	
Application Use	Protective conformal coatings for electronics; decorative coatings
Industries	Automotive, appliance, solar, electronics
Chemistries	Light-curable adhesives, Multi-Cure® adhesives



Potting Compounds	
Application Use	Component protection
Industries	Appliance, aerospace, automotive, solar, alternative energy
Chemistries	Light-curable adhesives, Multi-Cure® adhesives, moisture-cure adhesives, 2-part epoxies

Masking Materials	
Application Use	Protection during surface treatment and manufacturing processes
Industries	Aerospace, automotive
Chemistries	Light-curable resins, Multi-Cure® resins

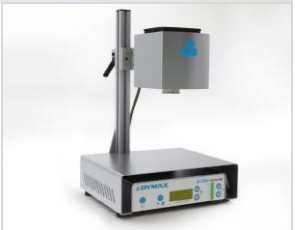
Gaskets	
Application Use	Moisture barrier, vibration resistance, noise reduction
Industries	Appliance, automotive, aerospace, solar, fuel cell, alternative energy
Chemistries	Light-curable resins

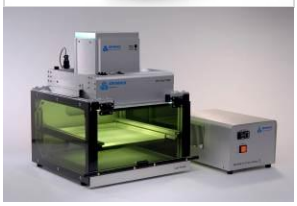
Curing and Dispensing Equipment

DYMAX offers a wide range of curing equipment including spot lamps, flood lamps, conveyor systems, radiometers, and other accessories**.** Since DYMAX designs and manufactures its own systems, lamps and adhesives are optimized to work together to gain process efficiencies by targeting rapid surface curing, depth of cure, and speed of cure, all while delivering light in a rapid and economical way. CE marked equipment is available.

Light-Emitting Spot Lamps

Spot lamps provide a variety of methods to deliver light to a very precise location. They can be used manually by an operator or incorporated into a high-speed automated assembly line. Spot lamps are ideal for fast, deep curing of adhesives, potting materials, and gaskets.





- ### Light-Emitting (Bulb) – Spot Lamps

  Multi-spectrum light-emitting lamps use high-pressure mercury vapor bulbs that, when ignited, produce light energy in the 300 to 450 nm range. These spot lamps can be equipped with single or multiple-pole lightguides or rod lenses for a variety of curing options.

- ### Light-Emitting Diode (LED) Curing Equipment – Spot Lamps

  These lamps generate UV-curing light using an array of surface-mounted LEDs instead of traditional metal halide or mercury bulbs. LED curing units emit over 15,000 mW/cm^2 of UV light (centered at 385 nm). These units offer cooler cures compared to traditional bulb-style lamp systems. They emit light over a narrow spectrum at a discreet wavelength and offer longer periods between maintenance due to longevity of the LED array. There are no bulbs to change and no warm-up; just cool cures and constant intensity for thousands of hours.

Light-Emitting Flood Lamps

Static flood-lamp systems are suited for area curing or for curing multiple assemblies. They use moderate to high-intensity multi-spectrum UV/Visible light for the fast curing of adhesives, coatings, potting materials, and gaskets. Stand-alone modular flood-lamp systems consist of a power supply, reflector housing, and standard 400-Watt metal halide bulb. Light-curing flood lamps can be easily integrated into existing manufacturing processes by mounting the lamps above high-speed assembly lines for cures in 5-30 seconds. Shutter assemblies, mounting stands, and shields are available to create a custom curing system.

Curing and Dispensing Equipment

Light-Emitting Conveyors

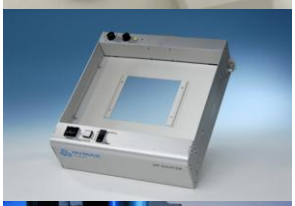
Conveyor systems consist of a moving belt that passes through a curing tunnel with multi-spectrum lamps mounted from above or on each side for fast curing of parts. These conveyor systems are designed to offer consistent, fast, and safe curing of adhesives, coatings, potting materials, and gaskets. They can be outfitted with standard metal halide (longwave UV), mercury (shortwave UV), or visible bulbs. Consistent line speed, lamp height, and intensity provide a consistent light-curing process for high throughput.

For more information on how light-curing systems work, please reference DYMAX literature LIT010AEU “Guide to Selecting and Using DYMAX UV Light-Curing Systems”.

Radiometers

Measurement of the lamp intensity and dosage is critical to the successful implementation of light-curing technology. DYMAX radiometers allow operators to monitor and document the light-curing process. A low UV/Visible measurement signals an operator to replace the bulb, reflector, or lightguide. Radiometers can also be used to confirm that operators are properly shielded from UV/Visible light exposure. Degradation of curing bulbs, lightguides, and reflectors can decrease intensity, resulting in incomplete cures.

- *UV radiometers measure UV-A (320-395 nm) intensity*
- *Visible radiometers measure the blue portion of the visible spectrum (395 to 465 nm).*
- *LED radiometers are optimized to measure spectral output in the 350-450 nm range*



Accessories

A wide variety of accessories, such as shields, stands, and shutters, exist for mounting or modifying lamps.

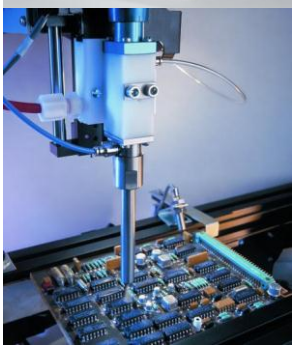


Photo courtesy of Asymtek

Dispensing Systems

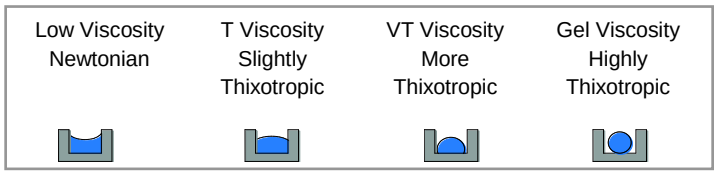
DYMAX offers a wide range of dispensing equipment including precision valves, electro-pneumatic dispensers and controllers, filling equipment, and fluid packaging systems. From complete systems to individual components and accessories, our products are ideal for use with many low-to-high viscosity materials including adhesives, pastes, solvents, and lubricants.

Reference Tables

Tables on the next two pages are useful for additional information about the DYMAX adhesives in this guide.

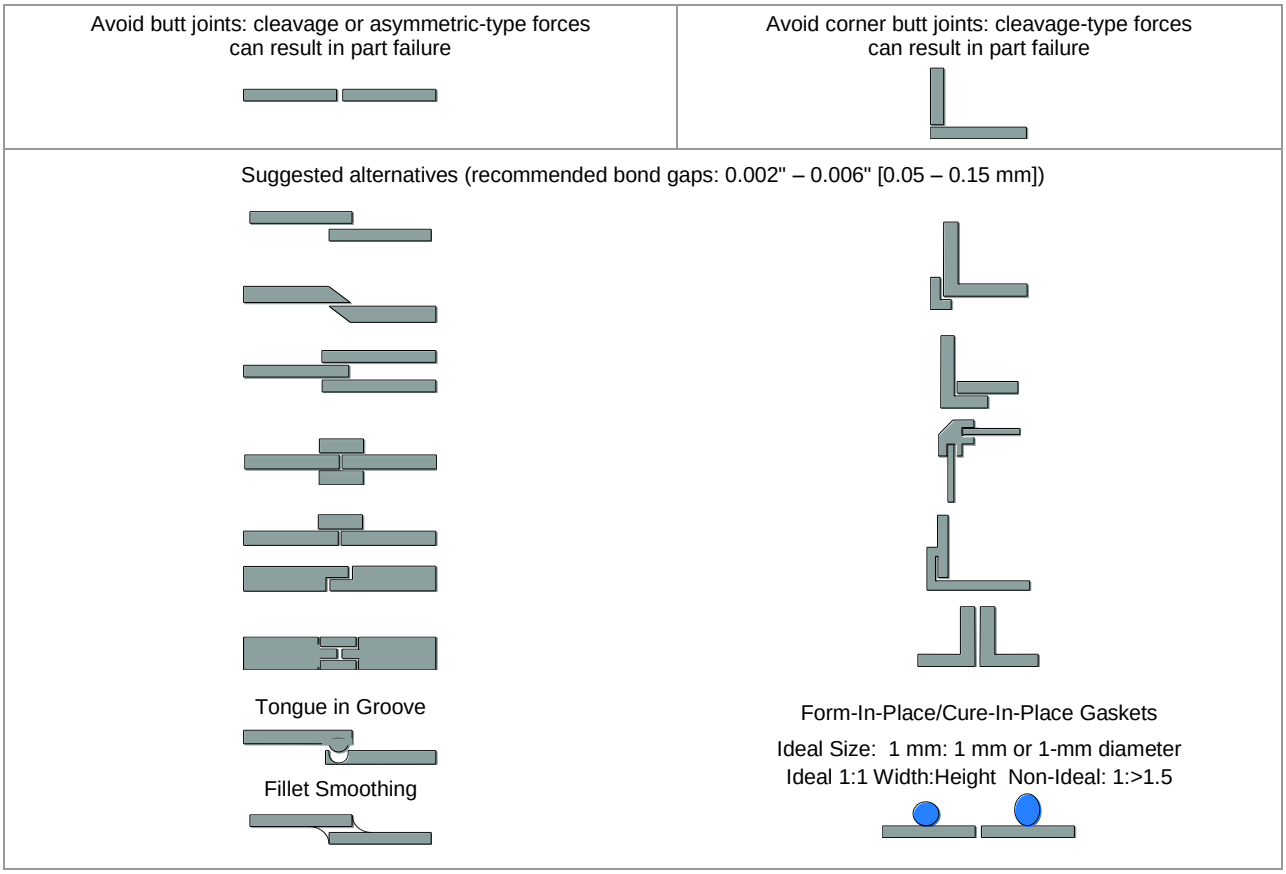
Viscosity

In choosing a viscosity, a material's resistance to flow, consideration should be given to how the adhesive must flow (or not flow) on the part after the adhesive is applied. Low-viscosity adhesives flow more readily than high-viscosity adhesives. Thixotropic gels flow very slowly and are recommended when adhesive flow must be minimized after dispensing onto a part. Part geometry, process design, and assembly speed and method should all be considered when selecting a viscosity.



DYMAX adhesives are available in a variety of viscosities. The identifiers appear as suffixes on product names: VLV = Very Low Viscosity, LV = Low Viscosity, T = Thick, VT = Very Thick, Gel = GEL. Standard viscosity products do not have a suffix.

Typical Centipoise (cP/mPaS)	Typical Reference Liquids at 20°C
1	Water
10	Kerosene
110	SAE 10 Oil
200	Maple Syrup
440	SAE 30 Oil
1,100	Castor Oil
3,000	Honey
10,000	Molasses
18,000	Chocolate Syrup
65,000	Vaseline
100,000	Sour Cream
200,000	Peanut Butter
1,500,000	Shortening



Reference Tables

Volume

Dots:
Volume of a dot is ½ the volume of a sphere V = .2618d^3

Volume (µL)	.1	.5	1	5	10	25
Volume (mL)	.0001	.0005	.001	.005	.010	.025
Diameter (mm)	.73	1.24	1.56	2.67	3.37	4.57
Diameter (in)	.029	.049	.061	.103	.133	.180

Production Throughput Planner

1 Piece Every…	Pieces Per Minute	Pieces Per Hour	Pieces Per Day (8 Hours)	Pieces Per Week (40 Hours)	Pieces per month (21 Days)	Pieces per year (50 Weeks)
0.5 second	120	7,200	57,600	288,000	1,209,600	14,400,000
1 second	60	3,600	28,800	144,000	604,800	7,200,000
5 seconds	12	720	5,760	28,800	120,960	1,440,000
10 seconds	6	360	2,880	14,400	60,480	720,000
30 seconds	2	120	960	4,800	20,160	240,000
1 minute	1	60	480	2,400	10,080	120,000
5 minutes	-	12	96	480	2,016	24,000
10 minutes	-	6	48	240	1,008	12,000
30 minutes	-	2	16	80	336	4,000
1 hour	-	1	8	40	168	2,000

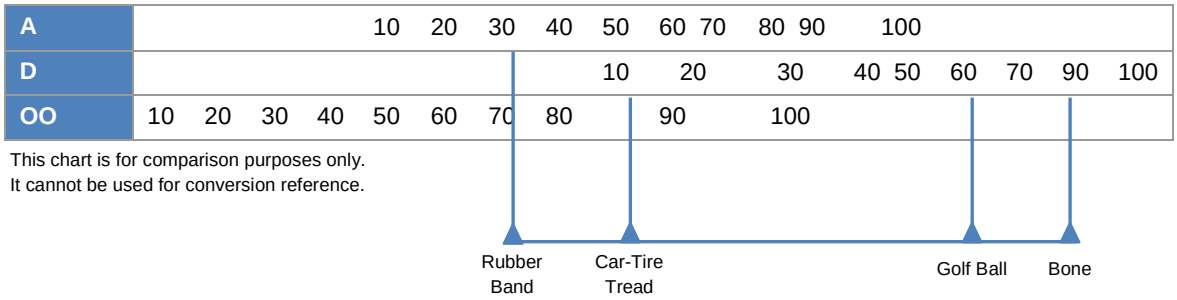
Estimating Usage

Thickness of the Bond-Line Gap or Coating	Theoretical Area Covered by 1 Liter of Adhesive or Coating
0.002" (51 µm)	30,500 in^2 (212 ft^2) (19.7 m^2)
0.005" (127 µm)	12,200 in^2 (84.7 ft^2) (7.88 m^2)
0.010" (254 µm)	6,100 in^2 (42.4 ft^2) (3.94 m^2)
0.015" (381 µm)	4,070 in^2 (28.3 ft^2) (2.63 m^2)

Bead Size	Theoretical Usage (Length per Liter)
1/32" (.79 mm)	66,300 in (1,684 m)
1/16" (1.6 mm)	16,600 in (422 m)
3/32" (2.4 mm)	7,400 in (188 m)
1/8" (3.2 mm)	4,100 in (104 m)
3/16" (4.8 mm)	1,900 in (48 m)
1/4" (6.4 mm)	1,000 in (25.4 m)

Reference Tables

Hardness Chart



This chart is for comparison purposes only.
It cannot be used for conversion reference.

Substrate Abbreviation Chart

Substrate Abbreviation and Polymer Name	
Plastic Substrates	
ABS acrylonitrile-butadiene-styrene	**PS** polystyrene
CAP cellulose acetate propionate	**PSU** polysulfone
COPE copolyester thermoplastic elastomer	**PU** polyurethane
EVA ethylene vinyl acetate	**PVC** poly(vinyl chloride)
PA polyamide	**SAN** styrene-acrylonitrile
PBT polybutylene terephthalate	**TPU** thermoplastic polyurethane
PC polycarbonate	**Metal, Glass, Ceramic, & Other Substrates**
PC/ABS Blend of PC and ABS	**AL** aluminum
PC/PCTG Blend of PC and PCTG	BRASS
PCTG poly(cyclohexylene dimethylene terephthalate)glycol	**CER** ceramic
PE polyethylene	**CO** cobalt
PEBA polyether block amide	**FR-4** epoxy fiberglass, FR-4 circuit board
PEEK polyetheretherketone	**GL** glass
PEI polyetherimide	LEAD FRAME
PET poly(ethylene terephthalate)	NICKEL ALLOYS
PETG poly(ethylene terephthalate)glycol	**PCB** printed circuit board
PI polyimide	**SI** Silicone
PMMA poly(methyl methacrylate)	**SS** stainless steel
PP polypropylene	STEEL
PPO poly(phenylene oxide)	**TI** titanium

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