

See-Cure Adhesives Selector Guide



SEE IT CURE

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See-Cure Technology



See It Cure

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

See it Cure from **Blue to Clear**



Frequently Asked Questions

Q. What is See-Cure?

A. See-Cure is a 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 Application 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



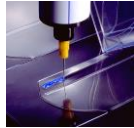




Product	Applications	Description	Nominal Viscosity cP (20 rpm)	Durometer Hardness	Tensile at Break, MPa [psi]	Elongation at Break, %
Catheter Bonding Medical Device Adhesives						
211-CTH-SC	<ul style="list-style-type: none"> Y-Connector Assembly Tubing Connectors Balloon Bonding Catheter Assembly Needle 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
212-CTH-UR-SC	<ul style="list-style-type: none"> Marker Band Adhesive Catheter Assembly 	LED-curable marker-band adhesive. Formulated with Ultra-Red™ technology; moisture resistant.	10,000	D62	18 [2,600]	185
215-CTH-UR-SC	<ul style="list-style-type: none"> Balloon/Lumen Hub/Lumen Marker Band Adhesive Manifold Bong Joints 	LED-curable bonding and assembly adhesive. Formulated with new Encompass™ technology that combines exclusive Ultra-Red™ and See-Cure technologies.	20,000	D53	15.1 [2,200]	360
Multi-Purpose Medical Device Adhesives						
1201-M-SC	<ul style="list-style-type: none"> 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	<ul style="list-style-type: none"> 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	<ul style="list-style-type: none"> 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	<ul style="list-style-type: none"> 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	<ul style="list-style-type: none"> 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	<ul style="list-style-type: none"> 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	<ul style="list-style-type: none"> 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

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	212-CTH-JR-SC	215-CTH-JR-SC	1201-M-SC	1201-M-T-SC	1201-M-GEL-SC	1202-M-SC	1204-M-SC	1205-M-SC	1206-M-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										●
PL		●								
SS		●					○			●

Typical Applications

Medical Device Adhesives		Industrial Adhesives		Masking Resins	Edgebond Adhesives	Form-In-Place Gaskets
						
Needle 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						
3220-SC	<ul style="list-style-type: none"> ■ 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	<ul style="list-style-type: none"> ■ 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
3221-SC	<ul style="list-style-type: none"> ■ 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	<ul style="list-style-type: none"> ■ 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	<ul style="list-style-type: none"> ■ 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	<ul style="list-style-type: none"> ■ 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
SPEEDMASK® Resins for Surface Protection						
726-SC	<ul style="list-style-type: none"> ■ Plating & Powder Coating ■ Decorative Etching & Anodizing ■ Part Handling & Grit Blasting ■ Air Plasma Spray 	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						
9309-SC	<ul style="list-style-type: none"> ■ Reinforcing Fine Pitch or Leadless Components on PCB ■ Shock Absorption ■ Underfill Replacement 	UV/Visible light-curable BGA, CSP reinforcement adhesive. Highly thixotropic for optimal placement and wetting of components.	42,500	D60	16 [2,300]	100
9422-SC	<ul style="list-style-type: none"> ■ Reinforcing Fine Pitch or Leadless Components on PCB ■ Shock Absorption ■ Underfill Replacement 	Light-curable BGA, CSP reinforcement adhesive. No VOCs; fast, room-temperature cure.	38,000	D50	16 [2,300]	170
9422-T-SC	<ul style="list-style-type: none"> ■ Reinforcing Fine Pitch or Leadless Components on PCB ■ Shock Absorption 	Light-curable reinforcement adhesive. No VOCs; fast, room-temperature cure.	8,000	D50	16 [2,300]	170
Form-in-Place Gasket						
GA-140-SC	<ul style="list-style-type: none"> ■ Fuel Cells ■ Automotive Door Handles ■ Appliance Housings ■ Critical Electronic Assemblies 	Light-curable, form-in-place gasket. Moisture and chemical resistant; tack free; 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										
	3220-SC	3220-GEL-SC	3221-SC	3223-SC	3224-SC	3225-T-SC	726-SC	9309-SC	9422-SC	9422-T-SC	GA-140-SC
Plastic											
ABS	●	●	●	●	●	●					●
CAP				●		●					
EVA					●						
PA	○	○	●	●		●					●
PBT				●							
PC	●	●	●	●	●	●					●
PC/ABS				●		●					
PC/PCTG				●	●	●					
PCTG				●		●					
PE				ST							
PEBA	●	●									
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							●				

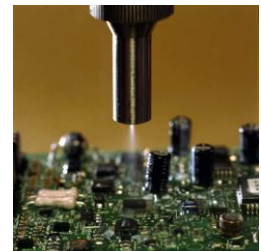
Types of Applications for Dymax Products

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:

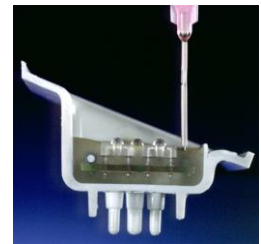
Adhesives	
Application Use	Bonding glass, plastic, metal, and ceramic
Industries	Appliance, aerospace, automotive, solar, alternative energy
Chemistries	Light-curable adhesives, Multi-Cure® adhesives, activator-cured acrylics, 2-part epoxies



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

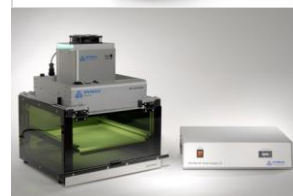
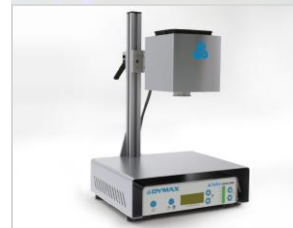
Multi-spectrum light-emitting lamps use high-pressure mercury vapor bulbs that, when ignited, produce light energy in the 300 to 450 nm range. These spot lamps can be equipped with single- or multiple-pole lightguides or rod lenses for a variety of curing options.

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/cm² 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 discrete 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 LIT010A "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.

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.

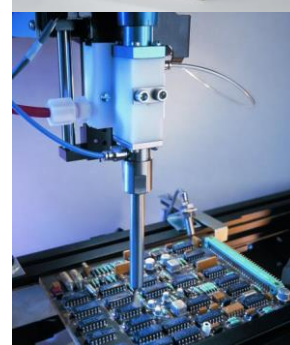
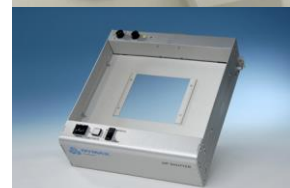


Photo courtesy of Asymtek

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.

Low Viscosity Newtonian	T Viscosity Slightly Thixotropic	VT Viscosity More Thixotropic	Gel Viscosity Highly Thixotropic

Typical Centipoise (cP/mPa)	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

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.

Avoid butt joints: cleavage or asymmetric-type forces can result in part failure 	Avoid corner butt joints: cleavage-type forces can result in part failure 
Suggested alternatives (recommended bond gaps: 0.002" – 0.006" [0.05 – 0.15 mm])	
       <p data-bbox="368 1794 568 1827">Tongue in Groove</p>  <p data-bbox="368 1861 568 1895">Fillet Smoothing</p> 	      <p data-bbox="938 1794 1302 1827">Form-In-Place/Cure-In-Place Gaskets</p> <p data-bbox="938 1827 1302 1861">Ideal Size: 1 mm: 1 mm or 1-mm diameter</p> <p data-bbox="938 1861 1302 1895">Ideal 1:1 Width:Height Non-Ideal: 1:>1.5</p> 

Reference Tables

Volume

Dots:

Volume of a dot is 1/2 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

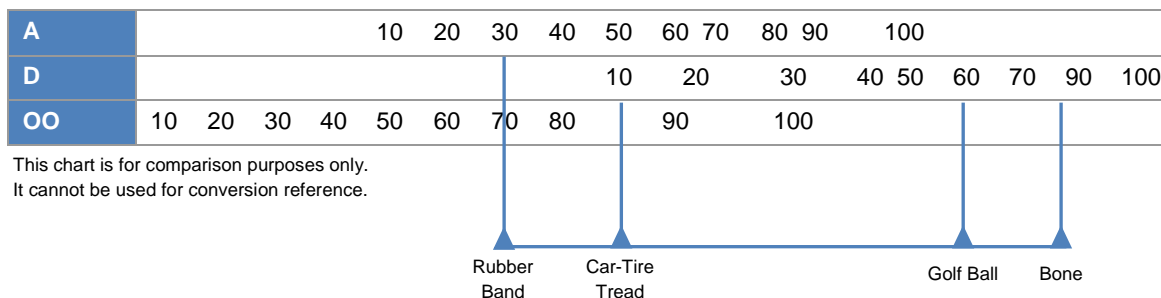
Estimating Usage

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



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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