

Industrial Adhesives Selector Guide



DYMAX Glass, Metal, and Plastic Adhesives for Alternative Energy, Appliance, Aerospace, and Automotive Assembly



About DYMAX

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

The company was originally 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 improvement to manufacturers of electric motors and were widely used in OEM and manufacturing 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 curing equipment.

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

Our complete line of light-curing systems, which are perfectly matched to our adhesives' chemistry, include 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 is headquartered in Torrington, CT, with more than 200 employees globally, and additional facilities in Germany, China, Hong Kong, and Korea.



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The DYMAX Edge – Making You, Our Customer, More Efficient

DYMAX offers manufacturers complete solutions to optimize the speed and yields of their assembly process:

- **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 consultative services** from the DYMAX Applications Engineering and R&D groups that enable selection of the best combination of bonding materials, curing equipment, and process parameters for the most efficient and robust assembly process.



Table of Contents

How to Use this Guide	4
Technical Consulting	4
Types of Applications for DYMAX Products	5
Adhesives for Plastics – Selector Guide	6
Adhesion Chart for Plastic Substrates	7
Adhesives for Metal and Glass – Selector Guide	8
Adhesion Chart for Metal and Glass Substrates	9
Type of Products	10
Adhesive Chemistries	10-11
Curing and Dispensing Equipment	
Light-Emitting Spot Lamps	12
Light-Emitting Diode (LED) Spot Lamps	12
Light-Emitting Flood Lamps	12
Light-Emitting Conveyors	13
Radiometers	13
Accessories	13
Dispensing Systems	13
Reference Tables	
Viscosity	14
Joint Design	14
Volume	15
Production Throughput Planner	15
Estimating Usage	15
Hardness	15
Substrate Abbreviation Chart	16

How to Use this Guide

DYMAX manufactures a wide range of light-curable materials and equipment that are used in industrial assembly environments around the world. This guide provides an overview of the DYMAX industrial glass, metal, and plastic bonding adhesives used to bond components and sub-assemblies for the appliance, automotive, aerospace, solar, fuel cell, and alternative energy markets.

Selector tables in the guide list glass, metal, and plastic bonding adhesives, their properties (such as viscosity and durometer hardness), and the unique applications for each product. Selector tables detail typical substrates and the bonding capabilities of DYMAX products. Also described in this guide are the types of light-curable products available and their chemistries, as well as compatible light-curing systems. Included for your convenience are useful reference charts and tables.

Choosing an Adhesive

Select the appropriate adhesive for an application as follows:

Step 1. Identify your application using page 5 of this guide. Bonding, potting, coating, or gasketing?

Step 2. Define the particular substrate used in your application. Plastics, metals, glass? Proceed to page 6 for plastics, or page 8 for metals and glass, and select the product category.

Step 3. Specify the particular product properties needed, such as hardness (defined on page 15), viscosity (defined on page 14), tensile, elongation, UL rating, and chemical or environmental resistance. Selector tables in the guide list glass, metal, and plastic bonding adhesives, their properties (such as viscosity and durometer hardness), and the unique applications for each product.

Step 4. Select the DYMAX product that best fits with your specific needs.

Step 5. Find the DYMAX product on the Adhesion Chart (page 7 for plastics, or page 9 for metals and glass) and find the specific substrates you wish to bond. A black dot indicates that proper bonding can be achieved on that substrate. If you are bonding two different substrates together, a black dot for *both* substrates indicates that the selected product will properly bond them together.

Step 6. Define your curing system needs by returning to page 6 or 8 and reviewing the cure options for the selected product.

Step 7. Consult with your local DYMAX representative or DYMAX Applications Engineering to confirm your adhesive selection. Follow by performing functional testing.

Technical Consulting

The Applications Engineering team is available to you to help choose the best combination of adhesives, coatings, sealants, gaskets, and curing systems, as well as full-system integration, to optimize your manufacturing processes.

The Applications Engineering laboratory 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.

DYMAX has a library of 3,000 adhesive formulations already developed to solve manufacturing problems. The Applications Engineering lab is available to engineers who want to visit and work alongside our engineers to evaluate a variety of UV/Visible light-curing spot, flood, and LED lamps, conveyors, and manual and robotic dispensing systems. The lab 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.



Types of Applications for DYMAX Products

DYMAX is a leading 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










Adhesives for Plastics

Adhesives in this table will bond plastics; additional uses are potting and coating.

Product	300-390 nm Light (Spot)	390-500 nm Light (Flood)	LED 385 nm Light	Heat	Activator	Moisture	2-Part Mixture	Also Bonds to Metal	Also Bonds to Glass	Features	Nominal Viscosity cP (20 rpm)	Durometer Hardness	Tensile at Break, MPa [psi]	Elongation at Break, %
... products for bonding														
3013	•	•	•					•		Moisture resistant; resilient	150	D70	18 [2,400]	70
3022	•	•	•							Hybrid acrylated urethane/epoxy for plastic and glass; high strength; tack free	500	D80	47 [6,800]	11
3025	•	•	•					•	•	General purpose	300	D65	17 [2,400]	70
3069	•	•	•							General purpose	450	D55	17 [2,400]	175
3086-T	•	•	•					•	•	UL-94V0 rated	6,700	D85	50 [7,250]	4
3099	•	•	•						•	Excellent glass, polycarbonate, and PMMA bonder	150	D75	19 [2,800]	170
3221-SC	•							•	•	General purpose; See-Cure technology	300	D55	12 [1,700]	220
MR290						•				Cyanoacrylate; resists moisture, humidity, & extreme temperatures	250-350	N/A	N/A	<2
RX50						•		•		Cyanoacrylate; rapid curing; high-performance grade	30-70	N/A	N/A	<2
... form-in-place/cure-in-place gaskets														
GA-105	•							•		Gel form-in-place gasket; soft and sticky	40,000	00-70	1.3 [190]	140
GA-140	•							•		Gel form-in-place gasket; tack free; low outgassing; resists moisture and chemicals	39,000	A35	1.5 [211]	167
... products for potting														
3-20796	•	•								Flexible; fast, deep curing	3,200	D40	15 [2,200]	500
... products for coating														
9-20557	•	•		•						Flexible for thermal cycling; MIL/IPC/UL recognized	2,500	D60	20 [3,000]	120
9481	•	•	•			•		•	•	Dual-Cure; light/moisture-cure conformal coating	125	D75	22 [3,200]	4

Typical Applications

						
Touch Screen Displays, Heads-Up Displays	<u>White Appliances:</u> Control Panels, Displays, Circuit Boards, Electrical	Side-Mounted Lights and Turn Signals	<u>Power Tools:</u> Circuitry, Control Panels, Electrical, Bodies, Motors	Motor and Magnet Assembly	<u>Household Appliances:</u> Housing, Electrical, Control Panels, Circuitry	Rearview Mirror Attachment

Adhesion Chart for Plastic Substrates

This table shows adhesives from the previous page that are suggested for bonding with the following substrates.

• = Recommended adhesive

ST = Surface treatment required in addition to adhesive (plasma, corona, UV, chemical, etc.)

Bonds These Substrates	Adhesives													
	3013	3022	3025	3069	3086-T	3099	3221-SC	MR290	RX50	GA-105	GA-140	3-20796	9-20557	9481
Plastic Substrates														
ABS	•	•	•	•	•	•	•	•	•	•	•	•	•	•
CAP	•			•	•	•				•	•	•	•	•
HDPE/LDPE	ST	ST	ST	ST	ST	ST	ST	ST	ST	ST	ST	ST		ST
PA 6-6	•	•	•	•	•	•	•	•	•	•	•	•	•	•
PC	•	•	•	•	•	•	•	•	•	•	•	•		•
PC/ABS	•	•	•	•		•	•			•	•			
PC/PCTG	•	•	•	•	•	•	•			•	•			
PCTG	•			•	•	•				•	•	•		•
PEEK	•									•	•	•	•	•
PEI		•	•	•	•	•	•			•	•	•		•
PET	•	•	•	•		•	•			•	•	•	•	
PETG		•	•	•		•	•			•	•	•	•	
PI	•	•	•	•	•	•	•			•	•	•		
PMMA	•	•	•	•	•	•	•	•		•	•	•		•
PP	ST	ST	ST	ST	ST	ST	ST			•	•	ST		ST
PPO				•	•	•				•	•	•	•	•
PS	•	•	•	•	•	•	•			•	•	•		
PU	•	•	•	•	•	•	•			•	•	•		
PVC rigid	•	•	•	•	•	•	•	•	•	•	•	•	•	
PVC flexible	•	•	•	•	•	•	•	•	•	•	•	•	•	
SAN	•	•	•		•	•	•			•	•	•		•
TPU	•	•	•	•		•	•			•	•	•		
Bonds These Other Substrates (metals, ceramics, glass)														
ALUMINUM T3		•	•	•			•	•	•	•	•	•	•	
ALUMINUM 2024		•	•	•			•	•	•	•	•	•	•	
BRASS							•	•	•	•	•	•		
CERAMIC	•	•	•	•		•	•	•				•	•	•
C.R. STEEL								•	•	•	•		•	
COPPER								•	•	•	•	•	•	
FR-4		•	•	•	•	•	•	•	•	•	•	•	•	•
GLASS		•	•	•	•	•	•	•	•			•	•	
STAINLESS STEEL 13	•	•	•				•	•	•	•	•	•	•	
STAINLESS STEEL 304	•	•	•				•	•	•	•	•	•	•	

Adhesives for Metal and Glass

Adhesives in this table will bond metals and glass; additional uses are potting and thread locking.													
Product	300-390 nm Light (Spot)	390-500 nm Light (Flood)	LED 385 nm Light	Heat	Activator	Moisture	2-Part Mixture	Also Bonds to Plastic	Features	Nominal Viscosity cP (20 rpm)	Durometer Hardness	Tensile at Break, MPa [psi]	Elongation at Break, %
... products for bonding													
425	•								Clear; high strength; dishwasher safe	4,000	D80	43 [6,200]	7
429	•								Clear; low yellowing with UV exposure; high strength; resilient	2,500	D60	21 [3,000]	120
4-20418	•	•	•					•	Clear; low stress for glass bonding and laminating	450	D60	11.4 [1,650]	130
6-621	•	•	•	•	•			•	Multi-Cure [®] ; tough and resilient for interfacial and potting applications	800	D80	14 [2,100]	180
6-625 SV01-Rev A	•	•	•	•	•				Flexible; low stress; bridge bonding; no gap; structural reinforcement of spring clips; for chokes, ferrite cores, and transformers	10,000	D50	23 [3,400]	26
846-GEL				•	•				High-performance and high-strength structural adhesive; fixes < 60 seconds with 501-E activator; full cure 24 hours; also cures at 50°C for 15 minutes; free of acrylic acid, non-corrosive; for E-cores, ferrite, motor housings, and applications needing impact/shock resistance	30,000	N/A	N/A	N/A
8-20626				•	•				High-viscosity; epoxy structural adhesive; induction cure; black; fixes in 3 seconds/1.5 kW or 8 mins/180°C; for DC motors, magnet-to-can, and inconsistent gaps	110,000	D85	55 [8,000]	2
... form-in-place/cure-in-place gaskets													
GA-108	•							•	Form-in-place; soft/sticky; black	45,000	00-65	0.4 [63]	200
GA-111	•							•	Moisture and chemical resistant; form-in-place; no tack; black	40,000	A40	1.0 [140]	140
GA-120	•							•	Soft/tacky; self-leveling viscosity; low-durometer resin; quick curing; no silicone/solvents	1,000	00-50	0.14 [20]	110
GA-140	•							•	Soft; no tack; clear; low outgassing; quick curing; no silicone/solvents; conforms to intricate recesses; resists tears	39,000	A35	1.5 [211]	167
... products for potting													
ER1196/ CT1196							•	•	2-part epoxy; flexible; long pot life	Resin: 15,500 Catalyst: 6,000	D60	5.7 [820]	19

Adhesion Chart for Metal and Glass Substrates

This table shows adhesives from the previous page that are suggested for bonding with the following substrates.

• = Recommended adhesive

ST = Surface treatment required in addition to adhesive (plasma, corona, UV, chemical, etc.)

Bonds These Substrates	Adhesives											
	425	429	4-20418	6-621	6-625-SV01 Rev A	846-GEL	8-20626	GA-108	GA-111	GA-120	GA-140	ER1196/CT1196
Metal Substrates												
ALUMINUM T3	•	•	•	•	•	•	•	•	•	•	•	•
ALUMINUM 2024	•	•	•	•	•	•	•	•	•	•	•	•
BRASS	•		•	•	•	•	•	•	•	•	•	•
COPPER	•			•	•	•	•	•	•	•	•	•
C.R. STEEL	•	•	•	•	•	•	•	•	•	•	•	•
FR-4	•	•		•	•	•		•	•	•	•	•
STAINLESS STEEL 13	•	•		•	•	•	•	•	•	•	•	•
STAINLESS STEEL 304	•	•		•	•	•	•	•	•	•	•	•
Bonds These Other Substrates (plastics, ceramics, glass)												
ABS	•	•	•	•	•			•	•	•	•	•
CAP	•		•	•				•	•	•	•	•
CERAMIC	•			•	•	•						•
GLASS	•	•	•	•	•	•	•					•
HDPE/LDPE	ST	ST	ST	ST	ST	ST	ST	ST	ST	ST	ST	ST
PA/6-6			•	•	•			•	•	•	•	•
PC			•	•				•	•	•	•	•
PC/ABS								•	•	•	•	•
PC/PCTG								•	•	•	•	•
PCTG			•	•	•			•	•	•	•	•
PEEK	•		•					•	•	•	•	•
PEI			•	•				•	•	•	•	•
PET			•	•	•			•	•	•	•	•
PETG			•					•	•	•	•	•
PI			•	•	•			•	•	•	•	•
PMMA	•		•	•				•	•	•	•	•
PP	ST	ST	ST	ST	ST	ST	ST	ST	ST	ST	ST	•
PPO			•					•	•	•	•	•
PS			•					•	•	•	•	•
PU				•	•			•	•	•	•	•
PVC rigid	•	•	•	•	•			•	•	•	•	•
PVC flexible		•	•	•	•			•	•	•	•	•
SAN		•	•	•				•	•	•	•	•
TPU		•	•					•	•	•	•	•

Types of DYMAX Products

DYMAX offers the following chemistries:

- Light-Curable Acrylated Urethanes
- Multi-Cure[®] Activator- or Heat-Cured Acrylated Urethanes
- Moisture-Cure Materials
- UV Light-Curable Epoxies
- Two-Part Epoxies
- Cyanoacrylates
- Heat-Curable Epoxies

Adhesive Chemistries

Light-Curable Acrylated Urethanes (Light Weld[®] and Ultra Light-Weld[®])

These one-component adhesives cure with light in seconds using either ultraviolet or ultraviolet/visible light. They are available in a range of different viscosities, with a variety of physical properties, and with adhesion to various substrates. Acrylated urethanes can be used in applications ranging from furniture assembly to decoration to electronics for industries including appliance, automotive, and aerospace.



Multi-Cure[®] Acrylated Urethanes

These one-component acrylic adhesives combine the high-speed cure of UV or UV/Visible light with secondary cure mechanisms that enhance polymerization. Secondary cure mechanisms, which include thermal (heat) cure or activator cure, are useful when light can only reach a portion of the bond line, or when tacking a part prior to thermal cure to allow easier handling and transport during the manufacturing process.



Dual-Cure Light/Moisture-Cure Adhesives and Coatings

Dual-Cure coatings are formulated to ensure complete cure in applications where shadowed areas on high-density circuit boards are a concern. Previously, areas shadowed from light were managed by selective coating - eliminating the need to cure in shadowed areas - or a secondary heat-cure process. Shadowed areas cure over time with moisture, eliminating the need for that second process step or concerns of component life degradation due to temperature exposure.



Adhesive Chemistries

One-Component Light-Curable Epoxy Adhesives

One-component epoxy adhesives cure with UV/Visible light in seconds to polymerize fully. The materials provide both chemical and high thermal temperature resistance. These materials work best in thin films or bond lines and become tackless (more easily) under both UV and visible light. One-component epoxy systems do not require freezing or thawing.

Two-Component Epoxy Adhesives

Two-component epoxy adhesives require mixing to cure the material, with accelerated cure possible with thermal exposure. When a two-part epoxy resin is mixed with the appropriate catalyst, the resulting reaction is exothermic, a chemical reaction that results in the release of heat. Epoxy resins are made of tightly linked adhesive polymer structures that are often used in surface adhesives and coatings and are characterized by toughness and low shrinkage.

Epoxy resins are nearly unmatched in heat and chemical resistance and provide excellent adhesion and component protection. They are ideal for potting, casting, encapsulating, and a wide variety of structural and electronic bonding applications. DYMAX epoxies adhere well to metal, glass, plastics, and ceramics.

High-Performance Cyanoacrylates

These one-component instant-cure adhesives bond many different substrates upon contact. They exhibit fast cure and high tensile strength. They are available in low-odor/low-bloom, rubber-toughened, surface-insensitive, and high-temperature grades. DYMAX cyanoacrylates replace many different grades of both methyl and ethyl cyanoacrylates due to their ability to adhere to a wide selection of substrates including polycarbonate, polyimide, PVC, PEEK, PETG, polysulfone, SAN, ceramic, glass, latex, graphite, stainless steel, and opaque and difficult-to-bond-to substrates.

For more information on how light-curable materials work, please reference DYMAX literature LIT008 "Comprehensive Guide to Light-Curable Materials".

Curing and Dispensing Equipment

DYMAX offers a wide range of curing equipment including various spot lamps, flood lamps, and conveyor systems, as well as radiometers and other accessories. Since DYMAX designs and manufactures its own lamp systems, the lamps are optimized to work with the adhesives 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 wide 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 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.

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 a 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

Our Applications Engineering lab can assist manufacturers with integrating the appropriate manual and robotic dispensing systems into their production lines.

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

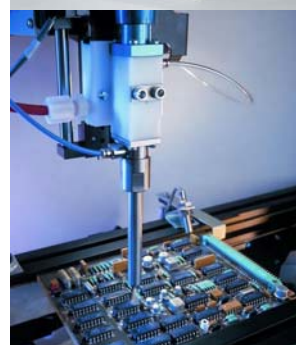
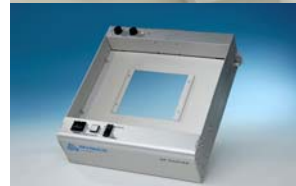


Photo courtesy of Asymtek

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

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

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

Importance of Joint Design

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

Reference Tables

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

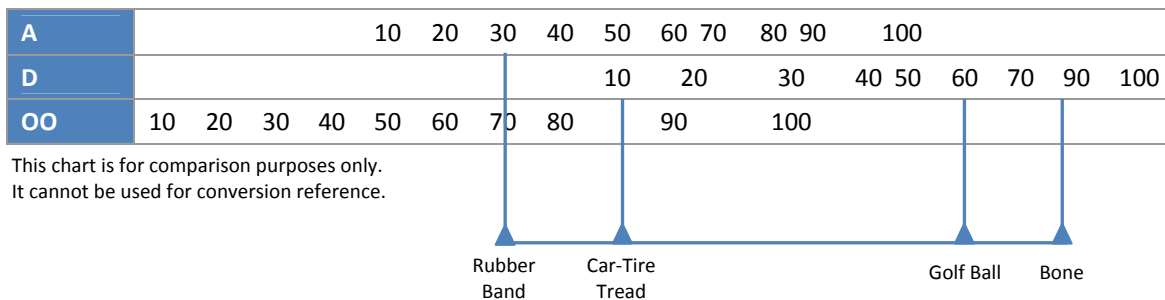
1 Piece Every...	Pieces Per Minute	Pieces Per Hour	Pieces Per Day (8 Hours)	Pieces Per Week (40 Hours)	Pieces per month (21 Days)	Pieces per year (50 Weeks)
0.5 second	120	7,200	57,600	288,000	1,209,600	14,400,000
1 second	60	3,600	28,800	144,000	604,800	7,200,000
5 seconds	12	720	5,760	28,800	120,960	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)

Hardness Chart



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

Substrate Abbreviation and Polymer Name	
Plastic Substrates	
ABS acrylonitrile-butadiene-styrene	PS polystyrene
CAP cellulose acetate propionate	PU polyurethane
HDPE high density polyethylene	PVC rigid poly(vinyl chloride)
LDPE low density polyethylene	PVC flexible poly(vinyl chloride)
PA/6-6 Polyamide	SAN styrene-acrylonitrile
PC polycarbonate	TPU thermoplastic polyurethane
PC/ABS Blend of PC and ABS	Metal, Glass, Ceramic, & Other Substrates
PC/PCTG Blend of PC and PCTG	AL ALUMINUM T3
PCTG poly(cyclohexylene dimethylene terephthalate)glycol	AL ALUMINUM 2024
PEEK polyetheretherketone	BRASS
PEI polyetherimide	CER ceramic
PET poly(ethylene terephthalate)	C.R. STEEL
PETG poly(ethylene terephthalate)glycol	COPPER
PI polyimide	FR-4 Epoxy Fiberglass, FR-4 Circuit Board
PMMA poly(methyl methacrylate)	GL glass
PP polypropylene	SS STAINLESS STEEL 13
PPO poly(phenylene oxide)	SS STAINLESS STEEL 304

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