



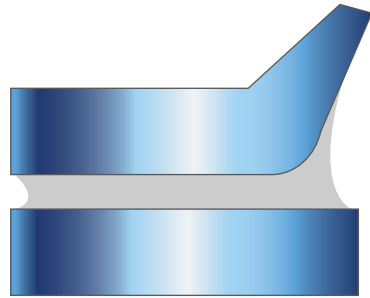
ELLSWORTH
ADHESIVES

TECHNICAL BULLETIN

ADHESIVE APPLICATION GUIDE

Adhesives vs. Stress

When considering the proper selection of an adhesive, one needs to carefully examine all factors. One of the most important considerations is the type of stress the adhesive will have to withstand. Stress is the force pulling bonded materials apart. The basic type of stresses are illustrated below.



Peel Stress

In order for peel stress to occur, at least one of the substrates must be flexible. The stress occurs as the flexible substrate is being peeled or lifted away.



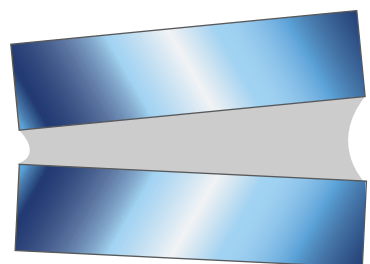
Shear Stress

As two bonded substrates are being forced to slide over each other, shear stress occurs. The stress direction is parallel to the adhesive. As shear stress occurs, the ends of the bond resist a greater amount of the stress than the middle of the bond.



Tensile Stress

This type of stress exerts an equal force over the entire joint. The direction of tensile stress is straight and apart from the adhesive bond (elongation of the object can occur with this type of stress).



Cleavage Stress

This type of stress is concentrated at one end of a joint and occurs when a prying force is placed on the adhesive bond.



Compressive Stress

Compressive stress occurs when two substrates are squeezed or pressed together.

Area

1 Sq. Inch = 0.00694 Sq. Feet
 1 Sq. Inch = 2.491 x 10⁽⁻¹⁰⁾ Sq. Miles
 1 Sq. Inch = 1 x 10⁽⁶⁾ Sq. Mils
 1 Sq. Inch = 645.16 Sq. Millimeters
 1 Sq. Inch = 6.4516 Sq. Centimeters
 1 Sq. Inch = 0.000645 Sq. Meters

1 Sq. Foot = 144 Sq. Inches
 1 Sq. Foot = 0.111 Sq. Yards
 1 Sq. Foot = 2.2957 x 10⁽⁻⁵⁾ Acres
 1 Sq. Foot = 3.58701 x 10⁽⁻⁸⁾ Sq. Miles
 1 Sq. Foot = 929.03 Sq. Centimeters
 1 Sq. Foot = 0.0929 Sq. Meters

1 Sq. Miles = 2.78784 x 10⁽⁷⁾ Sq. Feet
 1 Sq. Miles = 3.098 x 10⁽⁶⁾ Sq. Yards
 1 Sq. Miles = 640 Acres
 1 Sq. Miles = 258.999 Hectares
 1 Sq. Miles = 2,589,988 Sq. Meters
 1 Sq. Miles = 2.58999 Sq. Kilometers

1 Sq. Millimeter = 0.00155 Sq. Inches
 1 Sq. Millimeter = 1.076 x 10⁽⁻⁵⁾ Sq. Feet
 1 Sq. Millimeter = 1,973.5 Circular Mils
 1 Sq. Millimeter = 1.2732 Circular Millimeters
 1 Sq. Millimeter = 0.01 Sq. Centimeters
 1 Sq. Millimeter = 1 x 10⁽⁻⁶⁾ Sq. Meters
 1 Sq. Millimeter = 1.550003 x 10⁽⁹⁾ Sq. Inches

1 Sq. Centimeter = 0.155 Sq. Inches
 1 Sq. Centimeter = 0.001076391 Sq. Feet
 1 Sq. Centimeter = 3.861 x 10⁽⁻¹¹⁾ Sq. Miles
 1 Sq. Centimeter = 155,000 Sq. Mils
 1 Sq. Centimeter = 100 Sq. Millimeters
 1 Sq. Centimeter = 0.0001 Sq. Meters
 1 Sq. Centimeter = 15.50003 Sq. Inches

1 Sq. Meter = 1,550.003 Sq. Inches
 1 Sq. Meter = 10.7639 Sq. Feet
 1 Sq. Meter = 3.861 x 10⁽⁻⁷⁾ Sq. Miles
 1 Sq. Meter = 0.000247 Acres
 1 Sq. Meter = 10,000 Sq. Centimeters
 1 Sq. Meter = 1 x 10⁽⁻⁶⁾ Sq. Kilometers
 1 Acre = 6.27264 x 10⁽⁶⁾ Sq. Inches

1 Sq. Kilometer = 1.07639 x 10⁽⁷⁾ Sq. Feet
 1 Sq. Kilometer = 0.3861 Sq. Miles
 1 Sq. Kilometer = 247.1054 Acres
 1 Sq. Kilometer = 10⁽¹⁰⁾ Sq. Centimeters
 1 Sq. Kilometer = 1 x 10⁽⁶⁾ Sq. Meters

1 Sq. Decimeter = 100 Sq. Centimeters
 1 Sq. Decameter = 119.599 Sq. Yards
 1 Sq. Decameter = 100 Sq. Meters
 1 Sq. Decameter = 0.02471 Acres
 1 Sq. Hectometer = 10,000 Sq. Meters

1 Acre = 43,560 Sq. Feet
 1 Acre = 1.5625 x 10⁽⁻³⁾ Sq. Miles
 1 Acre = 4.04686 x 10⁽⁷⁾ Sq. Centimeters
 1 Acre = 4,046.856421 Sq. Meters
 1 Acre = 4.04686 x 10⁽⁻³⁾ Sq. Kilometers

Energy

1 British Thermal Unit (Btu) = 251.996 Calories (g)
 1 British Thermal Unit (Btu) = 777.649 Foot pound-force
 1 British Thermal Unit (Btu) = 1.0751 x 10⁽⁷⁾ Gram-force cm
 1 British Thermal Unit (Btu) = 0.000393 Horsepower-hours
 1 British Thermal Unit (Btu) = 1,054.35 Joules
 1 British Thermal Unit (Btu) = 0.2520 Kilogram-calories
 1 British Thermal Unit (Btu) = 0.000292875 Kilowatt-hours
 1 British Thermal Unit (Btu) = 1,054.35 Watt-seconds

1 joule (abs) = 0.0009485 British Thermal Unit (Btu)
 1 joule (abs) = 0.23901 Calories (g)
 1 joule (abs) = 0.0003485 Cubic-foot atmosphere
 1 joule (abs) = 0.7376 Foot-pound-force
 1 joule (abs) = 10,197.2 Gram-force centimeter
 1 joule (abs) = 3.7251 x 10⁽⁻⁷⁾ Horsepower-hours
 1 joule (abs) = 2.78 x 10⁽⁻⁷⁾ Kilowatt-hours
 1 joule (abs) = 1 Watt-seconds

Torque

1 Newton-meter = 8.8507 Pound-force inch
 1 Newton-meter = 0.73756 Foot pound-force
 1 Newton-meter = 10197 Gram-force centimeter
 1 Newton-meter = 0.10197 Kilogram-force meter
 1 foot pound-force = 13,825.5 Gram-force centimeters
 1 foot pound-force = 5.0505051 x 10⁽⁻⁷⁾ HP-hours
 1 foot pound-force = 0.13825495 Kilogram-force meter
 1 foot pound-force = 1.3558179 Newton-meters

Force

1 Oz-Force per Sq. Inch = 0.0625 Pound-Force per Sq. Inch	1 lb-Force per Sq. Inch = 0.04448 Joules per cm
1 Oz-Force per Sq. Inch = 9 Pound-Force per Sq. Foot	1 lb-Force per Sq. Inch = 4.44822 Joules per Meter
1 Oz-Force per Sq. Inch = 430.922 Newtons per Sq. Meter	1 lb-Force per Sq. Inch = 0.453592 Kilogram-Force
1 Oz-Force per Sq. Inch = 430.922 Pascals	1 lb-Force per Sq. Inch = 4.44822 Newtons
1 Oz-Force per Sq. Inch = 4.39418 Gram-Force per Sq. cm	1 lb-Force per Sq. Inch = 444,822.166 Dynes

1 Newton = 1.0 Joules per Meter	1 Kg-Force Meter = 7.233 Foot Pound-Force	1 Dyne = 0.0010197 Gram-Force
1 Newton = 0.10197 Kg-Force	1 Kg-Force Meter = 100,000 Gram-Force cm	1 Dyne = 1.02 x 10(-6) Kg-Force
1 Newton = 0.2248089 Lbs-Force	1 Kg-Force Meter = 9.80665 Newton-Meters	1 Dyne = 2.248 x 10(-6) lb-Force
1 Newton = 100,000 Dynes	1 Kg-Force Meter = 0.002724 Watt-Hours	1 Dyne = 0.00001 Newtons

Metric

1 Millimeter (mm) = 1	Millimeter (mm) = .10
1 Centimeter (cm) = 10	Millimeter (mm) = 1
1 Decimeter (dm) = 100	Millimeter (mm) = 10
1 Meter (m) = 1,000	Millimeter (mm) = 100
1 Kilometer (km) = 1,000,000	Millimeter (mm) = 100,000
Centimeter (cm) = .01	Decimeter (dm) = .001 Meter (m)
Centimeter (cm) = .10	Decimeter (dm) = .010 Meter (m)
Centimeter (cm) = 1	Decimeter (dm) = .10 Meter (m)
Centimeter (cm) = 10	Decimeter (dm) = 1 Meter (m)
Centimeter (cm) = 10,000	Decimeter (dm) = 1,000 Meter (m)

Temperature

Degrees Celsius = (Fahrenheit - 32) / 1.8
E.g. 170 °F = 76.6 °C

Degrees Fahrenheit = (1.8 x Celsius) + 32
E.g. 38 °C = 100.4 °F

Mercury Freezes	= -40 °C	= -40 °F
Water Freezes	= 0 °C	= 32 °F
Comfortable Room	= 22 °C	= 68 °F
Human Body	= 37 °C	= 98 °F
Water Boils	= 100 °C	= 212 °F
Baking Oven	= 150 °C	= 302 °F
Lead Melts	= 328 °C	= 622 °F

Length

1 Inch (in) = 25.4 Millimeters (mm)	1 Foot (ft) = 304.8 Millimeters (mm)	1 Yard (yd) = 914.4 Millimeters (mm)
1 Inch (in) = 2.54 Centimeters (cm)	1 Foot (ft) = 30.48 Centimeters (cm)	1 Yard (yd) = 91.44 Centimeters (cm)
1 Inch (in) = 0.0254 Meters (m)	1 Foot (ft) = 0.3048 Meters (m)	1 Yard (yd) = 0.9144 Meters (m)
1 Inch (in) = 0.08333 Feet (ft)	1 Foot (ft) = 3.048 x 10(-4) Kilometers (km)	1 Yard (yd) = 9.144 x 10(-4) Kilometers (km)
1 Inch (in) = 0.0277 Yards (yd)	1 Foot (ft) = 12 Inches (in)	1 Yard (yd) = 36 Inches (in)
1 Inch (in) = 1.578 x 10(-5) Miles	1 Foot (ft) = 0.000189 Miles (Statute)	1 Yard (yd) = 5.682 x 10(-4) Miles (statute)
1 Mile (mi) = 160,934 Centimeters	1 Micron = 1,000 Millimicrons	1 Millimeter (mm) = 39.37 Mils
1 Mile (mi) = 1,609.344 Meters	1 Micron = 0.001 Millimeters (mm)	1 Millimeter (mm) = .01 Centimeters
1 Mile (mi) = 1.609344 Kilometers	1 Micron = 0.0001 Centimeters (cm)	1 Millimeter (mm) = 0.001 Meters
1 Mile (mi) = 63,360 Inches	1 Micron = 1 x 10(-5) Meters (m)	1 Millimeter (mm) = 1 x 10(-6) Kilometers
1 Mile (mi) = 5,280 Feet	1 Micron = 3.937 x 10(-5) Inches (in)	1 Millimeter (mm) = 0.3937 Inches
1 Mile (mi) = 0.8684 Miles (Nautical)	1 Micron = 3.2808 x 10(-6) Feet (ft)	1 Millimeter (mm) = 0.00328 Feet
1 Centimeter (cm) = 393.7 Mils	1 Meter (m) = 39,370.08 Mils	1 Kilometer (km) = 10(+6) Millimeters (mm)
1 Centimeter (cm) = 10 Millimeters (mm)	1 Meter (m) = 1,000 Millimeters (mm)	1 Kilometer (km) = 100,000 Centimeters (cm)
1 Centimeter (cm) = 0.01 Meters (m)	1 Meter (m) = 100 Centimeters (cm)	1 Kilometer (km) = 1,000 Meters (m)
1 Centimeter (cm) = 1 x 10(-5) Kilometers (km)	1 Meter (m) = 0.001 Kilometers (km)	1 Kilometer (km) = 3.937 x 10(+4) Inches (in)
1 Centimeter (cm) = 0.3937 Inches (in)	1 Meter (m) = 39.3701 Inches (in)	1 Kilometer (km) = 3,280.84 Feet (ft)
1 Centimeter (cm) = 0.03281 Feet (ft)	1 Meter (m) = 3.28084 Feet (ft)	1 Kilometer (km) = 1,093.61 Yards (yd)
1 Centimeter (cm) = 0.01094 Yards (yd)	1 Meter (m) = 1.0936 Yards (yd)	1 Kilometer (km) = 0.62137 Miles (mi)
1 Centimeter (cm) = 6.2137 x 10(-6) Miles	1 Meter (m) = 0.000621 Miles (mi)	

Mass

1 Ounce (oz) = 283.5 Milligrams (mg)	1 Pound (lb) = 453.59 Grams (gr)	1 Short Ton = 907.185 Kilograms (kg)
1 Ounce (oz) = 28.35 Grams (g)	1 Pound (lb) = 0.4536 Kilograms (kg)	1 Short Ton = 32,000 Ounces (oz)
1 Ounce (oz) = 0.0283 Kilograms (kg)	1 Pound (lb) = 16 Ounces (oz)	1 Short Ton = 2,000 Pounds (lb)
1 Ounce (oz) = 0.0625 Pounds (lb)	1 Pound (lb) = 0.004536 Metric Ton	1 Short Ton = 0.89286 Tons (long)
1 Ounce (oz) = 2.79 x 10(-5) Ton (long)	1 Pound (lb) = 0.0004464 Long Ton	
1 Long Ton = 1,016.05 Kilograms (kg)	1 Milligram (mg) = 0.001 Grams (gm)	1 Stone (British) = 14 Pounds (lb)
1 Long Ton = 35,840 Ounces (oz)	1 Milligram (mg) = 1x10(-6) Kilograms (kg)	
1 Long Ton = 2,240 Pounds (lb)	1 Milligram (mg) = 3.527 x 10(-5) Ounces (oz)	1 Decigram (dc) = 1.0 Grams (gm)
1 Long Ton = 1.12 Tons (short)	1 Milligram (mg) = 2.205 x 10(-6) Pounds (lb)	1 Dekagram (dg) = 10 Grams (gm)
1 Gram (gr) = 1,000 Milligrams (mg)	1 Kilogram (kg) = 1000 Grams (gr)	1 Ton (metric) = 1 x 10(6) Grams (gr)
1 Gram (gr) = 10 Decigrams (dc)	1 Kilogram (kg) = 0.001 Tons (metric)	1 Ton (metric) = 1,000 Kilograms (kg)
1 Gram (gr) = 0.1 Dekagrams (dg)	1 Kilogram (kg) = 35.27396 Ounces (oz)	1 Ton (metric) = 35,273.96 Ounces (oz)
1 Gram (gr) = 0.001 Kilograms (kg)	1 Kilogram (kg) = 2.2462 Pounds (lb)	1 Ton (metric) = 2,204.62 Pounds (lb)
1 Gram (gr) = 1x10(-6) Tons (metric)	1 Kilogram (kg) = 0.001102 Tons (short)	1 Ton (metric) = 1.1023 Ton (short)
1 Gram (gr) = 0.03527 Ounces (oz)	1 Kilogram (kg) = 0.00098 Tons (long)	1 Ton (metric) = 0.98421 Ton (long)
1 Gram (gr) = 0.002205 Pounds (lb)		

Volume

1 Fluid Ounce (fl oz) = 29.57 Milliliters (ml)	1 Fl. Ounce (CA) = 28.413 Milliliters (ml)	1 Cup = 236.588 Milliliters (ml)
1 Fluid Ounce (fl oz) = 0.02957 Liters (l)	1 Fl. Ounce (CA) = 0.02841 Liters (l)	1 Cup = 0.2366 Liters (l)
1 Fluid Ounce (fl oz) = 0.0625 Pints US (p)	1 Fl. Ounce (CA) = 0.96076 Ounces US (oz)	1 Cup = 8 Ounces (oz)
1 Fluid Ounce (fl oz) = 0.0312 Quarts US (q)	1 Fl. Ounce (CA) = 0.00625 Gallons (gal)	1 Cup = 0.5 Pints (p)
1 Fluid Ounce (fl oz) = 0.00781 Gallons (US)	1 Fl. Ounce (CA) = 28.413 Cubic Centimeter	1 Cup = 0.25 Quarts (q)
1 Fluid Ounce (fl oz) = 29.5735 Cubic cm	1 Fl. Ounce (CA) = 1.7339 Cubic Inches	1 Cup = 0.0625 Gallons (gal)
1 Fluid Ounce (fl oz) = 1.80469 Cubic Inches		
1 Pint (US) = 473.176 Milliliters (ml)	1 Pint (CA) = 568.26 Milliliters (ml)	1 ml = 0.001 Liters
1 Pint (US) = 0.473176 Liters (l)	1 Pint (CA) = 0.56826 Liters (l)	1 ml = 0.035195 Ounces CA (oz)
1 Pint (US) = 16 Ounces US (oz)	1 Pint (CA) = 20 Ounces CA (oz)	1 ml = 0.0338 Ounces US (oz)
1 Pint (US) = 0.5 Quarts US (qt)	1 Pint (CA) = 0.125 Gallons (gal)	1 ml = 0.00219 Gallons CA (gal)
1 Pint (US) = 0.125 Gallons US (gal)	1 Pint (CA) = 568.261 Cubic Centimeters	1 ml = 0.000264 Gallons US (gal)
1 Pint (US) = 473.1765 Cubic Centimeter	1 Pint (CA) = 34.68 Cubic Inches	1 ml = 1.0 Cubic Centimeter
1 Pint (US) = 28.875 Cubic Inches		1 ml = 0.06102 Cubic Inches
1 Gallon (US) = 3.77854 Liters (l)	1 Gallon (CA) = 4.546 Liters (l)	1 Liter (l) = 1,000 Milliliters (ml)
1 Gallon (US) = 128 Ounces US (oz)	1 Gallon (CA) = 160 Ounces CA (oz)	1 Liter (l) = 35.195 Ounces CA (oz)
1 Gallon (US) = 8.337 lbs Water (62 °F)	1 Gallon (CA) = 153.722 Ounces US (oz)	1 Liter (l) = 33.81402 Ounces US (oz)
1 Gallon (US) = 0.83267 Gallons CA (gal)	1 Gallon (CA) = 10.0092 lbs Water (62 °F)	1 Liter (l) = 1.7598 Pints CA (p)
1 Gallon (US) = 3,785.41 Cubic Centimeters	1 Gallon (CA) = 1.2009 Gallons US (gal)	1 Liter (l) = 2.1134 Pints US (p)
1 Gallon (US) = 231 Cubic Inches	1 Gallon (CA) = 277.419 Cubic Inches	1 Liter (l) = 0.8799 Quarts CA (q)
1 Gallon (US) = 0.15556 Cubic Feet	1 Gallon (CA) = 0.1605 Cubic Feet	1 Liter (l) = 1.0567 Quarts US (q)
1 Cubic cm = 0.001 Liters (l)	1 Cubic Inch = 0.01639 Liters (l)	1 Liter (l) = 0.21997 Gallons CA
1 Cubic cm = 0.03519 Ounces CA (oz)	1 Cubic Inch = 0.57674 Ounces CA (oz)	1 Liter (l) = 0.26417 Gallons US
1 Cubic cm = 0.03381 Ounces US (oz)	1 Cubic Inch = 0.55411 Ounces US (oz)	1 Liter (l) = 1000 Cubic Centimeters
1 Cubic cm = 0.00022 Gallons CA (gal)	1 Cubic Inch = 0.00360 Gallons CA (gal)	1 Liter (l) = 0.001 Cubic Meters
1 Cubic cm = 0.00026 Gallons US (gal)	1 Cubic Inch = 0.00433 Gallons US (gal)	1 Liter (l) = 61.0237 Cubic Inches
1 Cubic cm = 0.06102 Cubic Inches	1 Cubic Inch = 16.3871 Cubic Centimeters	1 Liter (l) = 0.03531 Cubic Feet
1 Cubic cm = 63.366 Pounds of Water	1 Cubic Inch = 0.03609 Pounds of Water	1 Liter (l) = 0.00131 Cubic Yards

Viscosity

Viscosity: The measure of the resistance of a fluid to flow.

Centipoise: Water is the standard by which all fluids are measured (shown as cps). Water is 1 cps at 70 °F.

Thixotropic: This describes a fluid that is gel-like (toothpaste) at rest, but will move with agitation.

Water at 70 °F	1 to 3 Centipoise (cps)
Blood	10 Centipoise (cps)
Ethylene Glycol	15 Centipoise (cps)
Motor Oil (SAE 10)	50 Centipoise (cps)
Corn Oil	65 Centipoise (cps)
Maple Syrup	150 Centipoise (cps)
Motor Oil (SAE 40)	250 Centipoise (cps)
Motor Oil (SAE 60)	1,000 Centipoise (cps)
Honey	2,000 Centipoise (cps)
Molasses	5,000 Centipoise (cps)
Chocolate Syrup	10,000 Centipoise (cps)
Ketchup	50,000 Centipoise (cps)
Peanut Butter	150,000 Centipoise (cps)
Lard	1,000,000 Centipoise (cps)

Note: All viscosities are approximate at standard room temperature. Values will be higher at colder temperatures and lower at elevated temperatures.

Bead Length

Chart for methacrylates, epoxies, and silicones

	1/4" Wide Bead	3/8" Wide Bead	1/2" Wide Bead	5/8" Wide Bead
50 ml	124 Inches	56 Inches	30 Inches	20 Inches
300 ml	740 Inches	335 Inches	180 Inches	120 Inches
380 ml	945 Inches	420 Inches	230 Inches	151 Inches
400 ml	992 Inches	448 Inches	240 Inches	160 Inches
1 Pound	1,073 Inches	477 Inches	265 Inches	172 Inches
1 Gallon	9,450 Inches	4,200 Inches	2,360 Inches	1,510 Inches

Note: 1 Gallon = 3791.76 ml approximately = 128.1 ounces approximately

Adhesive Usage Chart for Cyanoacrylates and Anaerobics

Gap (Inches)	1 Sq. Inch	2 Sq. Inch	4 Sq. Inch	8 Sq. Inch	10 Sq. Inch	20 Sq. Inch
.015 Inches	1,940 Pieces	946 Pieces	475 Pieces	240 Pieces	185 Pieces	95 Pieces
.010 Inches	2,955 Pieces	1,420 Pieces	710 Pieces	355 Pieces	270 Pieces	140 Pieces
.005 Inches	5,915 Pieces	2,840 Pieces	1,420 Pieces	710 Pieces	565 Pieces	285 Pieces
.002 Inches	14,190 Pieces	7,100 Pieces	3,550 Pieces	1,655 Pieces	1,410 Pieces	705 Pieces

Note: Parts per pound of cyanoacrylate are based on gap (in inches) times bond area (in square inches).

Centipoise of Cyanoacrylate	Drops per Ounce Bottle	Drops per Pound Bottle
5 cps	1,097	17,552
45 cps	926	14,816
100 cps	904	14,464
500 cps	641	10,256
1000 cps	549	8,784
2400 cps	385	6,160
3000 cps	356	5,696
5000 cps	313	5,008

Note: Drops per pound of cyanoacrylate are based on free-falling drops at room temperature. Use as approximate.

Weight and Properties of Common Materials

Material	Specific Gravity	Weight (lbs per cu. ft.)	Weight (kg per cu. meter)
ABS	1.05	65.5	1,050.0
Acetone	0.79	49.3	790.0
Epoxy	1.26	78.3	1,255.0
Ethylene Glycol	1.11	69.5	1,114.0
HDPE	0.96	59.8	958.5
LDPE	0.92	57.7	924.5
Methyl Chloride	0.99	61.8	990.0
Nylon (Type 6)	1.13	70.5	1,130.0
Nylon (Type 6/6)	1.14	71.2	1,140.0
Polycarbonate	1.20	74.9	1,200.0
Polyethylene	1.70	106.1	1,700.0
Polyetheretherketone (PEEK)	1.31	81.8	1,310.0
Polyethyleneterephthalate (PET)	1.35	84.0	1,345.0
Polyester (Cast)	1.25	78.0	1,250.0
Polypropylene (PP)	0.91	56.5	905.0
Polystyrene (PS)	1.05	65.5	1,050.0
Polyvinyl Chloride (PVC)	1.30	81.2	1,300.0
Toluene	0.87	54.6	870.0
Trichlorethylene	1.47	91.8	1,470.0
Water (Pure)	1.00	62.4	999.6
Water (Sea)	1.03	64.08	1,026.5

Common Adhesives

Rating: 1= Poor 10 = Best

Acrylics

Commonly supplied either as a two component adhesive in a variety of ratios (1:1, 4:1, or 10:1) or as a single component with an applied primer. The dual component is used mainly for structural bonding of porous and non-porous substrates and is oil, gas, water, and salt resistant. More common uses are structural bonds of fiberglass, composites, ABS, PVC, etc. The automotive industry is a common user whereas the single component material is generally used in the speaker magnet bonding industry. Acrylics tend to be very good gap filling, fast curing adhesives that lend themselves well to automated or semi-automated production. These adhesives cure by way of an exothermic reaction and the cost of using these adhesives is medium to high depending on the bead thickness used.

Production = 9 Cost = 6 - 7 User Friendly = 8 Odor = 8 Strength = 10

Acrylonitrile (Rubber Cement)

Commonly used in schools to bond paper and cardboard substrates. Applied as a single component which cures by way of solvent release, it has limited potential as a production adhesive.

Production = 1 Cost = 2 User Friendly = 8 Odor = 8 Strength = 3

Aliphatic Resin (Yellow Glue)

Commonly used in the woodworking industry to bond a variety of wood products. This adhesive is very strong, moisture resistant (not waterproof), and has a high resistance to solvents and heat. This is a single component adhesive, non-toxic, non-flammable, and non-staining.

Production = 5 Cost = 4 User Friendly = 8 Odor = 2 Strength = 9

Contact Cement

Commonly supplied for bonding laminated assemblies such as counter tops and veneers. This adhesive is a single component and is usually applied to both substrates and then held together under high pressure. This adhesive can be purchased either with a solvent carrier, which is flammable, or the newer water-based cements, which in some instances can be just as fast setting as the solvented versions.

Production = 5 Cost = 3-6 User Friendly = 8 Odor = 3 - 6 Strength = 5

Cyanoacrylate Ester

This adhesive is supplied as a single component adhesive that cures by way of moisture. The thinner the bead displacement between substrates and the more residual moisture on the substrates equals faster cure times. These cure times (green strength) may be between 10 seconds and 2 minutes. Production guidelines as to substrates, fixturing, ambient humidity, and bead size all are important in ensuring the most success from this adhesive. Cyanoacrylates tend to bond rubbers very well, as well as Nylon, PVC, EPDM, and most plastics. Some hard to bond plastics such as polypropylene can be bonded with cyanoacrylates using some of the newer primers.

Production = 9 Cost = 6 User Friendly = 8 Odor = 3 Strength = 9

Common Adhesives

Epoxy

This adhesive is a very common commodity with a vast array of uses. Epoxies can be used as a single component heat cured product to a dual component adhesive with many different additives. The uses seem to be unlimited for epoxies and as technology grows so does the use for these adhesives. Epoxies range in cure times from a very fast 3 minutes to a slow cure of 24 hours with hardness and elongation covering a very wide range. As a true engineered adhesive, epoxies can be altered to fit nearly any manufacturing need for adhesives.

Costs and packaging are determined by the end use of this adhesive. Common uses are potting compounds, metal bonding, structural bonding, and consumer packaged general-purpose adhesives.

Production = 9 Cost = 5 - 8 User Friendly = 8 Odor = 3 - 6 Strength = 6 - 9

Hot Melt Glue

Hot melt adhesives form a large segment of the adhesive industry and are supplied as a single component material packaged in sticks, chicklets, pillows, slugs, pails, and drums. These adhesives can be used in a wide variety of applications ranging from labeling to structural automotive bonding to consumer craft glue. The more common hot melts are EVA and PVA and are generally used for medium strength applications while PURs (Polyurethane Hot Melts) and polyamides should be used for any structural applications.

The common applications include foam bonding, labels, automotive applications including headliners, seats, dashboard, and headlamp assemblies. Application methods can include hot melt glue guns using simple sticks to complicated roll coating dispensing systems for applying uniform thickness.

Production = 9 Cost = 2 - 5 User Friendly = 6 Odor = 3 Strength = 4 - 9

Latex Cement

Commonly used in paper items such as wallpaper and bonding of fabrics. This adhesive is a low cost, low strength, water resistant glue with a high degree of flexibility when cured.

Production = 7 Cost = 2 - 3 User Friendly = 5 Odor = 3 Strength = 2

Silicones

Generally used as a sealer or caulking compound, this product also has good adhesion characteristics. Silicones have an overall moderate strength on most porous to non-porous substrates and generally do not wet out well on polypropylenes or high olefin plastics. Silicones are also regarded as a very good waterproof adhesive that can withstand very low to very high temperatures (-40 to +600 °F). The downfall of silicones is the very long cure time of 2 hours to 48 hours depending on the residual humidity. The secondary use of silicones is as a two component mold-making product. Silicones offer superior performance with their flexibility and different cure catalysts available.

Production = 2 Cost = 2 - 3 User Friendly = 4 Odor = 8 Strength = 4

Ultraviolet Adhesives

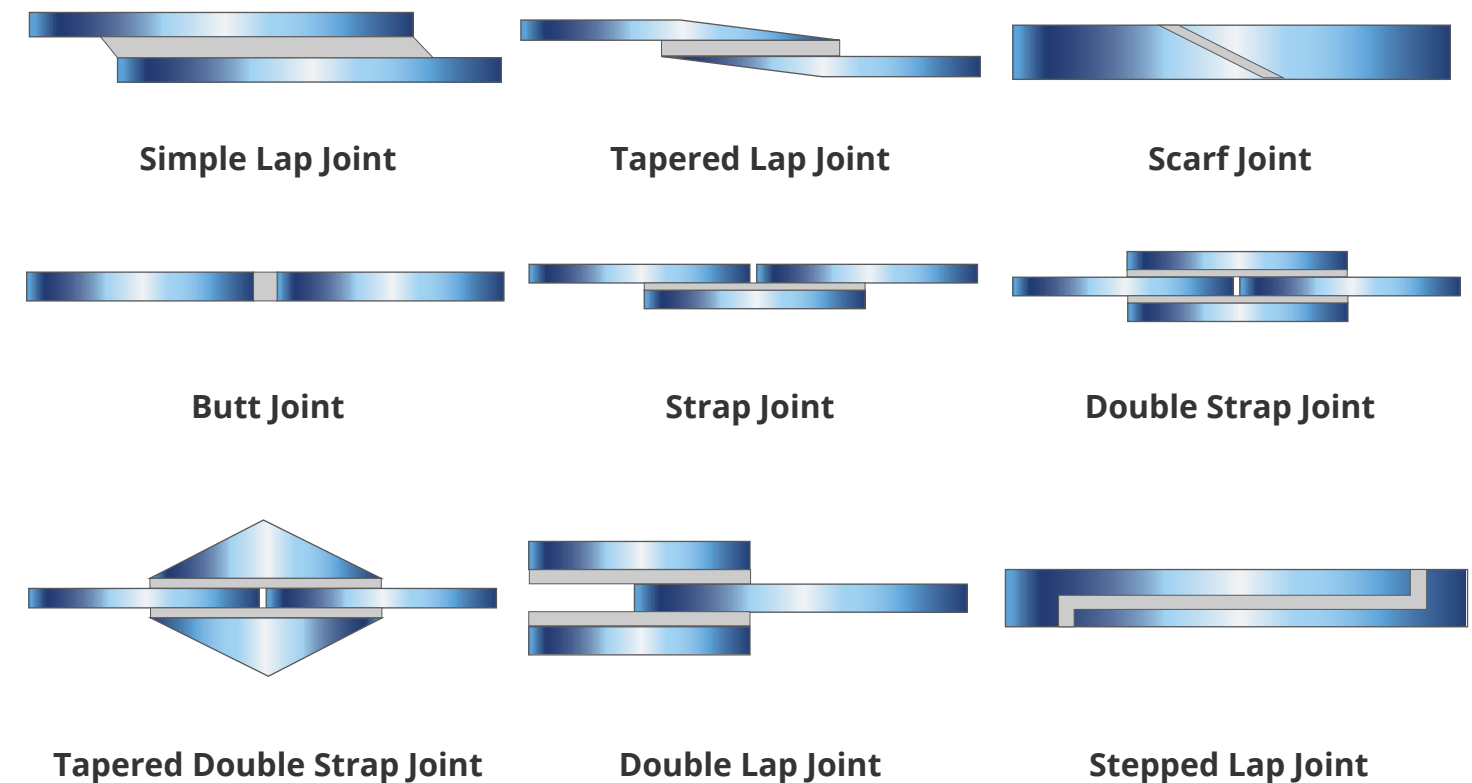
This branch of the adhesive world uses acrylics, epoxies, and urethanes to achieve the desired results both with the substrates and production process. UV cured acrylics are generally used for glass bonding while UV urethanes and epoxies are used in the electronic industry to coat circuit boards. As UV lamps become cheaper, safer, and easier to use, the use of ultraviolet adhesives will increase.

Production = 7 Cost = 8 User Friendly = 6 Odor = 6 Strength = 8

Common Adhesives Questions

1. What substrates are you bonding?
2. Is one substrate flexible while the other is rigid?
3. Do we have gap filling issues to contend with? Is there a slip fit or a press fit?
4. What is the processing time the adhesive needs to work with, to match the manufacturing parameters set out on the process?
5. Is there a concern with adhesive odors?
6. How will we apply the adhesive? Automated or semi-automated?
7. Is there a budget on both equipment and adhesives used?
8. How many operators?
9. How do we store the adhesives on line?
10. Do we need to match an automotive specification to use the adhesive? What testing needs to be done, such as PPAP, FMEA, or process flow documents?
11. Do we have any environmental constraints while using this adhesive?
12. How many parts are we processing per hour, day, month, or year?

Basic Bonded Joints



Adhesives Terminology

Adhesive Failure

The loss of adhesion between the adhesive and the substrates bonded. This would look as though the adhesive had peeled clean off of one side of the substrate and left adhesive on the other.

Bond Strength

The amount of adhesion between the bonded substrates usually measured in pounds per square inch. The usual test is to bond 1" x 4" coupons with a 1" overlap and pull in a tensile test.

Centipoise

The measure of flowability of a liquid, a unit of viscosity. Water is measured at 1 cps (Centipoise). See chart.

Cohesive Failure

Loss of adhesion due to adhesive tear or rupture, leaving adhesive on both substrates.

Cure

To change the physical properties of a material by chemical reaction, which may be condensation, polymerization, or vulcanization; usually accomplished by the action of heat, moisture, and/or catalysts alone or in combination with or without pressure.

Cure Time

The amount of time it takes for an adhesive to come to full strength.

Gel Time

The time it takes (usually in minutes), for a specific amount of mixed resin and hardener to become unworkable (gelled).

Green Time (open time)

Open time is the time between application and solidification of the adhesive. During the open time, it is still possible to position parts while being careful not to overlap the open time with the fixturing time of the adhesive. This will cause an interruption in the curing process and may lead to a less than adequate bond strength.

Peel Strength

The amount of force required to peel a material off of a substrate.

Shear Strength

The maximum shearing force, per unit area (sq. in.), an adhesive bond will endure before failure. Usual test is lap shear coupons 1" x 4".