POLYMARK RESIN SYSTEMS

Technical Bulletin

A260
Two-Part Epoxy

Thixotropic Epoxy Adhesive

Description:
Polymark A260 is a thickened epoxy adhesive which can be used in varying proportions of resin to hardener to provide optimum properties for particular applications.

The following is a list of suggested mix ratios (resin to hardener) and the applications and cured properties of each:
Rigid Bond: 2:1 by weight or 1.7:1 by volume. Bonds metals, glass, ceramics, and most plastics. Best chemical and heat resistance can be used in some applications to temperatures of 250^{o}F .
Semi-Rigid Bond: 1:1 by weight or 1:1.2 by volume. Improved impact and thermal shock resistance. Higher tensile shear strength than rigid bond.
Flexible Bond: 1:2 by weight or 1:2.4 by volume. For bonding hard rubber, teflon and treated polyurethane. Better peel strength than rigid or semi-rigid bond.

Within the range of mix ratios from 1:2 to 2:1 (resin to hardener by weight) cured properties can be effected as follows:

	Increasing the Proportion of Hardener	**Increasing the Proportion of Resin**
Flexibility	Increases	Decreases
% Elongation	Increases	Decreases
Water Resistance	Decreases	Increases
Heat Resistance	Decreases	Increases
Acid Resistance	Decreases	Increases
Solvent Resistance	Decreases	Increases
Tensile Strength	Decreases	Increases
Heat Distortion Point	Decreases	Increases

Surface Preparation:
Adhesives are only as good as the preparation of the surface to which they are applied. Adhesives should not be depended upon as the sole source of support in applications where failure of the adhesive may result in personal injury or damage to property. In such instances, mechanical means of reinforcement are recommended since perfect surface preparation may not be obtained in every instance. THE USER'S ATTENTION IS CALLED TO THE SECTION ENTITLED **SURFACE PREPARATION** ON PAGE 3 OF THIS DATA SHEET.

Typical Properties:
The values listed below are averages and they are not intended for specification purposes. Contact Polymark when establishing specifications. In the interest of achieving optimum properties in a minimal amount of time, the cured physical properties were developed by using a cure schedule of 24 hours at 25°C plus one hour at 100°C. The choice of cure schedule will vary with the application and users must establish their own optimum cure schedules.

Handling Properties:

Mix Viscosity @ 25^{o}C (ASTM D 2393)	Thixotropic
Working Life @ 25^{o}C (100 grams)	30 mins

Typical Cure Schedules of Thin Bond Lines

	Initial	**Full**
@ 25^{o}C	12 hrs	2-3 days
@ 85°C	2-3 min	1 hr
@ 150^{o}C	- - -	20 min

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Physical Properties:

Color	Tan
Mix Ratio vs Hardness (Shore D)	
@ 2:1 resin to hardener by weight	85
@ 1:1 " " "	82
@ 1:1.5 " " "	60
@ 1:1.75 " " "	40
@ 1:2 " " "	20
(ASTM D 2240)	
Mix Ratio vs Tensile Shear Strength (Al-Al)	
@ 2:1 resin to hardener by weight	3,100 psi
@ 1:1 " " "	4,600 psi
@ 1:2 " " "	810 psi
ASTM D 1002	
Compressive Yield ASTM D 695, mixed @ 100:50 by weight	12,000 psi
Tensile Strength ASTM D 638, mixed @ 100:50 by weight	7,600 psi
Percent Elongation ASTM D 638, mixed @ 100:50 by weight	12%
Flexural Modulus ASTM D 790, mixed @ 100:50 by weight	3.0×10^5 psi
Tensile Shear Strength (Steel to Steel) Mixed 1:1 by weight and cured @ 149^{O}c ASTM D 1002	4,920 psi
Maximum Heat Distortion Temperature ASTM D 648, mixed W 100:50 by weight	250^{o}F
Ultimate Flexural Strength ASTM D 790-63T	59,000 psi
Flexural Strength After Boiling 2 Hours in Water ASTM D 790-63T	39,000 psi
Flexural Modulus of Elasticity ASTM D 790-63T	2.2×10^6psi

Proportioning and Mixing:

A260 resin and hardener can be proportioned by weight or volume. Automated meter-mix, dispensing equipment may be used for high volume production. (A list of dispensing equipment manufacturers is available.)

When mixing small amounts of A260, it is best to use a balance and disposable containers. The containers should be large enough to hold both resin and hardener and still have ample room for mixing. After allowing for the weight of the container, the correct amount of resin is added to the container. The scale is then set for the total weight of both resin and hardener and the hardener is added slowly until the total weight is reached.

To insure thorough mixing, periodic scraping of the sides and bottom of the container is necessary. Even small amounts of improperly mixed material can cause soft spots or irregular curing.

Clean-Up:

It is recommended that customers use disposable containers and utensils when working with epoxies. However, when disposable materials are impractical, uncured epoxy can be removed by cleaning equipment with solvent. Observe appropriate precautions when using flammable solvents. Solvent-cleaned utensils should be thoroughly dried before reuse. Any remaining solvent can contaminate the next mixture.

Shelf Life and Storage:

Polymark A260 resin and hardener have approximate shelf lives of twenty four months at room temperature (25^{o}C) in closed containers. A260 resin may infrequently crystallize during storage, but the crystallization can be dissolved by loosening the lid and applying moderate heat (50^{o} to 60^{o}C).

Handling Precautions:

The labels on containers of Polymark materials contain current information on the hazards associated with each particular product. Most epoxy resins and hardeners are skin and eye irritants. Some may be corrosive to the skin and eyes. Other problems, such as skin sensitization or serious health hazards, may exist. Further information on each product is contained in the Material Safety Data Sheet which will be sent upon request.

SURFACE PREPARATION

Any adhesive, regardless of the type, can only be expected to perform well on a properly prepared surface. Most manufacturers will be quick to point out that such figures as "Tensile Shear Strength" were obtained on specimens tested in accordance with a certain standard. Included in the test will be preparation of the surfaces for bonding which is usually in accordance with another standard. It would be quite possible to write a complete volume on surface preparation and still not cover every material, application or situation.

Although Polymark Inc does not purport to be an expert on all types of surface preparation, we do, none the less, feel an obligation to offer some suggestions to aid the user in obtaining good bond strengths.

Some surfaces require little or no preparation and epoxies will cling to them tenaciously. An example of this is clean, dry, raw wood. Some woods, however, such as Teakwood, possess a high degree of natural oils which make bonding to it difficult to impossible. Other materials such as Teflon* or polyethylene are very resistant to bonding even with the best preparation methods known. In the middle of the spectrum, however, are materials which can be bonded successfully with proper surface treatment. These would include all types of metals, many plastics, glass and ceramics.

In order to properly understand bond strengths, the user should be familiar with the difference between adhesive and cohesive failures. Assume that two pieces of metal are partially overlapped and joined by a thin bond of adhesive. Now the specimen is placed in a machine designed to pull it apart lengthwise. The stress applied is known as "shear". The point at which the specimen breaks across the bond line is known as its "Tensile Shear Strength" and is usually expressed in pounds per square inch. By examining the bond line on the two pieces, we should find that a roughly equal amount of cured adhesive is left on both pieces. This ideal condition is known as a "cohesive break". However, if we find no adhesive left on one of the pieces (or very little adhesive) this is known as an "adhesive break" and is indicative of either poor surface preparation, the wrong adhesive, a non-receptive surface or a combination of these factors.
It is important to recognize the major hindrances to adhesion. These are: DUST, DIRT, GREASE, CORROSION, OXIDATION, SCALE

In addition, smooth, nonporous surfaces generally provide poor bonds. This is why most woods are easy to bond. The natural porosity inherent in wood allows the adhesive to "wick" into the surface and surround the fibers providing good mechanical strength. Metals, plastics and glass, on the other hand, need to be artificially roughed-up to provide a good bond. Also, materials containing polyolefins or fluorocarbons will require some type of special pre-treatment prior to bonding. For proper bonding, any adhesive must adequately wet the surfaces. Therefore, proper cleaning must also be considered.

In summary, we see that the two most important aspects of surface preparation prior to adhesive bonding are: PROPER CLEANING and PROPER PHYSICAL CONDITIONING

The following is a list of materials commonly encountered in adhesive bonding with a short general description of the preparation methods commonly employed.

WOOD - Insure that the surface is dry and free from contaminants such as grease or oil. A rough sanding will aid adhesion followed by removal of sanding dust.

PLASTICS- Most plastics to be bonded will have a smooth surface; therefore, particular attention should be paid to roughing or etching the surface in addition to a good solvent cleaning. As pointed out above, some plastics (such as polyethylene) may require special types of treatment. The plastics manufacturer or distributor should be consulted in cases where surface preparation is questionable.

METALS - Two common methods of surface preparation are generally used:

a. degreasing followed by treatment by or grit blasting, grinding, sanding or honing.
b. b. chemical cleaning by one or a combination of the following methods:
    1. degreasing with chlorinated or ketone solvents
    2. alkaline cleaning
    3. acid etching

GLASS - Solvent wiping and (where possible) sand blasting to improve mechanical bond are the preferred methods.

CERAMICS - Fired, unglazed ceramics generally require no preparation as long as they are clean. Glazed ceramics should be roughed-up by sanding.

The methods listed above are very general in nature and are not intended as specific recommendations by Polymark Inc They are provided solely to focus the user's attention on the importance of proper surface preparation. Polymark Inc does not warrant the results of usage of the above methods nor does it assume responsibility for alleged failures of the above methods. Polymark suggests that the user thoroughly familiarize himself with all available data for the particular materials he is using as well as conducting his own tests to determine the suitability of an adhesive for his particular application. There is considerable published information available covering surface preparation in detail. For example, the American Society for Testing and Materials publishes recommended practices such as:

ASTM D 2093 Preparation of Surfaces of Plastics Prior to Adhesive Bonding
ASTM D 2651 Preparation of Metal Surfaces for Adhesive Bonding

Complete publications listings are available from ASTM at 1916 Race Street, Philadelphia, PA 19103. In summary, the possibility of achieving successful adhesive bonding may be increased by following these procedures:

1. Consider the nature of the application and understand the problems associated with adhesive bonding.
2. Conduct thorough suitability testing.
3. Select the proper adhesive.
4. Prepare the surfaces properly