



Standards Bldg.

Reference book not to be taken from the library.

UNITED STATES

REFERENCE

Adhesives

FOR EVERYDAY USE



NIST PUBLICATIONS

19



A Consumer's Guide from the National Bureau of Standards NBS CIS 3

CONTENTS

	Page
Foreword	ii
Introduction	1
Selecting the Adhesives	2
Adhesives—Properties and Applications	6
Surface Preparation	10
Joining the Surfaces	14
String, rope, and wire	14



Adhesives

FOR
EVERYDAY
USE

by Karl F. Plitt

INFORMATION YOU NEED IN SELECTING AND APPLYING ADHESIVES FOR USE IN THE HOME AND HOBBY SHOP

NBS CONSUMER INFORMATION SERIES 3
Editor: James E. Payne

Issued November 1970



U.S. (FROM THE) NATIONAL
BUREAU OF STANDARDS

U.S. DEPARTMENT
OF COMMERCE

U.S. DEPARTMENT OF COMMERCE
Maurice H. Stans, Secretary
Rocco C. Siciliano, Under Secretary
Myron Tribus, Assistant Secretary
for Science and Technology
NATIONAL BUREAU OF STANDARDS
Lewis M. Branscomb, Director

For sale by the Superintendent of
Documents, U.S. Government Printing Office,
Washington, D.C. 20402.
Price 40 cents.

APR 10 1971

27-210-1-1
T-1385
4106
10-3
5-1

Foreword

Technology is changing not only the products you buy, but the marketplace as well. Unfortunately, this is not an unmixed blessing.

Products are constantly being improved, but designs are complicated, quality is variable, and good advice is hard to get. Modern stores and merchandising bring you a wide variety of products; but the large number of choices and the lack of dependable information often make shopping a confusing and frustrating experience.

A generation ago the merchant was likely to be a friend of the family. Products were out in the open where they could be seen, touched, smelled or tasted, and decisions about quality were comparatively easy to make. Today, stores are more impersonal; most of the items are pre-packaged, or made of unfamiliar materials, or so complicated only an expert can understand how they work.

If you are like most consumers you need more information—accurate, understandable, believable information which will help you make wise choices, and get more use and satisfaction from what you buy.

Your principal source of such information will be from manufacturers and vendors themselves. But the technical work at NBS brings our experts in contact with many subjects of potential interest to the citizen, who supports our work with his taxes. The Consumer Information Series is designed to share this knowledge and experience with you. The National Bureau of Standards does not test or recommend products, but our research on measurement and standards produces information in many areas which can be of practical value to you.

At the request of the President and the Secretary of Commerce, we are pleased to make this information available.

Lewis M. Branscomb, Director

Adhesives

FOR EVERYDAY USE

Introduction

“Gluing” or “pasting” used to be a very messy and often a very frustrating job. Whether it was home-prepared flour and water, or the kind that came in a tube, paste was weak, often lumpy, and anything but neat. Bottled glue was stronger, but if you wanted to repair a hard-use item like a chair, your best bet was to get out the glue pot and heat up a batch of animal glue.

Many materials could not be bonded successfully, and the endurance of a joint between even the most cooperative materials was always in doubt. The thrice-glued chair leg, the snap shots that would not stay put in the photo album, the laboriously repaired vase or toy that came apart the moment it was put to use again—these were typical headaches of the amateur handyman or hobbyist before modern chemistry came to the rescue.

Even today the use of adhesives requires a certain amount of thought and care, but nearly all materials can be joined, and most anybody can do a good and reasonably neat job if the right adhesive is used and the surfaces are properly prepared.

That is the purpose of this brochure: to help you select the best adhesive for the job you want to do, prepare the surface, and secure a good bond. Special purpose adhesives such as those used for floor or wall tile will not be covered, since these are one-purpose adhesives and clear instructions are on the package. But the principal household adhesives available in hardware and department stores and hobby shops will be discussed and their use will be illustrated.

Selecting the Adhesives

Before you look for a specific adhesive for a specific job you want to do, there are several general things about adhesives and their use which you should consider.



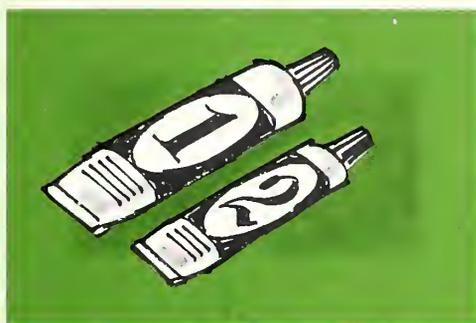
Types of adhesives

Readily available household adhesives fall into two main types. One comes already prepared as a liquid or paste, ready for use. It makes its bond when the solvent or liquid part evaporates or is absorbed by the material being bonded. A special variant of this type is the "contact" cement. This is a solvent-containing cement which is coated on the two surfaces to be mated. After the solvent has evaporated, the surfaces are brought into contact, and the bond is made immediately.

The other type is a two-part system that requires the measurement and mixing of two substances. One or both may be liquid. When they are mixed they react chemically to produce a substance which will make a firm bond. This chemical process is called "curing." Curing adhesives do not depend on absorption or evaporation.

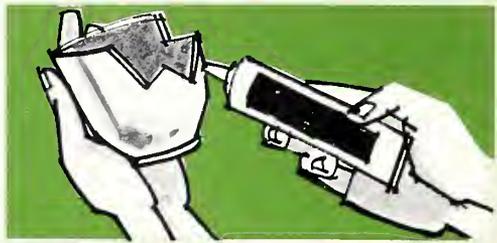
One new type of adhesive that does not fall into the two main groups is the silicone rubber type. (See table, page 7.) Silicone rubber adhesives cure by absorbing moisture from the air and releasing acetic acid, which smells like vinegar, as the cure takes place.

Another new type of adhesive is the "hot melt" type, usually requiring a special heater or "glue gun." This type is applied in a hot, melted condition, and the bond is made as the material cools.



Types of bonds which adhesives make

As they “set” or “cure,” some adhesives become hard and brittle; some set into rather stiff bonds but remain flexible; while others remain soft and rubbery. Match the adhesive to the material and the end use. If in doubt, read labels carefully, and consult your dealer.



Materials and adhesives must be compatible

In bonding two pieces of metal, avoid adhesives which contain solvents. The solvents are not absorbed by the metal and cannot escape through it, so the adhesives cannot dry or set. An adhesive which cures by chemical action, or a contact cement, would be better.



If you want to bond dissimilar materials, such as rubber and glass, you need an adhesive which will remain flexible after setting or curing. Dissimilar materials expand and contract at different rates when the temperature changes, and the adhesive must be resilient and “give” or it will break away.



To bond a porous to a non-porous surface, a solvent-containing adhesive may be used. For example, a felt or fabric covering might be bonded to metal with a rubber based adhesive.



The environment must be considered

If you want to repair outdoor wooden furniture, select a waterproof adhesive. Otherwise, dampness will cause the joint to weaken. Indoors, resistance to moisture is not so much of a problem unless the climate is extremely humid.

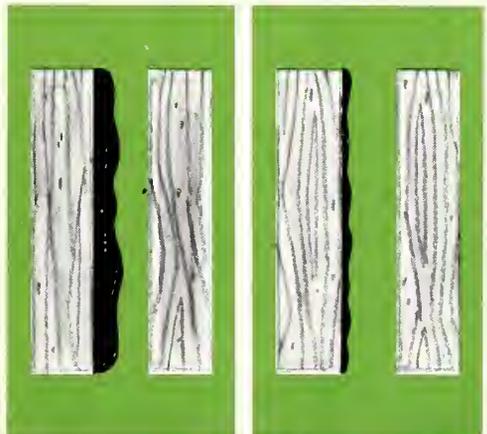
If you want to repair a cookpot handle, select an adhesive which stands up well under high temperature. The silicone rubber adhesives are a good choice for this purpose. A few adhesives support the growth of molds if used in damp, warm environments. Some animal, vegetable, and casein glues are attacked by molds. Silicone rubber sealants and adhesives may mildew unless formulated to be mold resistant.

Household chemicals may attack some adhesives. The curing types are generally resistant to chemical attack. Plastic and rubber adhesives may be softened by such liquids as cleaning fluids, turpentine, paint thinners, and kerosene. The moisture-sensitive adhesives may be softened by water containing ammonia or strong detergents.



The glue line

A most important consideration is thickness of the glue line—that is, the amount of adhesive between the pieces that you are joining together. Some adhesives, like the silicone rubbers, are best used where a relatively thick glue line is possible. Other adhesives, like the vegetable and casein glues, require a thin glue line; while some, such as the epoxies, are comparatively indifferent to glue line thickness.



Adhesives—

Properties

Types	Characteristics	Typical Applications
Animal glues	Also called hide glues. The oldest type of wood glue. May be applied as hot or cold liquids. Good strength but poor moisture resistance. Set by drying. Tend to become brittle upon aging.	furniture veneer
Vegetable glue “paste”	Generally a water-based treated starch, often a thick white paste, easily spread. Sets by drying. Poor moisture resistance and low strength. Requires a thin glue line.	paper cardboard wallpaper paper constructions
Casein glues	Made from milk protein. Dry powders mixed with water for use. Good strength, better moisture resistance than vegetable glues. Require a thin glue line and set slowly.	wooden toys furniture other wooden items cardboard
Urea-formaldehyde	Also called urea resin adhesives. Dry powders to be mixed with water for use. Easy to use. They produce a light colored glue line, high early strength, good resistance to heat. Not recommended for poorly fitted joints, thick glue lines, or outdoor use.	furniture veneer large wooden surfaces
Resorcinol	Two-part adhesives consisting of a dark-red or purple liquid and a curing agent. Produce high strength joints for use outdoors or under severe service conditions. Cured adhesive resists water, oil, most solvents, and mold. Produces a dark colored glue line. Requires a moderately thin glue line.	outdoor toys furniture wooden boats wooden structures
Polyvinyl acetate	Milky white liquids frequently sold in plastic squeeze bottles. Bond by loss of water. Produce a clear colorless glue line. Somewhat flexible. Moderate moisture resistance. Moderate strength. Resistant to oil, grease, and solvents. Excellent for repair of wooden items.	wooden toys textiles cardboard paper wood labels

and Applications

Types	Characteristics	Typical Applications
<p>Plastic</p>	<p>These are sold as general-purpose adhesives. May be composed of any of a number of materials. Clear, colorless solutions, and usually in tubes. Easy to use, moderate bond strength. Set by losing solvent.</p>	<p>photographs paper textiles craft and hobby materials some plastics plastic containers</p>
<p>Rubber</p>	<p>Both natural and synthetic rubbers are used as adhesives. Synthetic rubber adhesives usually produce stronger bonds than natural rubber cements. Very elastic, good for bonding flexible materials to both flexible and rigid materials. Lose solvent to set.</p>	<p>textiles rubber plastic laminates leather paper some plastic films</p>
<p>Silicone rubber</p>	<p>Available in squeeze tubes as clear, white, or black materials. Highly rubbery adhesives may be used indoors and out. They cure by absorbing moisture from the air and releasing acetic acid (smells like vinegar). Bonds of more than 1 inch from edge to center are not recommended. Good bond strength. Stable at high temperatures.</p>	<p>glass ceramics tile paper fabrics metal leather</p>
<p>Epoxy</p>	<p>Consists of resin and curing agent that must be measured and mixed. Excellent with non-porous materials and wood. Very strong bonds. Epoxy adhesives shrink little during cure, may be used in thick glue lines. Some epoxies are hard, filled adhesives; others are clear somewhat flexible materials. The flexible types are useful in bonding dissimilar materials.</p>	<p>wood glass pottery tile boats metals some plastics leather</p>
<p>Hot melt</p>	<p>This synthetic resin adhesive is supplied in sticks which are used in an electric glue gun. It is easy to apply, and sets quickly, but parts cannot be adjusted after they are joined. Hot melt adhesive is solventless and nonflammable, and no clamping is required. Moderate strength and durability.</p>	<p>wood leather some plastics metal paper and cardboard</p>

The end use of the article must be considered

To repair a tool, a toy, or a piece of furniture, or any other article which is likely to undergo heavy use, you will need an adhesive which makes a strong bond.



To repair a cup or a fragile picture frame, you will need an adhesive with only moderate strength, but one that can be easily cleaned up during bonding to leave an unblemished surface. Adhesives which dry or set slowly are easier to remove after the pieces are assembled.



To repair most household items, you will need an adhesive that makes a strong, permanent bond, sets within a reasonable time, and is convenient to use. Read the directions carefully, and carry out each step exactly as the manufacturer recommends.



The bonding of a wooden item that has a natural or stained finish requires the use of a colorless or matching color adhesive rather than an adhesive which produces an unsightly glue line. In bonding glass, it is desirable to use an adhesive which makes a transparent bond.



Your skill and patience should be considered

Some adhesives are troublesome to prepare and apply, while others require a long time to cure or set. You know your own level of patience and skill; select an adhesive which does not strain either the one or the other.



In selecting an adhesive, read carefully the manufacturer's instruction on the container. Most adhesive manufacturers provide carefully developed instructions for use. Many provide descriptive leaflets or booklets that are available at the same stores that stock adhesives. They will merit careful reading.

The table on pages 6–7 contains information that will help you compare the different types of adhesives and select the one best suited to the particular job you want to do. Detailed properties of individual brands are not discussed, but if you have questions beyond the scope of this brochure, ask your dealer or write to the manufacturer. Many hardware and hobby shop owners are hobbyists or do-it-yourself experts in their own right, and they will be glad to help you with your problem. But there is no substitute for personal experience, and there may be slight—but important—differences between the way you use the adhesive and the way that your adviser thinks you are going to use it.

CAUTION

Some types of cements—the rubber based and the plastic cements, especially—use hydrocarbon-based solvents. These are inflammable and should be treated with caution. In addition, these solvents as well as those used for cleaning may be toxic if inhaled excessively. In working with these materials open flames should be avoided, and good ventilation should be provided.

Surface Preparation



TO PRODUCE A STRONG BOND

For a strong bond, clean the surface thoroughly. The adhesive must have direct access to the bonding surfaces. If you do succeed in establishing a bond to a surface that has a film of wax or grease, the bond will be with the wax or grease and not with the underlying material. Such bonds are easily broken.

Adhesives may adhere strongly to oxide and scale on a metal surface; but because oxide and scale are weak materials, the joint will be likely to fail. Oxide and scale should be removed to the bare metal before the adhesive is applied. On painted surfaces, both metal and wood, the old paint should be completely removed before applying the adhesive to the underlying material.

An adhesive must “wet” the surface in order to make a strong bond. “Wetting” means that the adhesive spreads easily in a thin layer and does not ball up or remain in droplets. Any material which interferes with “wetting” — oil, grease, wax, moisture — should be carefully removed before applying adhesive. If possible, roughen the surface so that the adhesive can lock in pores and fine scratches, for this strengthens the bond.



For best results on:

WOOD

Roughen the surface lightly with sandpaper or a wood file. In repairing a previously glued joint, remove the old adhesive before applying the new. Paint should be stripped from the wood surface before the adhesive is applied. Old paint has poor bonding strength.



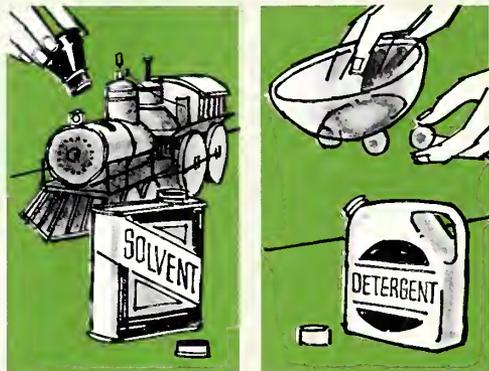
RUBBER

Wipe the surface clean with a solvent such as mineral spirits, household spot remover, or dry cleaning solvent to remove grease and oil. These solvents also remove any traces of chemicals remaining from rubber manufacturing processes which might interfere with bonding.



METAL

Remove rust and scale down to bare metal. Wash with a solvent such as mineral spirits to remove oil and grease.



GLASS

Wash with a strong detergent to remove dirt and grease, rinse completely to remove the detergent, and dry thoroughly.

CERAMICS AND POTTERY

If the edges of broken pottery or china are not dirty, the adhesive may be applied without further preparation. If the surfaces are dirty, wash with a detergent, rinse well, and dry.



Plastics

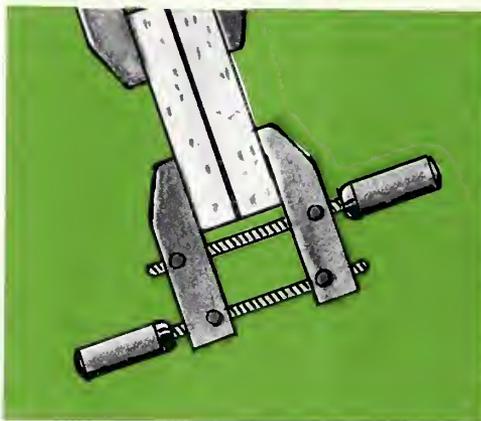
Wipe the surface with methyl alcohol, denatured alcohol, or shellac thinner to remove dirt, grease, fingerprints, and chemicals remaining from the manufacturing process. Solvents such as paint thinners and turpentine should be avoided, as they may attack the plastic. Some plastics require special methods and adhesives. For polystyrene, vinyl, and polyethylene, the following procedures are usually successful.

- **POLYSTYRENE ITEMS** such as toy cars, planes and ship models can be bonded with adhesives available at hobby shops. Some epoxies also bond well to polystyrene.
- **VINYL PRODUCTS** such as inflatable toys and wading pools can be repaired with a vinyl adhesive and plastic film patch sold in kits at many toy and sporting goods stores.
- **POLYETHYLENE**, the waxy-feeling plastic frequently found in squeeze bottles and resilient children's toys, may be made bondable by very **lightly** brushing the surface with a flame, such as that produced by a propane torch. Do not melt the surface; merely oxidize it. After flaming apply a droplet of water to the surface. If the droplet spreads the polyethylene is ready for the adhesive. Any flexible adhesive, except the polyvinyl acetate type which contains water, may then be used for bonding. Always use caution in dealing with open flames. Provide good ventilation and see to it that no inflammable liquids are nearby.



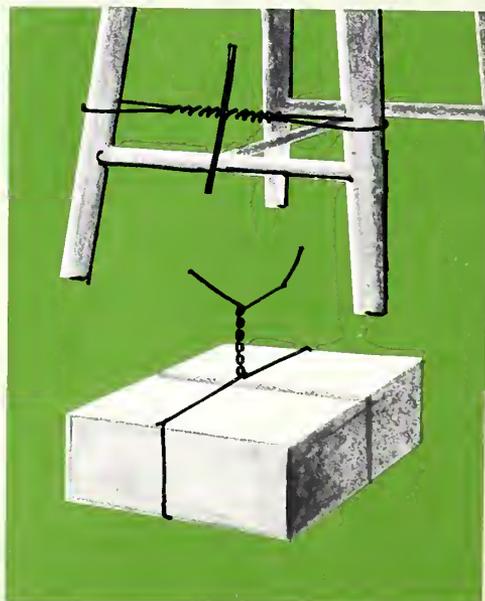
Joining the Surfaces

After choosing a suitable adhesive and cleaning the surfaces, one must join the surfaces in such a way as to produce a satisfactory bond. Usually the pieces should be clamped or in some other way fastened together until the adhesive has set or cured. The ingenious use of weights, string, wire, tape, or clamps to prevent the joint from moving during bonding will sometimes be an exasperating challenge, but properly done will insure a successful bond. In using contact cements, remember that the positioning of the surfaces **cannot** be adjusted after they are joined. The bonding of light materials, such as paper, cork, felt, or fabric can often be accomplished by using a "tacky" adhesive that will hold satisfactorily while drying or curing, or by using a contact cement.



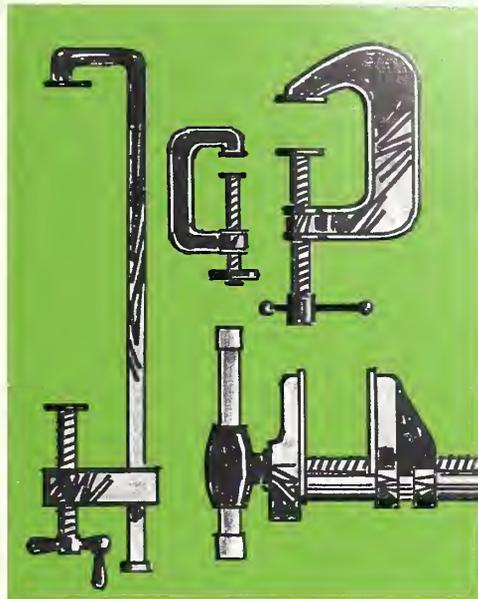
String, rope, and wire

Complicated objects may be subjected to pressure while bonding by the ingenious use of string, rope, or wire. The rungs of a chair might be held firmly in place by heavy cord, tightened by means of a stick twisted in the cord. The more complicated the item to be bonded, the more inventive you will have to be.



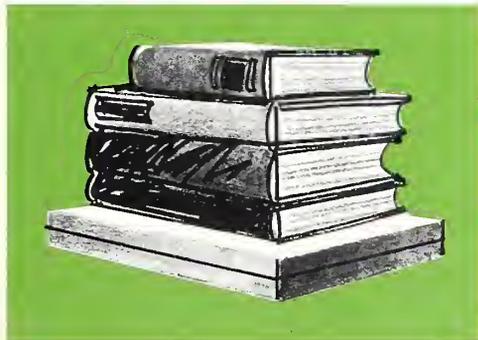
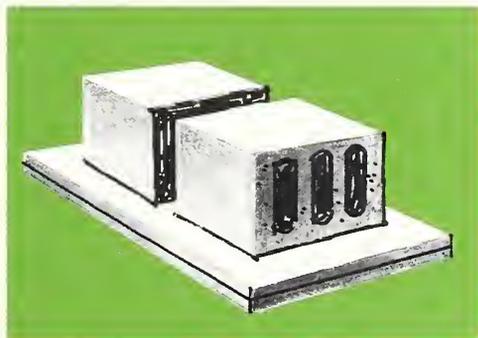
Clamps

Clamping devices vary from simple paper clips or spring operated binder clips to C-clamps and furniture clamps found in many home workshops. Special corner clamps for picture frames are available for this purpose. When clamping, care should be taken to apply the force as evenly as possible across the bonding surfaces. This distributes the adhesive to produce an even bond and minimizes the possibility of bending or warping. When a number of C-clamps are used, they should be checked a short time after clamping to be sure that adhesive flow has not caused the clamps to shift or become loose.



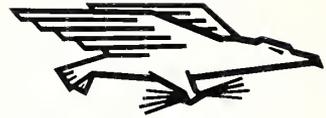
Weights

Flat surfaces may be held together by weighting with a pile of books, bricks, or any heavy object that will distribute the weight evenly. Care should be taken in assembly to apply the adhesive evenly to eliminate air bubbles and voids. To apply weight to uneven surfaces, a bag of sand or a plastic bag filled with water may be used.



U.S. DEPARTMENT OF COMMERCE
Washington, D.C. 20230

OFFICIAL BUSINESS



POSTAGE AND FEES PAID
U.S. DEPARTMENT OF COMMERCE



FROM THE NATIONAL
BUREAU OF STANDARDS
U.S. DEPARTMENT
OF COMMERCE