Lab 10: Adhesives and Fasteners

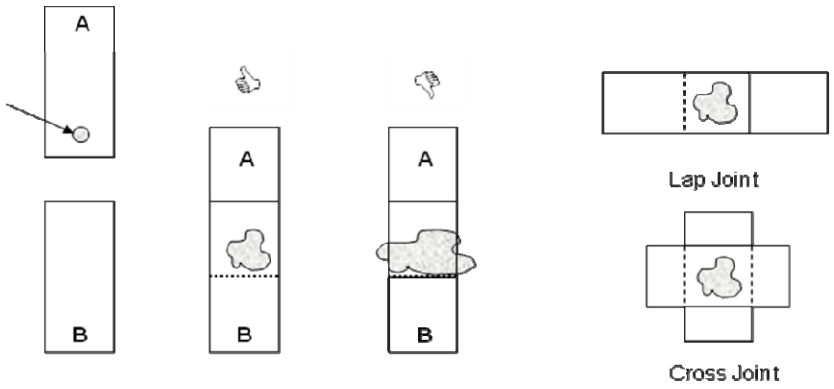
Background: This lab will explore the use of different types of adhesives and fasteners. It is meant to give you a qualitative "feel" for how choices of an adhesive and fastener will affect your optical design. In the first part of the lab, we will use "tongue-depressors" (aka wooden popsicle sticks), glass microscopic slides, and aluminum tabs to investigate several different epoxy, wax, thermoplastic, and UV curing adhesives. The second part of the lab will expose you to different fasteners and screws. You will learn how to use a torque wrench, thread/screw gauge, and how/when to use a Helicoil, plus you'll be exposed to several specialty fasteners that have specific but unique properties.

List of Adhesives

Name	Type	Form	Work Time	Cure Time Handling Strength	Use and Properties
Hardman D-50	Urethane	HARDMAN DOUBLE/BUBBLE® Green/Beige Package #04022	3-5 min	60 min	Shear strength, peel strength, good impact and fatigue resistance
Hardman A-85	Urethane	HARDMAN TUFF STUFF DOUBLE-BUBBLE Purple-Beige Package #04024	5-8 min	45 min	Fast setting, low temperature flexibility
Hardman-Red Non-Sag	Epoxy	Fast-Setting Non–Sag Epoxy 2 DOUBLE/BUBBLE Red Package #04008	3 min	15-30 min	Extra fast setting, non-sag adhesive
Loctite 326	Acrylic	LOCTITE® 326 + Primer 7649	5-10 min	24 hrs	For nonporous surfaces & fitted parts that require high-strength adhesive.
Loctite 435	Cyanoacrylate	LOCTITE® 435™	1-2 min	24 hrs	Strong bonds to nonporous materials
Elmer's Glue-All	PVAC BASED	ELMER'S GLUE-ALL	8-10 min	24 hrs	General purpose, fast-setting. Paper, wood, other porous & semi-porous materials
NOA 61	UV Curable	UV Curing Norland Optical Adhesive #61	Precure: 10 sec	Full cure: 5-10 min	Bond lenses, prisms & mirrors
UV 630	UV Curable	Permabond UV630	6 seconds		Glass, metal & plastics.
Duco Cement	Nitro cellulose cement	Devcon Duco Cement	10 min	16 hrs	Multipurpose glue for bonding wood, leather, glass, ceramics, Garolite and steel, stainless steel, aluminum, cast iron, & bronze

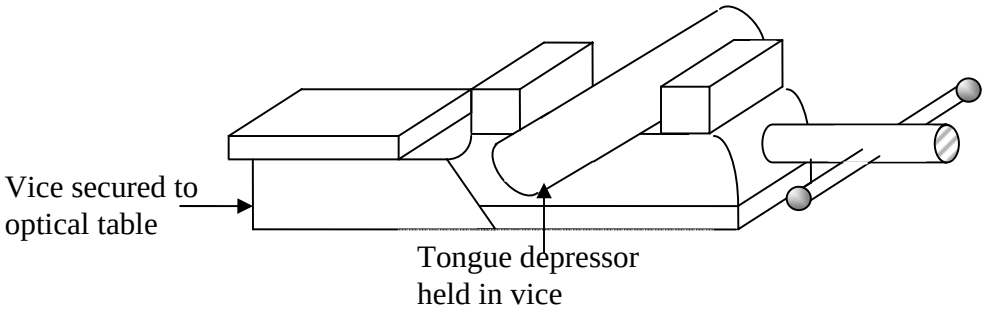
Adhesives tests

For each test, make sure to use a small amount of adhesive that does not bleed to the edge of your sample:



Approximately measure the amount of surface area that the adhesive will cover, especially for the metal samples. Label each sample (wood, glass, and metal) with masking tape to illustrate which adhesive was used.

Wood tongue depressor setup



1. Prepare a lap shear joint using Hardman D-50 and Loctite 326. Use the metal tins and wooden spatulas for mixing and applying. Feel the heat given out during mixing and curing.
2. Also, make a lap joint and cross joint using the aluminum tabs while D-50 is still uncured. Do the same with Hardman A-85 and Hardman Non-Sag Red Epoxy. For each sample be sure to carefully measure the amount of surface area that the adhesive will cover. Set aside.
3. Prepare a cross joint using Elmer's glue and Duco cement (set aside for 10 minutes to cure). Be sure the adhesive does not come out to the edges of the wood.

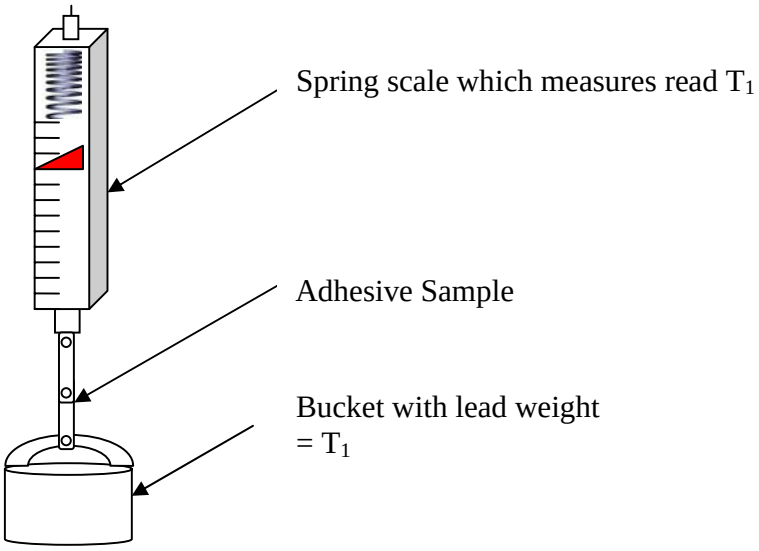
4. Wear safety goggles. Secure the sample in the vice and use pliers to apply a tension force to the wood.
5. What fails first, the material or the adhesive?

Glass microscopic slide setup

1. Prepare a lap shear joint using Loctite 435, NOA 61, UV 630. Again, be sure to only use a ***VERY SMALL AMOUNT*** of adhesive, and make sure it does not come to the edges of the glass. The Loctite 435 is a type of super glue; do not stick your fingers together with it.
2. The two UV adhesives require use of the UV light gun for curing. Be sure you and your group members only look through the orange filter screen when the light is turned on. Move the light over the sample for about 10 seconds (there is a switch on the handle which will automatically time the cure for you).
3. Wear eye protection. Place slide vertically into the vice. Add weight to the top of the device until adhesive breaks.

   Note: if you do not use a small amount of adhesive, you will not be able to break the bond.
4. Which adhesive would you recommend for
   a. Shear strength
   b. Peel strength
   c. Torsional strength
5. Place one of the UV cured bond into hot water to see if you can break the bond.

Metal Tab and Scale Setup



1. For each sample be sure to carefully measure the amount of surface area that the adhesive will cover. Use the Loctite 435, Loctite 326, and Duco cement to make shear lap and cross joints. Set aside to cure.
2. Retrieve the Hardman A-85, Hardman Non-Sag Red, and Hardman D-50 samples. One at a time, connect them to the spring scale and shown. Make sure everyone wears eye protection and is aware you are testing.
3. Start with the bucket on the ground. While one team member reads the scale reading out loud, have another person slowly pump the lift table up by pressing on the black pedal. When you get to 30 lbs start pumping slower. If you pass 50 lbs and the sample has not broken, release the tension by pressing the silver metal pedal. (Any fracture at this point would have to much recoil in the spring and isn't safe).
4. When tests are finished, be sure to wash hands thoroughly (you've handled pure lead and you don't want it in you)
5. Which adhesive would you recommend for
    a. Shear strength
    b. Peel strength
    c. Torsional strength
6. Use the stove or the torch to heat the sample. See if the bond can be broken.

Loctite threadlocker

Loctite threadlocker is an adhesive product that permanently secures a fastener into a hole, which is very desirable in some optical systems. During initial alignment, once an optic is in place, using Loctite will ensure that during normal operation, the fastener will not become loose and fall out.

Loctite's threadlocker products come in different strength grades, to suit the particular application.

- Blue Removable No. 242, 243, 246, 248, 2432 & 2440 - Used for things you may want to unscrew with minimal hassle. It cures into a brittle, glassy bond that takes one good twist to break, but removes cleanly after that. Recommended for use with valve covers, water pumps and oil pan bolts.
- Red High-Strength No. 271, 262, 266, 268, 272, 277 & 2760 - Used on things that you don't want to take apart for a long time. It requires heat from a torch or iron (to 250° C) to loosen its grip. It cures into a thicker, sticky bond that holds up better against vibration and shocks. It is typically used in mechanical applications such as nuts and bolts in cars, motorbikes, snowmobiles, and watercraft.
- Green - penetrating grade No. 220(blue), 290 & 294 - Used for parts that have already been assembled. Green No. 290 is commonly used to bond a bearing to a shaft. Due to its low viscosity, capillary action wicks the solution between the shaft and the inner race of the bearing.
- Purple - low strength grade No. 222MS & 222 - Used for set screws.
- For Plastic threads - No. 425. - Used for small plastic threads.

Fasteners exercises:

There are 2 basic classification of fasteners, metric and English, which correspond to the hardware that you need to use these fasteners. To specify what type of fastener you will use, you need to specify at least 7 categories, but for most purposes, only the first 4 (5 for metric) are commonly used.

English									
Dia (inch)		Threads per inch		Length (inch)	Head Style	Drive Style	Strength Level	Plating/ Coating	Type
1/4	-	20	x	1	Cap Screw	Hex	Grade 5	Zinc	UNC
1/4	-	28	x	1	Cap Screw	Hex	Grade 5	Zinc	UNF

Metric									
Dia (mm)		Pitch (only if fine)		Length (mm)	Head Style	Drive Style	Strength Level	DIN No.	Plating/ Coating
M8		x		25	Cap Screw	Hex	8.8	931 (partial thread)	Plain
								933 (full thread)	
M8	x	1	x	25	Cap Screw	Hex	8.8	960 (partial thread)	Plain
								961 (full thread)	

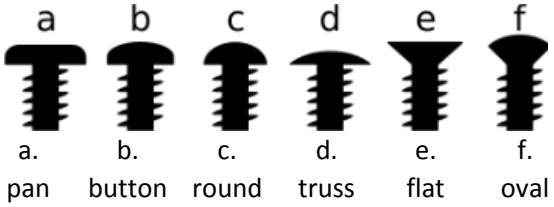


Figure 1: Head Style

	Slotted		Robertson		Polydrive
	Phillips		Tri-Wing		One-way (clutch)
	Pozidriv		Torq-set		Spline drive
	Torx		Spanner Head		Double hex
	Hex (allen)		Triple Square (XZN)		Bristol

Figure 2: Drive Style

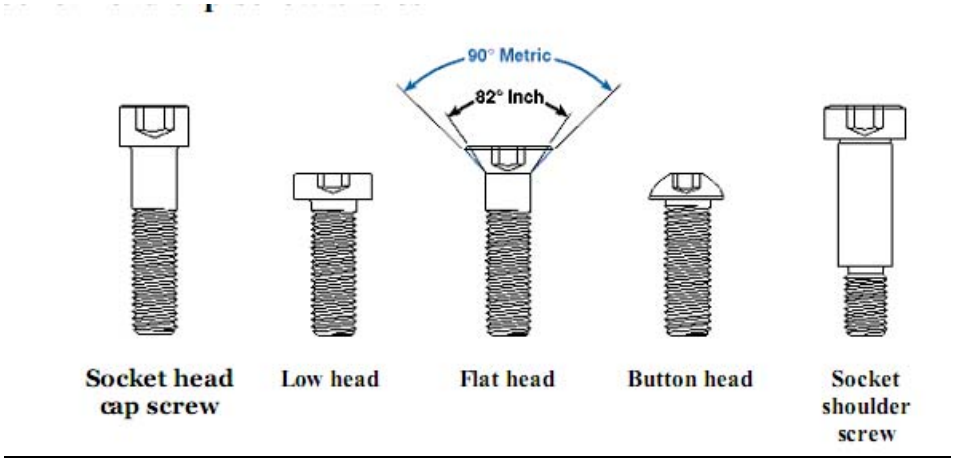


Figure 3: Socket Head Cap Screws

Identifying Fasteners

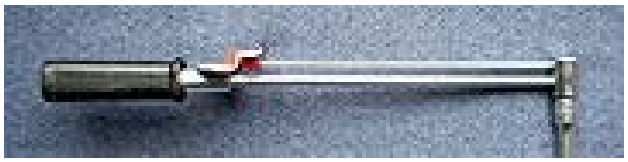
A thread gauge is a device that can measure the threads/distance of the fastener you're trying to identify, either by just identifying the pitch or also by determining the pitch and diameter. With the use of the chart above and the tread gauges in lab, identify the box of fasteners. Note the thread pitch, diameter, head style and drive style for 10 fasteners.

Specialty Washers

There are several types of washers that provide basic purposes such as increasing the head contact area of a fastener to secure locking to spacers. Examine and use the different specialty washers in lab, noting the purpose of each one.

- Belleville Disc Spring (load spread)
- Self-aligning (spherical set)
- Shim washers (different thicknesses)
- Laminated shims (adjustable thicknesses)
- Spring lock washers (resist vibrations)

Torque Wrench

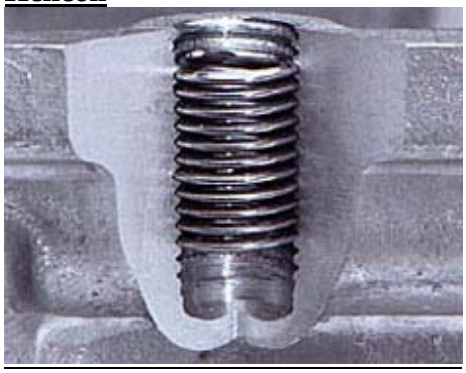


A torque wrench is simply a wrench that has a readout attached which, when calibrated, will determine the amount of turning force, or torque, you're applying to the fastener. There are different grades of fasteners based on the quality, thus there are different torque values for each grade. The lower the quality, the less torque the fastener can handle without causing internal stress and possibly failure. To determine the SAE grading for a flat head bolt, look at the number of lines coming from the edge of the head to the center. A lower number of lines correspond to a lower grade; no lines is a Grade 2, the lowest grade.

1. Determine the proper torque value for each of the bolts based on their pitch, diameter, and grade
2. Without using the torque wrench, tighten the bolt to what *you think* is the proper torque[†]
3. Using the torque wrench, tighten each bolt to the proper torque value. Did you over- or under-estimate how tight each bolt needed to be?

[†]If there is not a plate with the proper threading, tighten a bolt into the vice and use C-clamps to secure the vice to the table

Helicoil



A Helicoil is simply an insert that is threaded on both its inner and outer diameters, allowing it to be inserted into a hole and for another fastener to be threaded into the Helicoil. There are two main purposes for using a Helicoil: 1) you stripped the treading of the original hole, but you cannot use a larger diameter fastener or 2) you need a specialty thread pitch that isn't available to you using tap wrenches.

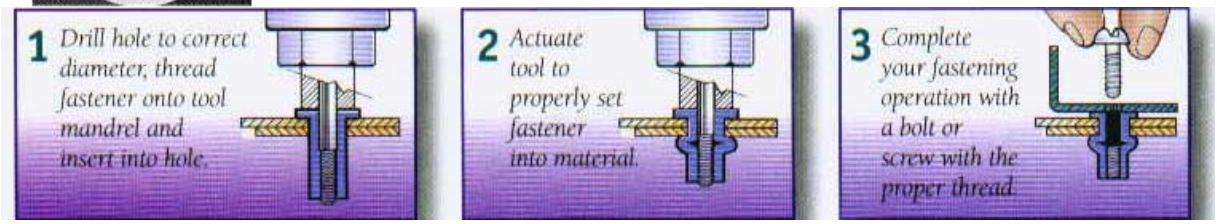
Installing a Helicoil uses the same procedure as tapping a regular hole (TA will do the drilling for you), but instead of inserting the fastener, you insert the Helicoil. Then you insert the fastener into the Helicoil.

1. Determine the drill size needed for ¼-20 Helicoil insert.
2. Tap the pre-drilled hole with the appropriate tap
3. Insert the Helicoil
4. Insert the fastener
5. Contain your overwhelming sense amazement

*FYI: In the space shuttle, there are over 250,000 Helicoil inserts!

Rivet Nuts

Rivet Nuts are also known as blind threaded rivets and AVK Rivet Nuts. Blind rivet nuts and Threaded Blind Inserts are designed to provide strong threads in thin panel sections.



They are called "blind" inserts because they can be installed from one side of the panel. There are two basic types of Rivet Nuts: standard and heavy duty. These inserts are ideally suited for tubing, extrusion and other similar types of applications. The bulge that is created presses against the panel creating a clamping force which tightly grips the sheet. In addition to high thread strength and torque-out, these Rivet Nuts have minimal inventory requirements since each size can accommodate many grip ranges. A pneumatic tool is used to draw the insert in, compressing the unthreaded portion of the fastener wall.

The standard insert types are used for most applications where strong threads are required for blind applications. Rivet Nuts, which can come in many different materials, such as Aluminum Rivet Nuts, are installed using a spin technique and tooling. Rivet Nuts provide an internal thread into thin sheet material and at the same time they can also function as a blind fastener to join two materials together. A hydraulic/pneumatic tool is used to draw the fastener in, creating the bulge and clamping force as described above.

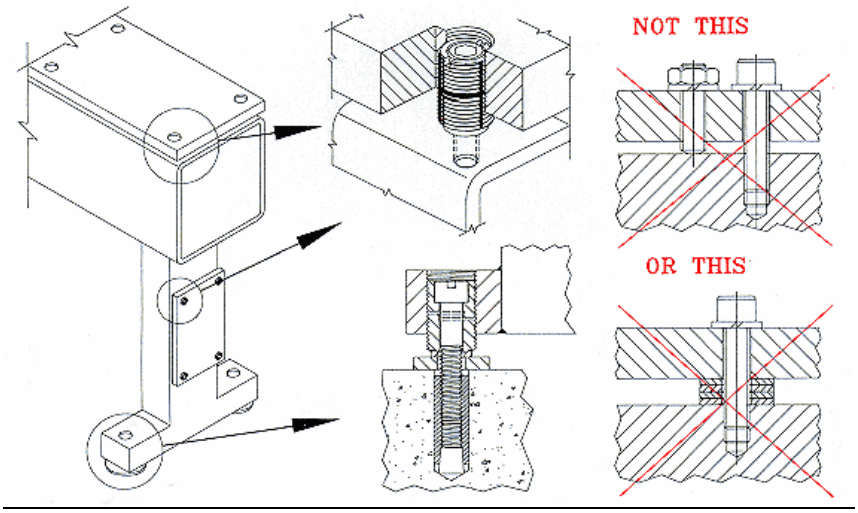
1. Insert rivet nut into the plastic boards

Micposi

http://www.harbingerengineering.com/

Conventionally, "machine leveler" means a "leveling foot" that screws into the bottom of machines and rests on the floor. MICPOSI was designed not only to level but to anchor and lock one component against another. Its typical use is the leveling of sub-assemblies to a main assembly with a thousandth of inch accuracy to each other, while often eliminating the need for machined pads.

They are used in diversified industries such as laser optics, tube bending machines, compressors and semi-conductor equipment.
Two slots allow upper and lower segments to compress and lock within the female thread without marring the top surface (With use of lock washer).
Micposi can be used without projecting above the base plate so moving components can pass over it. Just select the proper thickness of base plate or use an adaptor bushing
Micposi adjusts and locks from the top. The middle part of the base plate can be supported without the need to access lock nut or spacer.
Micposi can be installed upside-down and side-ways, as well as right-side-up.
Micposi is self leveling.



Screw Extractor

A screw extractor kit is primarily used to remove fasteners that have stripped heads. Typical extractor kits, including the one in lab, have left-hand treading, which means the normal "righty tighty, lefty loosey" does not apply. This, however, is how the extractor works. First, you need to drill a hole into the center of the stripped fastener (look at the extractor kit to determine the hole diameter). Place the extractor into the hole. Using a tap wrench, turn the extractor counter-clockwise. The extractor will begin to engage the stripped fastener, then as you continue to turn the extractor will not be able to twist into the fastener anymore, causing the fastener to start coming out of the hole.

1. Drill a hole into the stripped hole
2. Choose the proper size extractor
3. Remove the stripped fastener