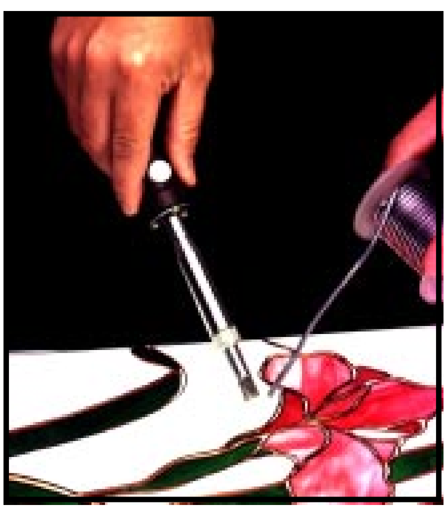
How to Solder Like a Pro

Detailed instruction, helpful hints, safety tips, and a comprehensive troubleshooting guide



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Thank you for your interest in Inland's How to Solder Like a Pro manual. Whether you are a beginner or an experienced stained glass artist, you will find useful information about selecting and maintaining your soldering tools and improving your soldering skills.

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The Importance of Safety

One of the most important aspect of soldering any stained glass project is to take the proper measures to safeguard your health. Soldering involves working with potentially hazardous materials like lead, flux and harmful fumes. By observing specific safety precautions and using informed common sense, working in stained glass can be a safe and enjoyable past time. The following is intended to serve as a general rule of thumb. Since each person and situation is unique, you should use this information as a starting point to help you make informed safety decisions concerning your soldering habits.

Fumes

Solder only in a well ventilated area, and use an exhaust device that moves solder fumes away from your face. It's preferable to exhaust outside (check local/state building codes and restrictions on venting to outside air). If you don't exhaust to the outside, use a bench top fan or intake device with a replaceable smoke/fume absorber made for stained glass artists. It should draw solder fumes into the replaceable filter. The filter should be activated charcoal and designed to remove particles smaller than 1/2 micron from the air. There are also several OSHA approved respirators available for fumes. Consider wearing one in conjunction with a venting system, especially if you plan on soldering for several hours every day.

Lead

Most popular solders used in stained glass are lead based. When you are using them, follow these precautions:

- Never eat, drink, or smoke in any area where soldering takes place.
- Always thoroughly wash your hands after soldering.
- Make sure your soldering equipment and supplies are kept out of the reach of children.
- Do not discard lead or solder scraps into the trash. Find a means or place to recycle them.
- Never use lead based solders or cames on items that will come in contact with food or children, or will be frequently handled. If you are making kaleidoscopes, jewelry or napkin holders, use lead free solder.
- Consider having your blood lead level checked by your physician on a regular basis to help you monitor your handling practices.
- If you are pregnant, or considering it, you should check with your doctor before using lead or solder.

Heat

Soldering tools operate at high temperatures, so these safeguards are important:

- Wear safety glasses! Solder and flux can "pop" and "spit."
- Solder on a fire resistant surface. Homosote, or dry wall are good .
- Never leave your iron plugged in and unattended.
- Do not overload a wall outlet with too many electric appliances.
- Never set your hot iron down on anything other than an iron stand.
- Replace the cord of your iron if it becomes worn or gets burnt.
- To prevent burning your fingers, use needle nose pliers or heat resistant gloves to hold small pieces.
- Never cut off a grounding prong on an iron plug to make it fit an ungrounded receptacle.

Soldering Irons

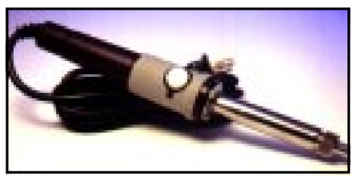
Choosing a Soldering Iron

There is a lot to consider when you choose an iron for stained glass. The handle should be heat resistant and comfortable for you to hold. You may be holding it for several hours at a time, so consider the weight and balance of the iron. Carefully check the wattage of the iron that you are considering. It must be able to continuously generate enough heat to melt all of the types of solder you plan to work with and be compatible with the type of construction you use (i.e.-copper, foil, lead came, rebar, etc.). You will need an iron that is at least 60 watts, with chisel type tips, and a way to control the temperature.

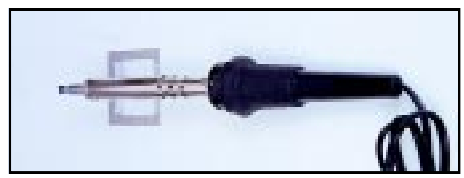
Types of Temperature Controls

A broad range of soldering irons are available. Most irons, which we will call "conventional irons," are made with wound wire heaters in a barrel with mica insulation. They are often inexpensive, but they do not offer the ability to control operating temperature. A separate temperature controlling device must be used with these irons to achieve the best results. There are three types of soldering irons that are easier to use for stained glass projects, because they allow you to control temperatures more effectively:

Irons with temperature controlled tips.



Irons used with temperature controlling devices.



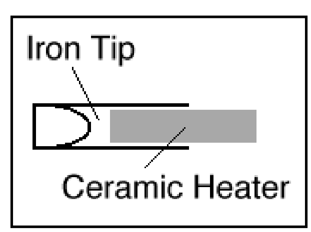
Irons with ceramic heaters.

Irons with Temperature Controlled Tips

These irons are supplied with an internal regulator in the tip that does not allow the iron to exceed a predetermined temperature. An example would be a 600^{o}F tip. The iron heats to that temperature then "shuts off." When heat is required, the iron "turns on" again. Tips are available in predetermined temperatures up to 800^{o}F. These irons are easy for beginners to use, because the temperature is automatically maintained for you, however, as your skills increase, you may prefer to control the amount of heat yourself for different soldering situations. The limited amount of control may become frustrating as your soldering skills increase. With this type of iron you will likely encounter "cold spots" where the iron will not melt your solder. These cold spots occur when heat is being drawn out of the tip faster than it is being replenished. You will need an iron with a minimum of 100 watts.

Ceramic Heating Element Irons

These irons are relatively new to the stained glass trade. They are made with highly efficient ceramic heating elements. Like a ceramic room heater, they produce a consistent temperature using less electrical wattage during operation. When initially heating and when reheating during "recovery" periods, they can draw a "burst" of power exceeding 100 watts and then efficiently reduce electrical consumption, often below 60 watts, during the soldering process. The result is efficiency and economy.



A remarkable feature of ceramic heater irons is they generally reach operating temperature in less than 60 seconds. Of the three types of noncoventional irons, the ceramic heater type best maintains consistent tip temperature over extended periods of time. Problems with slow heat recovery generally don't exist. A ceramic heater iron offers excellent flexibility and can be used with a temperature controller if you like.

Temperature Controlling Devices

A temperature controller is a device that operates similarly to a light dimmer switch. By dialing the control to a higher or lower setting, more or less electricity is fed to the iron. This increases or decreases the iron temperature, allowing the tip temperature to be controlled. You can establish the maximum temperature without changing tips.

A temperature control/iron combination offers you greater control and flexibility than a temperature controlled tip iron when working with different metals and solder mixes. Look for one that is at least 85 watts. Since the flow of electricity to the tip is consistent and never completely stops, encounters with cold spots are nearly eliminated. A temperature control/iron combination is suitable for all types of stained glass construction.

Temperature controllers are generally separate units that the iron plugs into. They are small, easy to use and relatively inexpensive. There are also irons that have controls built into the handle of the iron, which generally cost less than buying an iron and a separate control. Never plug an iron into a temperature control unless the manufacturer specifically states it is suitable for use with it.

Tip Sizes, Styles and Uses

Stained glass irons are generally sold with a "chisel" style tip. There are a variety of tip sizes and styles available for nearly every iron used in the stained glass industry. Different tips can expand the versatility of your soldering iron, so select an iron that offers more than one size replacement tip.

The standard tip size that comes with an iron is usually from 1/4" to 3/8" wide. This size works well for soldering either copper foil or lead came projects.

A smaller chisel tip, 3/16" wide, can be useful when soldering small pieces or when soldering in a tight area, such as a narrow inside part of a kaleidoscope. It is also very effective for decorative soldering.

Very small tips, 1/8" or narrower, are usually used for decorative soldering. They allow you to create very fine details and designs with the solder.

Iron and Tip Maintenance

The Importance of Proper Care

Your soldering iron may very well be one of your biggest tool investments, so you will want to do everything possible to ensure that it gives you many years of service. Well maintained soldering irons and tips perform better and make the job of soldering much easier. Always place your soldering iron in a stable iron stand whether it is being used or not.

The Cord

- Make sure you plug the iron into the correct type of outlet.
- Try not to use an extension cord. If you must, use a heavy duty one.
- Don't drop or bang the iron. Ceramic heaters are especially easy to crack or break.
- Regularly check the cord for burns or cracks and have a professional electrician replace worn cords before using the iron.
- Make sure that the cord is not hanging in such a way that it can be pulled off of the table.

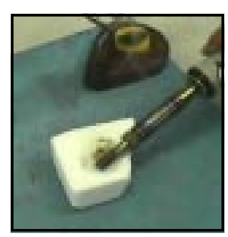
The Heating Element

- Do not allow the iron to idle at operating temperatures for extended periods. This could burn out the heater element. Unplug the iron or, if you are using a rheostat, turn it down to a low "idle" setting.
- Occasionally, remove the tip and **lightly** tap the barrel of wire wound heater irons to remove debris.
- If you will not be using your iron for an extended period of time, you may want to store it (after it has fully cooled) in a zipper type bag to protect it from corrosion and humidity.

The Tips

- When you are finished using your iron, remove the tip from the barrel. Removing the tip is essential to preventing "seizing" which can occur if it is left in the iron for extended periods. (If your tip seizes, you can easily damage the heating element trying to remove it. It is best to return you iron to the manufacturer for removal.)

- When reinserting tips, make sure they are properly seated in the barrel.
- Never dip your tip into flux in order to clean it. Instead, use a clean damp sponge to wipe all sides of the tip periodically as you solder. Doing this removes impurities the tip has accumulated from the solder and the environment. It will ensure that you are receiving the maximum heat at the tip surface.



- Properly cleaned tips are bright and shiny. If your tip becomes "blackened," you can usually remove the buildup with a wet sponge, a tinning block or by gently using a brass brush. A “tinning block” (sal-amoniac) is used by placing a small amount of flux on the block and rubbing the tip of your hot iron in it. Wipe the tip on a damp sponge to remove debris. You may need to repeat this several times if your tip is very dirty.)
- Never use sandpaper or any abrasive material to clean a tip.
- The best way to minimize your tip maintenance is to find a good quality solder. Use one that has a high tin content and high metal purity.

Solder

Why Do We Use Solder?

Solder is a combination of tin and lead used to create a strong bond between other metals. Since solder won't stick to glass, we apply a copper foil tape (our metal) to the edges of the glass. This is refered to as the copper foil method of stained glass construction. Solder is melted over the copper foil, creating a structure that holds the pieces of glass together. The other option is to set the glass into channels of lead or metal, and solder the channels together. This is refered to as the lead came method.

The Advantages of Solder

Some of the advantages of soldering versus other bonding methods are:

- Solders are easy to use and relatively inexpensive.
- Low energy is required to solder.
- Properly soldered joints are highly reliable.
- Solder joints are easy to rework or repair.
- Experienced craftpersons can exercise a high degree of control over the soldering process.
- Solder joints age very well. They can last for years, decades and centuries.

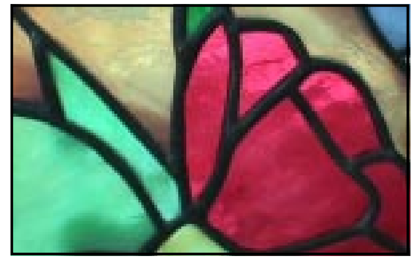
Types of Solder

Stained glass solders are usually a mixture of tin and lead, designated by two numbers representing the percentages of each metal in that specific mix. The first number always refers to the percentage of tin, the second is the percentage of lead. The most commonly used solders in stained glass are 60/40, (60% tin/40% lead) 50/50 and 63/37. "Lead-free" solders have no number designation and are a mixture of tin and small amounts of other metals. Avoid solders containing antimony, a very toxic element. Instead look for lead-free solders containing silver, or copper. They are safer and easy to use. (Note they are, however, more difficult to patina.)

In North America, you will find solder is generally sold in solid core wire form on a spool. The common spool size is one pound. In Europe, you will find solders primarily sold in a bar form. Never use acid-core or rosin-core solders for stained glass work. Look for solders that are sold as "free of impurities" in the component metals. Impurities cause a "scum" on your solder bead, degrade soldering iron tips, and interfere with the proper reaction of patina chemicals resulting in undesired finishes.

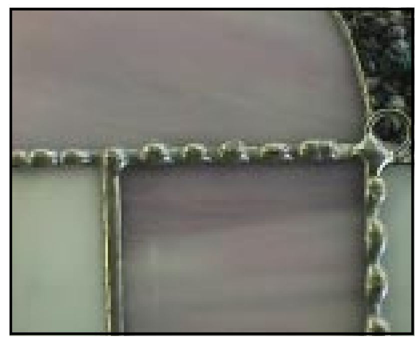
An important term for solders is the "working range" or "pasty range." This is the range of temperature between which solder transitions from liquid back to solid.

Characteristics of Solder Types



60/40 Solder: Composed of 60% tin and 40% lead, this solder melts at 374°F, but doesn't become completely solid until it cools to 361°F. This means it has a "pasty range" or "working range" of 13 degrees. This solder is your best choice for copper foil work. The liquid temperature and narrow "pasty range" make it easy to form and maintain consistent high, rounded, beaded seams. Because of its relatively low melting point, "60/40" solder is easy to rework to maintain a smooth finish solder bead.

50/50 Solder: This is composed of 50% tin and 50% lead. It is liquid at 421°F, solid at 361°F and has a pasty range of 60 degrees. This solder will produce a much "flatter" bead than 60/40. Because of its higher melting point, 50/50 solder is often used on the back (or inside) of a stained glass project to protect against "melt through" when soldering the front. Because it spreads and flattens out, 50/50 solder is often used when soldering lead came joints.



63/37 Solder: This solder is 63% tin and 37% lead. It becomes liquid at 361°F, and solid at 361°F, with a pasty or working range of 0 degrees. This solder is called a eutectic alloy which means at 361°F, you can go instantly from solid to liquid to solid just by applying or removing the heat source. You will often find "63/37" solder referred to as decorative or quick set solder. It is primarily used to create dimensional effects in the solder itself and can be "pulled" and manipulated to produce a variety of textures and designs. 63/37 solder also makes an excellent solder to bead up the outside rim of copper foiled pieces.

Lead-Free Solder: Depending on the specific mix of metals, lead free will produce differing liquid, solid, and pasty range temperatures. Check with the solder manufacturers for these specifics. Lead-free solders will perform similar to a 50/50 mix. Lead-free solders require more practice in order to obtain a smooth bead on copper foiled pieces and should not be used on lead came projects. Lead-free solder is the most expensive solder, but is the solder of choice when constructing pieces that will contact food, that will be handled frequently, or that will be used in a child's play area or room.

Solder Composition Reference Table

Alloy	Tin%	Lead%	Solid to	Liquid at	Pasty Range
50/50	50	50	361^0	421^0	60^0
60/40	60	40	361^0	374^0	13^0
63/37	63	37	361^0	361^0	0^0

Flux

Why Do We Use Flux?

Flux is a chemical compound that is used to promote the bonding of metals by removing the oxide residue simultaneously with the soldering process. Most metals left exposed to the air around us react with the air to form residue on the surface of the metal. The process is oxidization and the residues are oxides. Each mix of metals being joined has a specific flux that best promotes this bonding process. In stained glass, the metals being joined are primarily copper to tin/lead solder and lead, brass or zinc to tin/lead solder.

Types of Flux

Selecting the correct flux for your application is as critical as any other step of the soldering process. The proper flux will assure less soldering problems and a satisfactory solder bond. The best fluxes do three things:

- They remove all the residue that has formed on the surface of the metals you are going to solder.
- They prevent oxides from forming while you are soldering.
- Any post-soldering residue they leave is noncorrosive and easily cleaned off.

Fluxes are available in organic and inorganic forms. If you touch the flux and your skin seems to have a sensitivity to one type of flux, an inorganic type for example, try an organic variety. Often you will find that you are less sensitive to irritation by using the opposite type flux. Organic fluxes are generally some form of oleic (fatty) acids, while inorganic fluxes are most often zinc chloride based.

Characteristics of Fluxes

Liquid flux is the most widely used. It may or may not be water soluble. Water soluble fluxes clean up very easily, but are thinner and some have a tendency to evaporate quickly and require repeat applications. Some liquid fluxes are thinner than others and have a tendency to run or spread out from their point of application.

Gel Flux is generally water soluble and "adheres" well to the surface being soldered. Gels tend not to evaporate as readily as liquid flux, but if you apply too much, they produce more "spitting" and "popping" as you solder.

Paste Flux is very thick, stays where it's applied, and doesn't evaporate easily. It's effective when soldering 3-D forms such as lamps. Paste fluxes can be difficult to clean. Be very careful not to over apply a paste flux as it will also spit and pop, leaving pits on your solder seams.

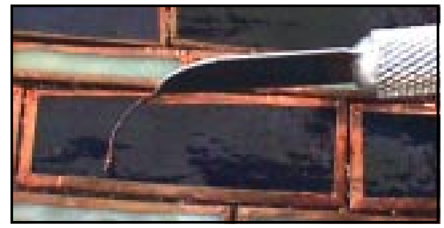
Getting the Most From Your Flux

It is important to keep your flux clean and free of impurities. This will ensure the purest possible solder joint. One way to keep your flux clean is to avoid dipping in and out of the original container. Pour out the amount you will need for your current project into a separate, smaller container. Don't leave the flux bottle sitting around with the cover off. Never pour leftover flux back into the original container. Fluxes often will produce fumes as you solder. Make sure you are aware of and follow the precautions suggested in the health and safety section of this guide.

Soldering Basics for Copper Foil

The quality of the solder job can make or break your project, yet it is the step that takes the most practice to become good at. Soldering is more difficult than the other steps in stained glass because there are so many things that can effect it: the amount of heat, the amount of solder, the type of flux, the rate at which you move, gaps in the project, etc. The following step-by-step instructions will give you the basics of soldering. If you are just starting out, you will learn a lot. If you are experienced, you may just find the trick that makes it all come together. Great soldering takes a little bit of knowledge and a lot of practice.

Before You Start

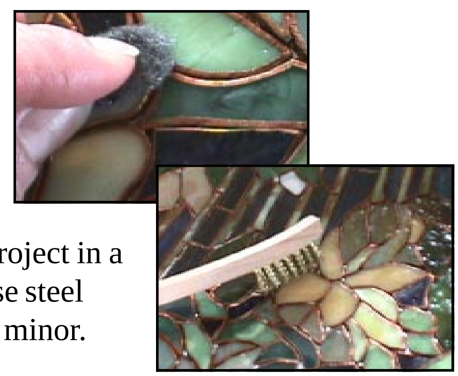


Preparation is the key to producing a good solder bead. Here are some suggestions to help you get of to a great start!

- Make sure that the foil is seated properly over the glass.
- Trim all overlaps in the foil using a sharp craft blade.
- Assemble all the tools you will need so they are at hand.
- Wear safety glasses.
- Have a proper ventilation set up.
- Make sure the foil is well burnished and sealed smoothly to the glass surface.
- Secure the glass pieces using pins, or squaring blocks made for this purpose before soldering.

Set aside enough time to solder your entire project all at once. If you don't, dried flux and solder residues on the unfinished parts will make further soldering difficult. Flux allowed to remain on a project can compromise the strength of the solder joints.

Cleaning Before Soldering



Sometimes the surface you are going to solder needs cleaning to remove visible grime, dirt, residue or oxidization. In this case, use 000 or 0000 steel wool to clean the surface of copper foil. For lead came or excessive oxidation carefully use a soft brass brush. If you won’t be able to solder your project immediately after it is copper foiled, store it in a plastic bag to help reduce oxidation. If you partially solder the project and have to stop before it is complete, be sure to clean off all of the flux and store the project in a plastic bag until you are ready to continue. You will probably still need to use steel wool on the joints when you are ready to solder, but the clean up should be minor.

Getting Started

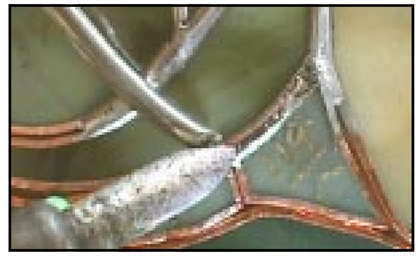
Begin the soldering process by fluxing all intersections of the glass project. Then "flat tack" solder these intersections together by using a very small amount of solder and the flat face of the iron tip. The solder should lay flat on the intersection and you shouldn't have any beads or bumps of solder on the piece. Hence the name "flat-tack" soldering.

Now, fill any gaps between the glass pieces by melting solder into them until the solder is level with the surface of the glass. If you have large gaps, you can ball up some copper foil, with the sticky sides together, and fill the gaps. This will help keep the solder from seeping out the other side.

"Tin" the entire perimeter making sure to work some solder into seams that intersect the perimeter. (Tinning is the process of coating a surface with a thin layer of solder. Apply just enough solder to turn the foil to the silver color of the solder.) This creates a "dam" that prevents solder from spilling over the edge when you solder the interior seams.

Next, flux an area you can comfortably finish soldering before the flux can evaporate. Start at the top of the piece and work down. This prevents you from dragging your sleeves and hands through the flux.

Running The Solder Bead



Hold your soldering iron in your writing hand. Position the iron comfortably so the face of the iron tip is perpendicular to the seam. If you hold your iron like a carving knife you will automatically put the tip in the best position for soldering. It will also keep you from "painting" with the iron. You will hold the solder in the opposite hand. Start soldering by placing the iron tip down on the foil seam with the wider face perpendicular to the seam and facing you. Touch the solder to the tip of the iron, just above the point where the iron tip touches the copper foil. Allow the solder to flow down the tip face onto the seam as you move the iron along the seam. Feed the solder at a continuous, even rate to create a consistent, rounded bead of solder over the seam. This takes practice!

If you apply too little solder or move too quickly, your seam will be flat. To correct this problem, allow the solder to cool, then resolder the joint applying more solder. On the other hand, be careful not to feed the solder too fast or move the iron too slowly, as this will cause the solder seam to bulge and flow out over the glass.

Fixing Imperfections

If you have too little solder, just add more, being sure to remelt the previous solder line as you apply another coat. If you applied too much solder the first time, it’s easy to remove the excess with the following procedure. Clean your iron tip thoroughly on a sponge. With the iron tip positioned with the flat face down, move it across the seam, "pulling" the excess solder onto the glass. Clean your tip and repeat the process until all excess solder is removed. Another method for removing excess solder is to wait until all the seams have been soldered. Then place your project up on edge and run the tip through the seam allowing the excess to run off. Lay the piece flat, reflux, and rework the seam, adding additional solder as needed.

When you solder, work slowly enough to produce a good bead, but not so slowly that solder melts through seams to the back side of the project. Here's a hint: one way to prevent this is to put damp paper towel under your panel before you start soldering. Moving too slow also increases the likelihood of causing heat fractures on your glass.

Other Things To Consider

Always keep your tip clean by frequently wiping all sides of the tip on your damp sponge. Wait momentarily for the tip to reheat before continuing to solder. A clean tip maintains proper heat and removes impurities.

To achieve a smooth solder line, solder the longest continuous seam possible. Don't start or stop a solder seam at an intersection with another seam. As you meet an intersection, allow the solder to break or "y" out over the intersecting seam about 1/2" and then return to the original path you were soldering in one continuous motion. As you continue to solder seams, you will connect these branches, thus preventing pulling out at intersections of seams (which is a noticeable sign of a beginner). When you encounter a "v" type joint. Solder in a direction that moves up into the "v" point, instead of coming down onto the point. This keeps a nice clean "v" joint without excess solder obscuring it. Do this by soldering up one leg of the "v" and as you approach the apex, drop your iron tip down flatter on the glass, so that it crosses over both seams. Then continue soldering into and out of the point of the "v."

Avoid a "painting" motion when soldering. Visualize your iron as a magnet pulling along a metal strip. Maintain a small puddle of solder at the base of the tip as you solder. When two adjacent pieces of glass vary in thickness, ride the tip on the higher piece of glass as you solder.

Effects of using the iron like a paint brush

A big advantage of using copper foil is that not-so-perfect solder seams can be reworked. Allow the seam to cool, reflux it, then resolder. Be careful because reworking a seam too many times (more than 2-3) can cause the adhesive on the foil to loosen and bubble.

Solder one side of your project completely, then turn it over and repeat the process on the other side. Some of the flux from the first side you soldered will have seeped to the other side. You may encounter more "spitting," so use flux very sparingly. To achieve a smooth, beaded solder seam: practice! practice!

Ending A Bead

When you are ready to end your seam, pull off across the face of the glass making sure you are in a liquid section of the solder seam and do not lift straight up. This technique leaves a smooth exit point that is virtually unnoticeable. You may notice that this is the same photo used for removing extra solder. It’s not a mistake. The action is very much the same.

Practice!

Creating perfect solder seams takes practice. One good way is to make a practice board. Make sure to include all types of intersections and lines (curvy and straight). Foil the piece and flat solder it on the front and back. Practice each different soldering technique. When you are finished, you can hold the piece vertical and melt the solder off. Now you are ready to start again. Many people use the practice board before they start soldering each project, just to get the feel of soldering again.

Cleanup After Soldering

After soldering, you will need to remove all flux and solder residues from your solder lines and glass. The best cleaners to use are ones that neutralize the acid property of fluxes. To properly clean your project, you will need a good flux cleaner, very warm water and a soft scrub brush. Thoroughly brush the cleaner into every corner of your project, front and back. Follow this with a long rinse in clean, warm water and then towel the project dry. This step is very important because any flux that remains will continue to react with the solder, causing oxidation. If your project looks good after the initial cleaning, but the solder lines have a white or green growth on them after a few weeks, it generally means that all of the flux was not removed from the project. You can use 000 steel wool to remove the patina and finishing compound and thoroughly clean the project. Then reapply the patina and finishing compound.

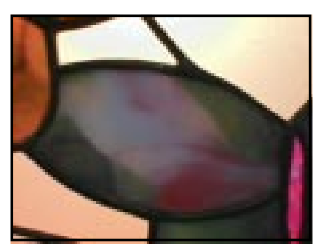
A small stiff scrub brush is the best way to clean the entire project. After the initial cleaning, you may find some areas that need additional attention.

You may find small pieces of solder stuck to the glass. You can easily remove these using your fingernail, or 000 steel wool. Be careful not to scratch the glass.

An old toothbrush can be helpful for cleaning in tight intersections and right up against the solder line.

Occasionally you may find that after applying patina, certain types of glass acquire a “rainbow” effect. This is most likely to occur on hot colors, black, white and iridized glass. It is one of those things that is unpredictable and difficult or impossible to remove. You can try to remove it by using a paste made from baking soda, but it doesn’t always work. The only way to prevent this occasional problem is to be very careful not to get patina on your glass. Use a cotton swab to apply the patina only to the solder lines of the project. If you have this problem, it is a good idea to make note of it on any remaining glass, so you can be more careful the next time you use that particular glass.

Finishing

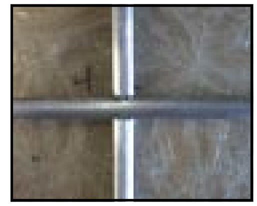


After cleaning your project you should use a finishing wax or compound to keep it looking it’s best. A good quality carnauba wax or pre-mixed wax and cleaner should be applied to all of the solder lines. A nice side effect is that the wax also enhances the color of the patina making it either rich black or shinny copper. You may find it helpful to reapply the wax after a few months. (If you would like to change the color of the solder, see the section about patina on page 16.)

Soldering Basics for Metal Cames

Lead came construction requires a different soldering technique than that used for copper foil. You can use the same iron and flux, but the preparation and actual soldering will differ. You will be soldering only the joints, instead of running an entire bead. With a little knowledge and some practice, you will be able to make perfect solder joints on lead or other metals.

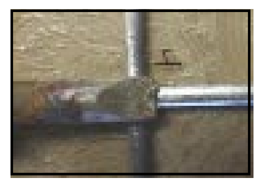
Getting Started



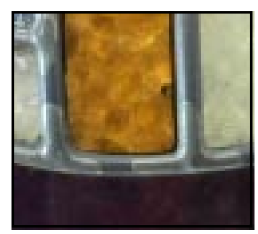
First, make sure that all joints are in line with each other and butt against each other with no gaps. Use a triangle and/or square to check the squareness of the panel and make sure that your lines run true across the panel in all directions. Make any adjustments that are needed. Thoroughly clean surface oxidation from intersections with a soft brass brush.

Soldering

The most desirable solder to use when constructing a lead project is 50/50. It flows out from the point of contact, leaving a nice joint. Do a "lead" test to check the heat of your iron. Allow the iron tip to heat for several minutes. Then, place the flat face of the tip on a scrap of lead. If the lead melts, the iron is too hot. Lower the temperature or change to a lower temperature tip. (This is where a rheostat iron is great.) Now test the tip with 50/50 solder to make sure it can melt it. If it does, your tip temperature is adjusted correctly. If not, raise tip temperature just until you melt the solder. Recheck the tip temperature and test it on the lead again. Now flux all the joints on your panel.



Begin by holding the solder on the joint. Move in to the joint across the glass, not from across the came. The wide face of the tip should be down toward the joint. Coming into the joint over the glass prevents leaving a solder trail on the lead came at one end of the solder joint. Techniques like these are the signature of an accomplished craftsperson.



Melt only a small amount of solder and move the tip in a slight circular motion allowing it to flow out over the joint a distance equal to the width of the came being used. Pull the iron tip straight up off the center of the joint. The desired end result is that intersections of the lead cames are not visible through the solder and the solder on them is smooth, not beaded. You should be able to run a fingernail over the came and into the soldered joint without it catching or clicking. Solder the joints on the front of the project. Then turn the project over and repeat the same process on the back.

Finishing

Lead projects need to be finished by applying a cement. The cement will weatherproof the project and secure the glass in the channels. This step is necessary on any came project to ensure a strong, secure panel. Cement is easily applied to the panel by using a small scrub brush to work the cement under the channels both on the front and back of the project. After the cementing process is complete, whiting sprinkled over the entire surface and allowed to absorb excess moisture for a few minutes. Using a stiff brush, vigerously brush the lead channels, removing excess cement from the glass. The brushing process allows a natural patina to form on the lead, so it is not necessary to apply patina to the project. Allow the project to dry thoroughly, usually for a few days, before installing or hanging the project.

Soldering Basics for Other Metals

Vase Caps

Vase caps are generally made from spun brass. The cap must be very clean of all dirt and oils for the solder to adhere. Use 0000 steel wool to clean the areas that you will be soldering. The cap also needs to be quite hot in order to achieve a good bond between the solder and the brass. An easy way to get the cap hot is to heat it in a hot oven for about 15 minutes. Use pliers to carefully remove the cap from the oven. Center the vase cap on the lamp. Flux all areas you will be soldering. (Paste flux is easy to use for this purpose, because it doesn't drip.) Get a small amount of solder on your iron and hold it on the vase cap for a minute or so at the area you want to make a connection to the lamp. When the cap is hot enough, the solder will spread out instead of lumping up. Add more solder to make a connection to the lamp. (Some vase caps have a lacquer finish on them. This must be removed at the areas you need to solder. Use a craft knife to gently scrape the lacquer in these areas.

Spiders

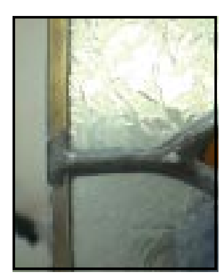
Spiders are made from brass as well. You can either cut the legs to fit, or bend them. Like a vase cap, you need to get the brass quite hot in order to create a good bond with the solder. Unlike vase caps, you can get the smaller area of the spider hot enough using just your soldering iron. Simply hold your iron tip on the area that you need to solder for a minute or so. Apply flux and a little solder, and continue to heat the spider with your iron. When it is hot enough, the solder will smooth out around the spider leg and adhere to the lamp. If the solder is globed up, the spider leg isn't hot enough. Continue in this manner for all of the legs.

Metal Outer Channels

When attaching a zinc, copper or brass edge to a project, use this solder technique: Cut the zinc, copper or brass came vertical members to overlap the horizontal members in a "butt" type joint. A butt joint provides structural stability and distributes weight. Before you solder the butt joints, you can use masking tape to contain the size of the solder joint.

Clean and flux these joints and solder them to each other using the flat tip of the iron on the metal. The metal channel will take a little longer to get hot than copper foil. If the metal is not hot enough the solder will not smooth out. The metal frame should be attached to the panel by soldering it to any lead lines that it touches.

On leaded projects, solder from the outer metal edging onto the lead came, pulling the iron tip straight up over the point of intersection when completing the solder joint. This simple technique will level the solder smoothly over the joint.

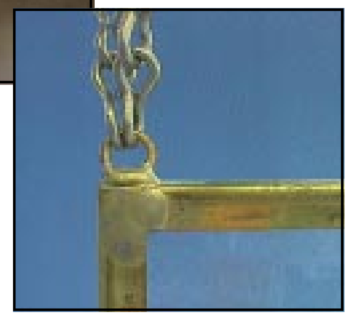


For copper foil pieces, stop your solder bead about 1/4-1/2" from the outer edge to allow room for the metal edging to fit onto the perimeter of the project. If you forget to do this initially, flatten the solder bead so the outer edging fits onto the project. After fitting the outer edging material, flux and solder the corners as outlined above. Connect the copper foil beads that intersect with the outer edging metal by continuing the solder bead into the edging making sure that the solder adheres securely to the metal edge.

As you work more with your iron, different solders, lead came, and copper foiled projects, your skills will increase. You will quickly develop the techniques that will make you more confident in tackling increasingly complex projects.

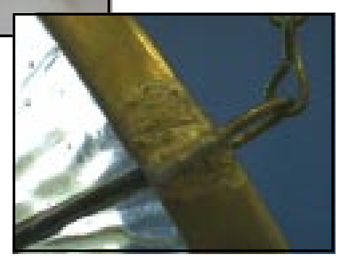
Hanging Hardware

There are many ways to hang your project. You will want to make sure that the method you choose will support the weight of the project. You can purchase pre-made hardware from your stained glass store, or make your own using any type of solderable wire. If you are using wire look for 16 to 18 gauge.



Rings can be added to the metal border of the project if it is not too heavy. A general rule of thumb is about one square foot. Hold the ring with pliers and solder rings to the metal border of the piece wherever they allow it to hang properly. Just like soldering the channel together, if you don't allow the metal to get hot enough, the solder will not adhere well. This will result in your hanging rings failing.

A stronger type of hardware is made using wire. Twist together four strands of 16 -18 gauge wire, leaving a loop at the end. Cut the wire to about 1/2". Insert the wire into the opening of the metal channel, bending the loop the direction you need it to be. Solder the hanger to the channel and fill the opening with solder.



Another option is to make a loop from twisted wire and solder it to the front and back of the metal channel, with the loop extending above the project. Be sure to solder the hanger into an existing solder joint, not just to the channel. This will prevent the weight of the project from pulling the channel away from the glass.

By the way, the joint on the hanger at the right was painted to match the brass channel using a gold paint pen.

Patina

Solder and lead change color naturally over time, but you can change their color instantly by using patinas. There are several different formulas producing a variety of colors. Patinas are easy to use. Make sure that your project is thoroughly clean and free of solder, flux and cutting residues. Use a brush or soft rag to apply the patina to the solder until you reach the desired color. Wash the panel again to remove any patina from the glass.

- 👍 When using antique brass patina, first scrub your solder seams with fine steel wool. Apply the patina sparingly with a clean brush, using only a few strokes. Over use will produce a coppery finish.
- 👎 Never mix patinas and always use proper ventilation and skin protection.
- 👍 To get a nice black finish on brass, add a dash of table salt to a little black patina in a glass or plastic jar. Mix well, apply and allow to dry. Clean and finish a usual.

Trouble Shooting

Problem: The solder won't adhere to the foil or came.

Solutions/Explanations:

1) Did you apply any flux?
2) Did you apply enough flux?
3) Was your iron too cool?
4) Is the foil or lead came too oxidized for flux to activate the surface?
    A) Buff copper foil with 000 or 0000 steel wool.
    B) Clean lead came with brass brush.

Problem: Solder is melting through to the backside of my project.

Solutions/Explanations:

1) Your iron is too hot. Depending on what type of iron you are using, either turn the temperature controller down or change to a lower temperature tip.
2) You may be soldering too long in each area. Move on and let the solder cool. Return to those spots later.
3) The gaps between your glass are too wide. Try to fill the gaps with solder and let it cool. Then go back and solder a bead on top of the filled gaps.
4) Try placing a wet paper towel under the project to provide cooling.

Problem: My solder is "stiff." I am unable to get a smooth bead.

Solutions/Explanations:

1) Your iron is too cool. Depending on what type of iron you are using, either turn the temperature controller up or change to a higher temperature tip.
2) You may not be using enough flux.
3) Is the tip of the iron getting hot? Check to see that the tip is seated correctly down in the barrel of the iron.
4) Are you "painting" with solder, instead of running a long bead with a steady, even, one directional movement? This is one of the most common mistakes that beginners make. In order for the solder to create a bead, it has to get molten. If you are using the iron as a “paint brush”, the solder is not getting hot enough to melt thoroughly.
5) You may be soldering with just a corner of the iron tip. Check for proper positioning of your iron.
6) Try a different solder with a lower melting point.

Problem: My iron seems to be hot, but the solder isn't melting as fast as normal.

Solutions/Explanations:

1) Check your tip. Is it loose?
2) Is your tip too dirty?
    A) Clean it on a wet sponge.
    B) Clean it on a tinning block.
3) Your tip is too corroded or defective. Replace it.
4) Your rheostat may be malfunctioning.
    A) Plug the iron into the outlet you are using without the temperature controller. If the iron works, the controller is malfunctioning. If the iron doesn’t work, the problem may be with the iron itself.
    B) With some types you can check the temperature controller by plugging a lamp into it. Turn on the lamp and see if the controller dims and brightens the lamp.

Problem: My solder seams are flat.

Solutions/Explanations:

1) You are not using enough solder. Reflux your project and add more solder.
2) You are soldering too fast. Move at a speed that lets the solder bead.
3) If the bead was there, but disappeared, you may be working too long in one area causing the solder to melt through to the other side. Allow the area to cool down before trying again. Another option is to place a damp paper towel under the seam you are working on. This will help keep the glass cool, allowing you a little more time to work.
4) Check the type of solder mix you are using. For copper foil work, 60/40 will help produce a higher, more rounded bead. Don't make the mistake of buying 40/60 solder. It has an even longer pasty range than 50/50, and is not recommended for stained glass work.

Problem: My solder seam is too wide.

Solutions/Explanations:

1) Do you have large gaps between the pieces you are soldering?
   A) You may have to recut some pieces.
2) You may be using too much solder causing the seam to bulge over onto the glass. "Pull" or "bleed" the excess solder from the seam.
3) Is the copper foil too wide? This is another common mistake for beginners. Remember that the width of the solder seam is determined by the width of the foil. An attractive solder seam is accomplished by using a foil that shows about 1/16" on both sides of the glass.

Problem: My solder seams are irregular in width.

Solutions/Explanations:

1) You may have poorly fitting pieces that create different size gaps in your project. Recut these pieces.
2) Your foil may be applied unevenly on each side of the glass in some places. You may try to correct this by trimming the foil with a craft knife. If that does not work, remove the foil and start again.

Problem: My glass fractured while I was soldering.

Solutions/Explanations:

1) Your iron is too hot. Depending on what type of iron you are using, either turn the rheostat down or change to a lower temperature tip.
2) You "worked" too long in one location with the iron.
3) There could have been a small chip or crack in the glass which was expanded when it was heated by the iron.

Problem: My solder bead is not bright and shiny. It appears dull and splotchy.

Solutions/Explanations:

1) The solder was applied too cold, so it never fully reached its "liquid state." Turn up the temperature if you are using a rheostat or change to a higher temperature tip if you are using a temperature controlled tip.
2) You may not be using enough flux to "wet" your foil or lead and create a proper solder condition.
3) If you're using 50/50 solder, try 60/40. Because solder crystallizes as it cools through the pasty range, 50/50 is more prone to having a textured look on its surface because of its considerably larger pasty range.
4) The solder you are using may be of inferior quality.

Problem: My solder is "spitting" as I work. What's wrong?

Solutions/Explanations:

1) You are likely using too much flux. It is literally boiling when you apply the solder. Wipe some of the flux off with a paper towel and try soldering again. You may find areas that now need a little more flux, because you removed too much.
2) If the spitting only occurs on the back side of your project (or the second side you are soldering), the problem is still too much flux, but the cure is different. When you use too much flux on the front side of the project, the excess to flows through the panel, so the spitting isn't as bad as it could be. When you use too much flux on the back side of the project, it can't flow through to the front, because the front is already sealed. The obvious cure for this problem is to use less flux the next time. But what about now, when you already have too much and can't remove it from between the glass? The only good solution is to apply your solder, and allow the flux to boil up and out of the seam. (Keep your face as far away from the project as you can.) Once it stops spitting, you can remelt the solder and make it look as good as new.

Problem: I have gooey, glue residue along my solder seams that won't wash away.

Solutions/Explanations:

1) Adhesive from foil may be working up and out onto your glass. This can be caused by poor foiling or burnishing of the copper foil, which allowed flux to seep underneath the foil. To correct this use a cuticle stick or soft toothbrush to clean adhesive away.
2) Your iron is too hot, causing the adhesive on the back of the foil to melt and seep out onto the glass. Depending on what type of iron you are using, either turn the rheostat down or change to a lower temperature tip.
3) If you reworked a seam too often, it may have loosened the foil. Allow the seam to cool to the touch and gently press the foil back down to the glass.

Problem: Attached hooks and rings are pulling away from my project.

Solution/Explanations:

1) Hooks and rings should never be attached to just a foiled edge. Attach hooks/rings to vertical seams in the piece or at a juncture between a vertical seam and the perimeter.
2) If there is no vertical seam or intersection, then attach the ring/hook to a horizontal seam in the piece.

Problem: My solder has a white chalky growth on it. What did I do wrong?

Solution/Explanations:

1) All of the flux was not washed off of the project after it was soldered.
2)The project was not sealed with a finishing compound or wax, or it has worn off. Use 000 steel wool to remove the patina and any remaining wax. Clean the project thoroughly paying special attention to the corners and edges. Reapply the patina and wax.
3) The project has been exposed to the outside elements. Most waxes are intended for indoor use only. Others can be used outside, but must be reapplied regularly. Projects that will be exposed to the elements are better constructed using the lead came method.

Glossary of Soldering Terms

Antimony

An element used in the production of some solders. It should be avoided for use in stained glass.

Ceramic Heater

A type of heating element comprised primarily of ceramic, noted as extremely fast heating and efficient.

Chisel Tip

A soldering iron tip shaped like a chisel tool. This is the most common shape used for soldering stained glass. Chisel tips are made in a variety of sizes, the most common being 1/8”, 1/4” and 3/8”.

Heat Sink

A device used to draw or absorb heat being generated by another source. For example, an object being soldered acts as a heat sink to the soldering iron.

Decorative Soldering

Any decorative effects created in solder. These effects are created with a soldering iron, usually with a very narrow tip. Special solder, like 63/37 or QuickSet, make it easier to create special effects because it has a “zero” pasty range.

Eutectic Point

An exact single temperature point at which an alloy goes from solidus to liquidus with no pasty range. For example, the eutectic point of lead and tin is 361^0 F. This point is obtained only by 63/37 tin/lead alloy.

Flux

A chemical agent used to remove compounds from the surface of metals during the soldering process. (See organic and inorganic flux.)

Idle Temperature

A very low temperature at which the iron is on, maintaining the capability of a more rapid heat up than if the iron was off or “cold”. This is usually between 200^0F and 300^0F.

Inorganic Flux

A flux comprised of one or more inorganic salt such as zinc chloride or ammonium chloride. Inorganic fluxes are more corrosive and conductive than organic fluxes,. They are effective on all common metals.

Leaded Solder

A material used to join metals comprised of tin and lead.

Liquidus

The temperature at which a pure metal becomes completely molten or liquid.

Mica

A mineral based material used as a construction component in wire wound type heaters of soldering irons.

Organic Flux

Organic fluxes are not as corrosive as inorganic fluxes. They are often used when the surface of the glass may be effected by the flux, such as painted glass.

Oxides

Debris on the surface of a metal which is the result of the reaction with chemicals in its environment. Oxides must be removed mechanically (with steel wool or a brass brush) and chemically for proper wetting to occur.

Pasty Range of Solder

The temperature range which is the difference between the solidus and the liquidus temperatures. This is sometimes referred to a the "working range".

QuickSet™

Another name for 63/37 solder. See decorative solder.

Recovery Time

The time required for a soldering iron to reach soldering temperature after it has hit a "cold spot".

Rheostat

The term applied to a soldering iron control which is used to vary the temperature of the heater in the iron.

Solder

An alloy of two or more metals with a liquidus temperature of less than 800^0 F.

Solder Bead

The term used to describe the look of solder when it has been properly applied to a copper foil seam.

Solidus

The temperature at which a pure metal or alloy goes from liquid to solid (or "freezes").

Temperature Control

An electrical or electronic device into which a soldering iron is plugged, or which is within a soldering iron. The device is used to vary the temperature of the soldering iron heater.

Tinning

Applying a thin layer of solder to a metal surface. Most commonly used in reference to the copper foil technique.

Tinning Block

A block of sal-ammoniac on which a soldering tip is cleaned and resurfaced with a layer of solder. It is not actually used for soldering.

Tip Tinning

The process of renewing a soldering iron tip using a sal-ammoniac (tinning) block.

Wetting

The term used to describe the proper flow of liquid solder, promoted by flux, on the surface of another metal. "Wetting" is necessary to form a proper soldering joint.

Wire Wound Heaters

Soldering iron heaters constructed with heating wires wound in a coil around Mica.