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The Stained Glass Process (Copper Foil Method)

1. Choose pattern

- a. Your pattern should not have too many deeply concave (inside curved) shapes. These are hard to cut for beginners, and may be best cut with a diamond band saw or ring saw. Try to redraw your design to eliminate these deep curves.
- b. Also avoid long sharp points in your design. These points will likely break during the cutting process.
- c. Examine your design for what will become weak sections in the glass that maybe prone to cracking. Alter the design to eliminate these.
- d. Plan in your reinforcement from the beginning if your piece is going to be large (larger than 2 square foot).
- e. Plan out how the glass will be hung. Will it be framed or will the outside edges be free-form. If it is free-form then plan to have two hangers at locations so that the glass hangs correctly, that is, not askew. The hangers must be at joints and not just on a copper foiled edge.
- f. For this introduction class free-form edged projects are preferred.
- g. Designs that must fit a predetermined rectangular or other geometric shape are more difficult for a starting project. Every piece must be exact and the overall pieces of glass must also fit into the rectangular limits for the design.
- h. A boarder board should be used around all sides of this type of design to insure it is held secure within the predetermined limits.

2. **Make two copies of your design** and number each piece within the design.

- a. One copy will be used to layout your glass on your layout board. Use tracing paper for this copy.
- b. We will be using contact paper for the second copy. This copy used as a guide to cut and grind your glass.

3. **Use pattern shears** to cut out the design drawn on contact paper.

- a. Insure all pieces are numbered.
- b. Stay to the center of your line.
- c. On sharp turns a short cutting motion may give you better control.

4. **Choose glass** for each design part.

- a. **Before cutting glass** please put on your safety goggles.
- b. From a larger sheet cut out a section for your piece, or, preferably leave as much of the sheet as intact as possible by cutting out your shape directly from the sheet.

- c. Remember to cut on the smoothest side of the glass.
- d. Since the majority of the glass for this class is clear there are few color/patterns in the glass itself to be concerned about. However, many projects use opalescent glasses which have color and shape patterns in the glass itself. In this case there is a front and back of the glass to consider, because the color and pattern are typically different on both sides, and you may prefer one side over the other to be seen on the front of your design. Because you should always cut on the smooth side of glass and if the smooth side is on the side you chose as the back, then this would require you to flip your design pattern over when cutting on the 'back' side of your glass.

5. **Fitting your pieces** to the design pattern

- a. After cutting your glass compare it to your contact paper pattern. If it is larger you will need to grind the glass to fit the pattern.
- b. Peel off the contact paper and place it on your glass.
- c. Grind the glass to match the pattern.
 - i. **Before grinding** glass please put on your safety goggles. Small pieces of glass are often thrown off from the grinder.
 - ii. **Before grinding** glass lightly touch all sides of the glass against the grinder. This will dull any sharp edges which might cause a cut when you start forcing the glass against the grinder with your fingers.
 - iii. Insure that there is a constant water supply on the grinder head when grinding. If a white substance (ground glass) begins to collect on the glass or grinder then this is an indication that there is not enough water going to the grinder head.
- d. Dry and place the finished shaped piece on the tracing paper design on your layout board and move onto the next piece.
- e. After you have a few pieces in place you can begin to use push pins to hold the pieces in place.
- f. The ground pieces of glass should match very closely to the design on your layout board, and should just be touching the black line of the traced design (not crossing into or over the black line).

6. **Copper foil you glass**

- a. Clean all of your glass pieces being careful not to wipe the numbers away. There is typically cutting oil on the glass.
- b. Apply the foil so that it is even on both sides of the glass.
- c. In tight curves avoid cracks in the foil. Do this by starting the foil in the deepest part of the curve and foiling in both directions with a ¼ over lap.
- d. If cracks are unavoidable then put a second layer of foil on the glass.
- e. You can use an Exacto knife to trim any copper that is uneven.
- f. Use your fid (wooden stick) to smooth out the foil on the front, back and side.

7. **Soldering the glass**

- a. Plug your soldering iron in. It will need to be hot before starting.
- b. If your design had a front and back (for this class yours do not) then place the foiled pieces of glass front side down.
- c. You will begin by soldering the back and filling in any areas where there may be gaps between pieces of glass. Ideally, there are no gaps larger than 1/16 inch. If there are, then remedial action should be taken such as recutting the glass, attempting to fill in with solder, or filling in the gap with a piece of copper band (such as Strong Line). Filling in a large gap in this manner however will result in an unsightly thickening of the lead line at that section.
- d. Before beginning insure that the design is secured with push pins.
- e. Dip your flux brush lightly into flux. Do not apply too much flux. It may weaken your project if the flux seeps into the copper foil, breaking the bond with the glass.

- f. Notice when applying the flux that the copper changes color becoming 'cleaner' looking. This is an indication that enough flux has been applied. If the copper still looks 'dirty' (oxidized), then the solder will not stick to it.
- g. Begin by tack soldering the project. This is done by touching solder beads throughout the design so that all parts are tack soldered together.
- h. Next fill in any areas that need attention. There should be no gaps between glass pieces after you are done with this step.
- i. Next tin all exposed copper. Tinning is the process of putting a very thin layer of solder on the copper. If the copper won't tin, then scrub it with steel wool, reflux it and continue.
- j. The next step is to put a solder bead on the tinned surface. Cut a 12 to 16 inch piece of solder. Begin this process by placing the iron on the surface of the tinned copper and putting the solder onto the iron tip. As the solder melts onto the copper continually move the iron leaving behind enough solder to form a rounded bead. Do not let the iron stay in one place for too long. The heat of the iron could crack the glass.
- k. Work section by section. Leave a section when all areas have a rounded bead, then continue on to another section.
- l. When all copper has a bead of solder applied to it turn the design over and repeat the process on the front side.
- m. After the front is finished you can optionally place a bead of solder on the sides of the design. You should at least tin all the sides.

8. Securing the support loops

- a. As part of your initial design creation you should have identified locations to put the copper loops from which your stained glass will hang.
- b. Insure that you have chosen a copper joint location for the loop. Place a fluxed loop at the joint and solder it in place. Insure that you solder the open end of the loop into the new solder joint.

9. Clean your art work, apply patina, and wax

- a. Clean your glass with soap and water, and then lightly rub with steel to clean the soldered copper.
- b. Dry your work and fill a paper cup $\frac{1}{4}$ with a patina solution. Never put patina into a metal container.
- c. With a new brush paint the patina over all solder surfaces. The solder should take on a dark look. If there are areas staying gray then clean them with steel wool and attempt to patina again.
- d. Finish your work by putting a thin layer of wax. Buff the wax until it is shiny. This will help reduce the effects of oxidation on your work.

Glass Scoring Tips

- Dip your cutter in cutting oil before making a cut.
- Always use your cutter with the head screw facing up or forward for the best cutting angle.
- Before starting a score, position the glass so that you can comfortably complete the whole score.
- Always score glass on the smoothest side. This is not always the 'front' of the glass. Highly textured glass, like ripple or granite, is scored on the back side. (Don't forget to turn your pattern piece over!)
- If you get stuck in a bump or pit, gently ease your cutter out and continue scoring.
- At the end of a score, lift your cutter up instead of rolling it off the glass. This prevents damage to the cutter head and the glass.
- It is easier to follow your pattern line by pushing your cutter instead of pulling it. When scoring along a ruler or bar, it is easier to ride the cutter head along the edge if you pull instead of push.
- Use a bench brush to keep your work area free of small slivers and cutting debris that can scratch your glass or yourself.
- Use a mirror to occasionally test your cutter. The mirror helps to see the cut. Your cut line should be even and without breaks. Breaks in the line indicate a damaged or worn wheel. The line should be hair thin. A furrowed line with splinters indicates a problem with the cutter or too much pressure being applied.

Breaking Glass

Choosing the correct pliers

Each type of pliers has a different purpose and is used in different situations. Using the right pliers for the job will make your stained glass experience easier and more fun!

Breaker/Grozier Pliers are dual purpose pliers with a flat jaw and a curved jaw. Both jaws are serrated for removing flares and tiny points of glass

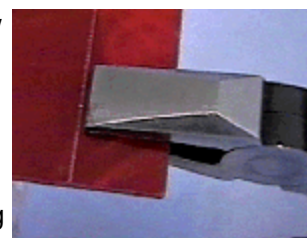
To break out a score, hold the glass firmly near the score line with the pliers, flat jaw up. Use your right hand to hold the other half of the glass near the score line opposite the pliers jaws. Use a downward, rotating motion to break the score.



To groze, hold the pliers curved side up and use a rolling motion to gently scrape the glass edge against the serrated teeth. Use the tips in a chewing motion to remove small sections of glass or nibble out deep inside curves.

Breaking Pliers have a smooth, flat jaw used for breaking long, thin pieces of glass. They allow you to reach into a piece of glass and hold it firmly at the score line without chipping the edge of the glass.

To use, firmly hold the glass close to one side of the score line with the pliers and close to the opposite side of the score line with your other hand. Use a downward, rotating motion with your hands to separate the pieces of glass. If you don't get a nice clean break or the glass is chipping and shattering, you may be squeezing the pliers too hard.



Running Pliers let you break difficult scores with ease. The curved jaw applies equal pressure to both sides of the score line causing the score to 'run'. There is an adjustment screw on some types for adjusting to the glass thickness and amount of force needed to run the score. More pressure runs a score more quickly, less pressure more slowly. Curves are easily broken out by running the score slowly from one end to about half way and then from the other end until the scores meet.



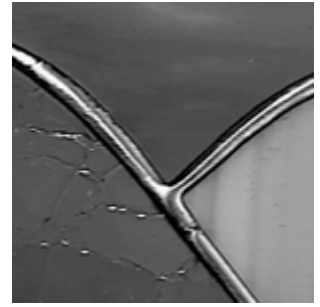
To use, place the jaws (with the center indicator line facing up) squarely onto the glass with the score line centered in the jaws. Turn the adjustment screw until it just touches the bottom handle, then back it off 1/2 a turn. Squeeze the handles gently until the score runs. You must have the jaws fully on the glass for the pliers to work properly.

Breaking Tips

- Always wear proper eye protection when breaking glass.
- Prevent tools from rusting by storing them away from any corrosive chemicals. Wash and dry your tools if they come in contact with flux or patina.
- Holding and bending is the correct action when using breaking or breaker/grozier pliers. Squeezing too hard causes the glass to chip and shatter.
- Instead of holding the glass in your hand when using breaking pliers, try holding the glass flat on the table with the score line just off the edge. Use your breaking pliers to grasp the piece hanging over the edge and bend the glass down to separate the score. This is most useful for straight cuts.
- You have more control over how your glass breaks when you squeeze gently with your pliers. Apply pressure in small, increasing amounts until the score runs or breaks.
- **From Dan Nolan:** I have found that on tough inside cuts, after you run the glass it is sometimes helpful to turn the runners over and repeat the process. This creates opposite pressure and helps the glass break away. Try it, it works for me.

Soldering Tips

- After each soldering session, unscrew the iron tip with pliers. It's not necessary to remove it, but loosening the nut or screw will help keep it from fusing to the barrel of the iron.
- If you use an iron control (rheostat, mark the spot that seems ideal with a permanent marker for quick reference.
- If your solder spits and sputters while soldering, you may be using too much flux.
- To keep from applying too much flux, trim the bristles of you flux brush to about 1/4".
- For neat solder seams, avoid stopping and starting the solder line at an intersection or joint.
- Pre fill large gaps with solder before trying to run the final solder bead.



Finishing Tips

- 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 until you reach the desired color. Quickly move on to the next area.
- Spotting on the edge of mirror is caused by oil, flux, patinas and other chemicals penetrating the silvered back. Avoid grinding mirror and apply a mirror edge sealant before foiling or leading.
- **Never** mix patinas and always use proper ventilation and skin protection.
- To patina brass black, add a dash of table salt to a little black patina in a **glass or plastic container**. Mix well, apply to brass and let it dry. Clean and finish as usual.
- For best results, plan your time so that you can clean and patina as soon as you're done soldering.
- When patina won't take evenly, remove it using fine (0000 gauge) steel wool, clean, rinse and reapply the patina.
- Use a clean coffee filter to dust and remove finger prints from you waxed projects.

There are a few special purpose tools that are necessary for The Craft of Stained Glass. Here is a basic list of tools and other items that you will need to get started.

Tools

- Glass cutter
- Glass pliers (running, breaking, grozing)
- Soldering iron (80-100 watt)
- Glass grinder
- Workboard
- Lathekin or Fid
- Glass pattern shears
- Glass marking pens
- Push pins/Layout kit
- Drawing equipment
- Straight edge/Glass square

Materials

- Copper foil tape
- Solder
- Cutting Oil or Turpentine
- Flux & Applicator brush
- Antique patina
- Pattern paper, Pattern card, Carbon paper
- Standard clear glass - for practice - 3 square feet (.3m2)
- Stained glass - for your project, refer to the project pattern specifications.
- Glass cleaner & Soft rags
- Bench brush or Whisk broom
- Pattern books (Dover makes cheap ones)