Glass Campus www.glasscampus.com

Coldworking Glass

Introduction

Hotwork is what you do in a kiln, in a furnace, or in the flame of a torch. Coldwork is what you do before or after the hotwork. Good preparation before hotworking the glass can make your work a lot easier and can make it more likely to come out the way you hope it will. Coldworking after hotwork can elevate your work from average to exceptional. It can greatly improve your projects, or it can salvage otherwise unsuitable projects.

- smooth off and polish or shape edges.
- smooth off and polish flat or curved surfaces.
- remove smooth polish to produce a textured surface.
- expose underlaying glass.

Coldworking can do many wonderful things but it can't fix all problems. Some things it can't do are:

- correct bubbles
- fill holes
- correct a misfiring

Safety First

Working with glass can be dangerous. Safety should be your first consideration. If you don't make it your first, failure to do so might make it your last.

Dust – glass dust is a serious hazard. If you can't be sure glass dust is kept wet, wear a dust mask. Glass dust left on tools or glass after coldworking should be wiped or rinsed off. Funny thing about glass dust. It's the ultimate unwanted guest. Once it moves into your lungs, it refuses to ever leave.

Eyes – Always wear safety glasses. Fast moving machinery can easily launch a piece of glass into your eye. It's unlikely your local hospital emergency ward needs you to help generate more business for them.

Ears – Many coldworking machines are noisy enough to cause hearing damage. Ear protectors are a lot cheaper than hearing aids.

Hands - Take special care to keep your hands away from moving machinery. Keep all your fingers attached. You never know when you'll need that special one for that special wave for bad drivers.

Fingernails – Long fingernails can easily get caught in moving belts and discs. You'll survive having a nail pulled out but probably swear a lot when it happens.

Hair – Long hair should be tied back to keep it from getting caught. Getting your hair ripped out by getting caught in a machine is a plenty dumb way to experiment with baldness.

Jewelry – All jewelry should be removed when working with machinery to avoid it getting caught. Even if you don't mind losing the appendage it's attached to, at least consider the value of the jewelry.

Clothing - Avoid loose fitting clothing that can get caught in moving machinery – unless you plan to film yourself getting sucked into a machine by the sleeve as a submission for Funniest Home Videos.

Apron – Coldworking is often wet. Sometimes very wet. Wearing a rubber or vinyl apron is always a great idea. If you want to get soaking wet, go swimming or take a shower. For some coldworking tools, a full wet weather rain suit is recommended.

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Electrical – When you are using any electrical equipment around water take special care to be sure it is safe to use wet. Tools like grinders, laps, and wet belt sanders have sealed motors that are specially made to work wet. Tools not designed to work wet can easily short out or deliver a serious electric shock if water gets into the electrical workings. This is NOT a do-it-yourself defibrillator. Be sure all tools are plugged into a GFI (Ground Fault Interruption) outlet

In addition to personal safety precautions, you should consider some special precautions to protect the glass you're working on.

- Annealing – glass that hasn't been adequately annealed can be fragile enough to break during coldworking.
- Cooling – glass that hasn't thoroughly cooled after firing can suffer thermal shock during coldworking.

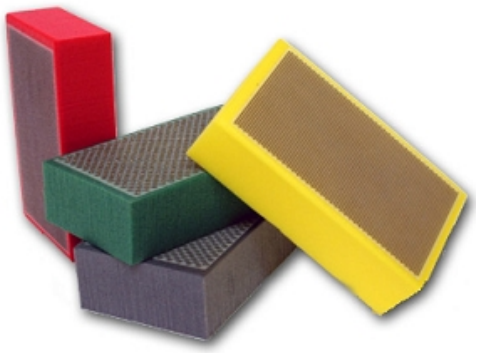
Soft Glass or Hard Glass

The softer the glass, the faster it grinds. That corresponds with the COE of the glass. Softer glass has a higher COE. The lower the COE, the harder the glass. The higher the COE, the softer the glass. COE 104 or 108 glass grinds faster than COE 96 which grinds faster than COE 90. Slower still is COE 82 clear float an textured architectural glass. Slowest of all is COE 33 borosilicate. To estimate how long it will take you to grind different glass with different grit, you will have to allow for how hard the glass is. Harder glass will take much longer and generate more wear on the Silicon Carbide or Diamond Belts or Discs.

Coldworking by Hand

Machines always make the job easier but not being able to afford coldworking machinery doesn't mean you can't improve your work with coldworking by hand. Diamond Hand Pads are available in different grits and with a little manual effort can do fine work on glass. Diamond Files are relatively inexpensive and work exceptionally well to reach into difficult to reach spots. Sheets of Silicon Carbide or pieces from belts can be used on a block of wood the same way a carpenter uses sandpaper on wood or can be cut to fit a hand sander like the ones used for sanding drywall.

Diamond Files



Diamond Hand Pads

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Saws

Many different kinds of saws are used to cut glass. They all have in common the use of a diamond coated blade to cut glass with the blade running through water to act as a coolant.

Band Saw – has diamonds along the edge of a revolving metal band similar to band saws used for cutting wood or metal.

Ring Saw – has diamonds along the outer rim of a revolving disc like a metal frisbee.

Wire Saw – has diamonds wrapped around a wire. Some wire saws work like a ring saw while others work like a band saw.

Tile Saw – also called a Trim Saw, works like a small table saw using a blade with diamond encrusted edge that runs through a bed of water.

Bridge Saw – like a Cut-off or Chop Saw using a diamond encrusted blade with water spraying onto the blade while running.

If your project comes out of the kiln with a severely ragged edge, and you own a saw, it may be more efficient to cut it into a straight line instead of grinding it down. You can also use a glass saw for a lot more than just cutting glass. Cutting a series of notches into the edge of a glass project before firing in the kiln will produce an attractive decorative edge. It can also be used to cut shallow notches into the glass face for a decorative pattern.

Drilling or sawing glass usually creates chips on the underside. Attaching the piece to be drilled or sawn to another piece of glass with wax or double-sided tape will minimize chipping.

Cutting a glass bar with a Tile Saw

Dry Belt Sander

You can use Silicone Carbide belts dry on a conventional belt sander. This is a popular way for professional glaziers to edge polish or bevel glass shelves or tabletops. Avoid sanding too long or holding the sander in one place to avoid friction-generated heat burning off the grit from the belt. Spraying a little water onto the belt will help lubricate and cool the belt but be careful to not apply so much water it gets into the electrical motor.

If you have a Compressor, you might consider buying an air powered Rotary Sander and using it with Silicone Carbide Discs. Although you can run one with diamond discs, unless you rig up a hose system to keep the discs constantly wet, you'll be spending a lot of money burning through discs.

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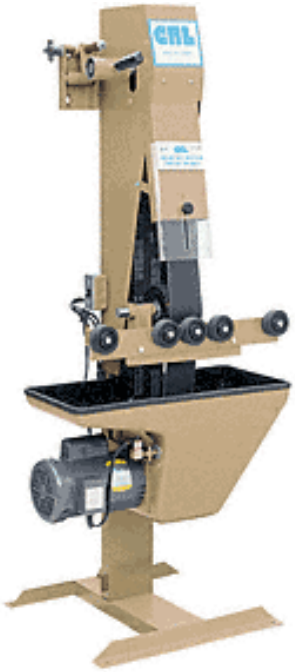
Edge sanding a mirror with a Silicon Carbide belt

42” belt Table top Wet Belt Sander

Wet Belt Sander

Most professional glass artisans consider the Wet Belt Sander to be the most valuable of all the coldworking machines because it’s the most versatile.

Edge grinding a screen melt on a Wet Belt Sander



106” belt Floor model Wet Belt Sander

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Variety of grits – belts are available in a variety that will allow you to do everything from slicing off large amounts of glass to applying a jewelry quality full polish.

Smooth off sharp edges or spikes. Often all you need do is to take a quick swipe to remove the sharper underedge of spikes left after kiln firing.

Produce straight edge. By running a piece of glass back and forth along the belt, you can be sure to have a uniformly straight line.

Straighten out a bulged-out shape. A coarse grit belt will quickly remove any undesired excess. Then use progressively finer belts to smooth it down to whatever finish you want.

Create a smooth flat bottom. Although not as good as a lap grinder for large surfaces, with a little practice you can learn how to smooth out even relatively large surfaces with a belt sander.

Prepare edges before kiln firing. If you fire textured art or architectural glass too high, you'll remove the texture but if you don't fire it high enough you'll have the same razor-sharp edge you started with. The belt sander can smooth off the edges before firing in the kiln so the edges are finished the same as for higher temperature firings.

Special edges. You can produce a variety of custom edges (bevel, cant, rounded) on your work for special effects after firing or on glass shelves or mirrors.

Can do curves. Although it's the best of all machines for edging straight lines or outside curves it can also be used on inside curves by applying a very gentle touch along the edge of the belt.

Wet Belt Sander Belt Choice

You can use cork, diamond, felt, or silicone carbide belts on a wet belt sander. Diamond belts work fastest but are so pricey most people prefer silicon carbide for grinding and cork or felt for polishing. What grit belt to use depends on what you're doing. Here's some suggestions for choosing grit:

40 grit – used on rare occasions when you have made a huge mistake and need to remove a huge amount of glass.

60 grit – like 40 grit, for when you need to remove a lot of glass in a hurry.

80 grit – the most common grit to start with. It's rough enough to take off glass quickly to get below chips and imperfections from a poorly cut break or to remove a lot of spikes.

100 grit – often used instead of 80 grit when the edge needs work but not enough to need 80 grit.

220 grit – to produce a smoother finish than 100. To remove a sharp edge on glass, a quick swipe with 200 grit is often all that's needed.

400 grit – smoother still then 200 grit. If you have removed all the scratches with each coarser grit belt, this will leave a satin smooth finish on glass.

600 grit – smoother still. This will leave a finish somewhere between satin and semi-gloss.

Cork – doesn't grind but polishes. It will leave a semi-gloss finish almost as smooth as a fire polish.

Felt – used with Cerium Oxide to produce a full sheen polish.

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Helpful tip *– changing belts takes time. You'll save a lot of time if you prepare all the glass you want to belt sand and do everything on one grit belt before changing the belt to do everything on the next grit.*

Another helpful tip *– keep a firm grip on the glass and be gentle when you first press glass against the moving belt. Push too fast and the moving belt can eject it from your grip at a disturbingly high speed.*

Vibrating lap

Lapping the rim of a fused glass bowl

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These machines vibrate at high speed to grind the glass with silicon carbide or polish it with cerium oxide.

Preparation
Before putting your glass into the lap, grind off any rough edges and bevel grind the edges to prevent it from chipping on the edges.

Level the Lap
Make the lap as level as you can. A "bullseye" level is a handy device for checking level, or pour some water into the lap to check level. An unlevel lap will produce uneven lapping.

Grit Slurry
Spread 2 or 3 tablespoons of grit over the surface of the metal pan and slowly add about 1/3 cup of water. Run the machine for a minute or two to thoroughly mix the slurry. Add water or grit as needed to form a slurry about the consistency of heavy cream making sure there is enough slurry to cover all of the Lap Plate. Keep the grit slurry as dry as possible but DO NOT allow the grit or polish to dry out during operation. Water acts as a lubricant so overly wet slurry takes much longer to grind.

CAUTION: *DO NOT use too much grit and water. If the slurry is splashing out, stop and dry out any excess water with paper or sponge*

Finer grit requires less water. Too much water can cause the glass to hydroplane and move without grinding. No problem if it just fails to grind but a big problem if it grabs the grit and catapults across the room.

Because the grit breaks down during lapping, it's a good idea to add a small amount of fresh grit during every hour of operation.

Add Weight
The smaller or thinner the piece to be ground, the more important it is to weigh it down. You can hold the weight in place with butyl tape, double sided carpet tape, dop wax, or fiberglass tape onto a dry surface. Set the weight in the middle of the glass to ensure it grinds evenly. A container of water makes a convenient and effective weight.

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Rotation
The glass should rotate about as fast as a clock second hand moves. If it isn't rotating smoothly, check to see if the lap is level, if weight needs to be placed on the glass or if water needs to be added to the slurry.

Evaporation
If some of the water evaporates during the operation and the slurry becomes too thick, add a small amount of water to keep the slurry creamy and smooth moving.

Vibration
These machines vibrate a LOT. The steady vibrations can easily shake loose anything in contact with the table the machine is on. If the table isn't heavy enough to remain still, you might want to clamp or bolt the lap to the table to ensure it doesn't walk right off the table as it vibrates.

Cleaning the Slab
It is ESSENTIAL to thoroughly clean out the pan before adding fresh grit. A few bits of 80 grit left behind when 220 grit is added will create 80 grit scratches in your 220 grit finish. Remove the pan and bumper ring and thoroughly clean out all the grooves with a brush.

Disposing of Grit
Avoid flushing used grit down your drain. A very small amount is safe but it doesn't take much to cause expensive problems. Silicone Carbide grit compacts like cement and can effectively plug up your drains. A few minutes of your time spent manually removing grit from the lap pan can save several hours of expensive plumber's time cleaning plugged drains. Wipe out as much as you can with a cloth or paper towel then brush out as much as you can from the grooves before rinsing clean with water. Doing this outside with a garden hose is much better than draining it out in your sink.

Choosing Grit
- extra rough grind – 60 grit silicon carbide
- rough grind – 80 grit silicon carbide
- semi smooth – 220 grit silicon carbide
- smooth grind – 400 grit silicon carbide
- super smooth – 600 grit silicone carbide
- polish – cerium oxide

Checking Finish
Remove the glass from the lap and wipe off the side being ground. With a soft lead pencil, make a grid of squares across the glass. Return to the lap and run for another 2 or 3 minutes. If all the marks are not removed, continue to grind and repeat the test.

Pre-Polish
Some artisans prefer to do a grinding cycle with Pumice before moving to the polish cycle. This a personal preference and isn't essential.

Polish
After thoroughly cleaning out the Lap Pan and Bumper Ring, insert the felt Polish Pad and install the Bumper Ring. Slowly pour in water until the pad is saturated. Add Cerium Oxide and water until a light surface of polish slurry covers the pad. It should be the consistency of heavy cream. Avoid having too much water to avoid needlessly slowing down the polishing time.

Average Grinding Times
- 80 grit 2 – 3 hours
- 220 grit 1 – 2 hours
- 400 grit 1 – 2 hours
- Polish 1 – 2 hours

Multiple Projects
If you're doing several projects and not in a hurry to finish just one, you can save a lot of time and grit by doing all the projects with one grade grit before changing grit.

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Razor Sharp Edge
The glass will have a razor sharp edge after lapping. This can be easily removed either by hand with a Diamond Pad, a piece of Silicone Carbide belt or on a Wet Belt Sander.
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Rociprolap

Rociprolap

This big brother to the Vibrating Lap is the easiest to use machine for grinding and polishing a flat surface. It does the work for you while you're off doing something else. Using Silicon Carbide to grind and Cerium Oxide to polish the same way as the Vibrating Lap. Instead of vibrating, it rociprocates at 575 times per minute to lap glass.

Preparation for 1st Lapping Operation
With the machine running, pour about 4 tbsp of 80 grit Silicon Carbide onto the Lap Plate. Pour in enough water to create a creamy slurry. Stop the machine and place the item to be lapped on the Lap Plate and start the machine. Because the grit breaks down as the machine runs, it's recommended to add 1 tbsp of grit during every hour of operation.

Testing if Material is Flat
Wash the piece off. With a soft lead pencil or aluminum marking pencil mark the bottom of the piece off in a grid of 1/2" squares. Replace and lap for about 10 more minutes. Remove the piece and examine the bottom. If the lines have been ground off, the piece is flat and ready for the next lapping operation.

2nd Lapping Operation
Remove the grit in the lap and replace with 4 tbsp of 220 grit and enough water to create a slurry. This should be enough for 4 hours of lapping which will take you to the next stage in the lapping operation.

3rd Lapping Operation
Exchange 220 grit for 400 grit and run for about 4 hours.

4th Lapping Operating
Exchange for 600 grit and run for about 5 hours.

Polishing
Install the Neoprene Polishing Pad smooth side up. Replace the splash guard and bumper ring. Start the machine and place 3 tbsp of Cerium Oxide on the pad and add enough water to create a creamy liquid. Most objects need about 5 hours of lapping to be polished, however, the size and weight of the piece will make a difference in the lapping time so you will have to be your own judge when it's enough.

NOTE:
The quantities of grit suggested are for 24" lap plates. Use proportionately larger or smaller amounts of grit for larger or smaller lap plates.

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Rotary Lap Grinder

Beveler/Grinder

These machines use Silicon Carbide coated or Diamond Discs to grind and polish glass. Small tabletop machines use water as coolant by either flooding the discs with water or by spraying out a jet of water while running. Larger floor models either spray water onto the glass or up through a hole in the center. Most use either a Velcro or magnetic hold to attach the Diamond Discs to make it easy to change from one grit to another. Discs are available in the same grits as for a Wet Belt Sander and are used in the same way. A rotary machine is exceptionally effective for grinding and polishing a flat surface but very difficult to use for edging.

Handheld Wet Grinder-Polisher

Like an Angle Grinder but with a built-in hose to dispense a steady stream of water while running. These use Velcro-attached 4 inch diameter Diamond Discs in 50, 200, 500, 1000, 2000 and 3000 grit as well as felt for polishing with Cerium Oxide.

These are wonderfully versatile machines. They work well on flat surfaces but are exceptional on curved shapes like sculptural castings. Be warned - they distribute a lot of water and do it indiscriminately (a nice word that means all over the place). Unless you have a waterproof room, it's a good idea to build some kind of containment booth (a shower stall works great) or connect it to a garden hose do it outside. I usually suit up with a full rain suit when using one.

Working with Diamonds

I don't know if diamonds are a girl's best friend, but they sure enough are a glass artisan's best friend. Nothing will cut or grind glass as effectively or efficiently. They're pricey, so whether or not to invest in diamond equipment is a tough decision all glass artisans must make for themselves depending as much on their budget as the quality of work they hope to produce.

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Types of diamond coating

- Electroplated – a single layer of diamonds electroplated onto metal. As the diamonds were down are come off, they no longer work. This is the least expensive diamond coating.
- Resin coated – diamonds embedded in a resin or plastic.
- Sintered – diamonds set all the way through. These are the most expensive and last the longest.

Be patient

Diamonds are extremely hard but they are not indestructible. They will burn off and it takes surprisingly little friction-generated heat to burn them. Even when drilling a hole in glass submerged in water, if you try drilling too fast, you will see what looks like black smoke in the water. That's the diamonds from your drill bit saying goodbye as they burn away. The same can happen with saw blades, diamond belts, or discs. Be patient. Let the diamonds do the work. Resist applying a lot of pressure to speed up the job. Too much pressure will destroy the job. Start slow. Ease the glass onto the diamonds gently and maintain a steady consistent pressure and speed for drilling, sawing, or grinding. A little bit of patience will save a lot of diamonds.

Not all are born equal

As with all tools, not all diamonds are the same. Inexpensive drill bits, blades and discs will work but will not work as well or last as long as the more expensive ones. If you don't do a lot of work, the less expensive ones are all you need, but most professional glass artisans have learned that the more expensive ones often end up being the cheapest because they last so much longer. A diamond drill bit from the local hardware store is likely to only give you 3 or 4

good holes while a professional quality one could produce 100. It's the same with all diamond cutting devices. For long life, buy good gear. For limited use buy the least expensive.

Some tips for working with diamond discs

- The finer the grit, the less water is needed. Use progressively less water in the slurry with each progressively finer grit.
- Coat the surface to be ground with paint or felt pen. This will allow you to see where you have ground and identify where more grinding is needed.
- Grind the glass in just one direction so all the scratches created by the diamonds are in the same direction. In the next grinding stage, grind across the scratches so you can see there the finer grit grind has removed the coarser grit grind.
- When you finish each grinding stage, pour about a cup of water out onto the disc to rinse off any glass dust to prevent it from drying on the disc or from interfering with the next grit stage.
- Polishing is slow. I usually takes as longer to polish as all the grinding stages combined. Where you working only in one direction to grind, vary directions in polishing. Move the glass around as you polish.

- It's easy to make your cerium oxide slurry by premixing in a bottle and pouring some of the mixture out onto the disc than to try mixing on the disc.

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Sandblasting

Sandblasting is like spray painting but you use abrasive sand (usually either Aluminum Oxide or Silicon Carbide) instead of paint. A "resist" material is applied to the glass and the desired pattern or design is cut into the resist and removed to expose the part of the glass to be blasted. Various kinds of vinyl and rubber are available specially for sandblasting. Small simple blasts can use masking tape or painter's tape. Blasts that will take a little longer will need a tougher resist to prevent the blasting grit from pulling the tape off.

Although it is recommended to sandblast using a compressor that runs at least 5 horsepower, it is possible to use much smaller compressors as

long as you don't run them too long. Trying to get too much time sandblasting with a small horsepower machine will just burn out the compressor. It is possible to sandblast without owning a compressor. Small pressure tanks are relatively inexpensive and can be filled at gas stations with the air hose use to fill tires.

Sandblasting grit is available in the same grits as used for lap grinders or on belts for wet belt sanders. The coarser the grit, the faster it will blast and the rougher a texture created. Most decorative sandblasting on glass is done with 100 or 120 grit with finer grits used only for special effects.

Aluminum oxide is much cheaper than Silicon Carbide but wears down much quicker so you won't be able to reuse it as many times as Silicon Carbide.

Silicon carbide costs more but is harder so can be used many times more. If you do a lot of sandblasting, the greater number of uses can make Silicon Carbide cheaper in the end than Aluminum Oxide. It also has the wonderful feature of producing bright sparks where it hits the glass during blasting. This makes it easy to see exactly where the grit is hitting – a terrific aid for very fine detailed work or for shadow blasting. It's important to keep a uniform distance away from the glass while blasting and to blast straight at the glass – not on an angle.

Different sandblasting methods are used for different effects.

Surface etching is a single uniform blasting that produces a uniform texture.

Shadow etching is done the same as surface etching but instead of a single uniform etch, the design is shadowed with some parts sandblasted more than others so the texture can vary from only slightly etched to fully etched.

Multi-stage (also called deep carving) is done at higher pressures than regular sandblasting and usually requires especially thick rubber resists. This is done by removing the stencil in stages.

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One part is removed and sandblasted, then more resist is removed and sandblasted, then still more removed and sandblasted. The earliest removed stencil parts will be more deeply etched than the later removed stencil parts.

Sandblasting isn't just for decoration.

Removing Devitrification is easily done by just sandblasting off all the devitrification then firing the glass in your kiln to fire polish the sandblasted surface.

Matte finish can be applied to produce an attractive satin finish to contrast with the usual full polish of glass.

Drilling holes can be done very quickly by holding the sandblasting nozzle just a few inches away from the glass. This is especially handy if you want to drill a hole you don't have the right size drill bit for.

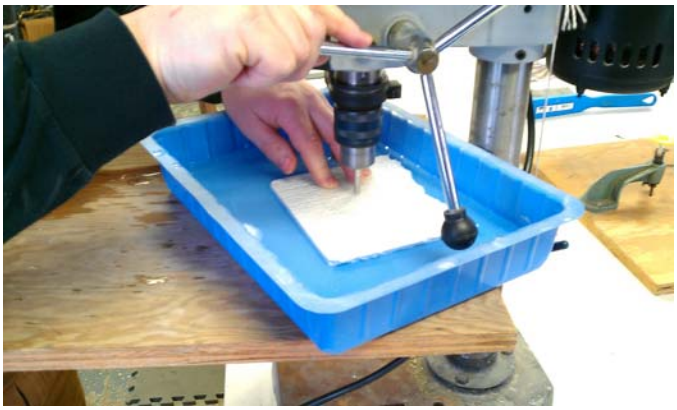
Removing layers of glass to expose lower layers allows you to experiment with some very unusual and attractive techniques. A perfect example is Kilnformed Flashed Glass.

Photos and instructional tutorials on how to make and use Kilnformed Flashed Glass are available in PDF format on the Glass Campus website at www.glasscampus.com

Drilling Glass

Diamond coated drill bits for drilling glass are available as small as 1mm diameter or as large as 60mm. If you only need to drill a few holes,

inexpensive drill bits will be fine as long as you're extra patient and drill extra slow with them. The only important difference between cheap bits and expensive ones is how fast you can drill with them and how many holes you can drill before they wear out. The best diamond bits are hollow (like a cookie cutter) to allow any glass dust from the drilling action to escape up inside the drill bit and not remain alongside the bit to generate friction



Drilling a piece of glass in a tray filled with water and a piece of styrofoam beneath the glass

Drilling a large round of glass using putty to contain a pool of water as coolant.

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Stabilize. If you're using a handheld drill, keep it as stable as possible. It's better to use some kind of stationary Drill Press. If you don't have a Drill Press, there are devices available to adapt a hand drill or Dremel to work like a drill press.

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Moderate speed. If you drill too fast, you will produce friction which produces heat which will burn off the diamonds. It takes time to drill through glass. Be patient and drill at about half speed.

Keep cool. Keep your diamond bit constantly wet. If you drill dry, the diamonds will burn off and your bit will now be useless. The ideal way is to keep the glass submerged in water while drilling. Placing the glass in a plastic or fiberglass tray and covering it with water works extremely well. If you're using a glass or metal tray, place a piece of wood or styrofoam beneath the glass. If the glass is too large to be submerged, build a dam around the drill hole with putty or clay and fill it with water. For small holes, you can place a metal washer on the glass and fill it with water.

Use coolant. You can drill without coolant, but using a few drops in the water will reduce the likelihood you'll crack the glass or burn off your diamonds while drilling.

Bob the bit. If you just start drilling and keep the bit in the hole until it drills through, there's a chance the glass dust created by drilling will create enough friction heat to crack the glass. If instead, you bob up and down gently with the bit, you'll swish out any glass dust from the drill hole. A good practice is to drill down for a count of 5 then bob the bit up – then repeat and continue until the hole is drilled through.

Cold Fusing (aka Laminating or Gluing)

Which glue to use depends on the surface of the glass. UV cure glue provides the best bond but is only reliable when used on a fully polished surface. Epoxy or Silicone are a better choice for a less than fully smooth surface. Whatever glue you choose, take care to be sure there is no residue of cleaning materials (like windex) on the glass. If you have used anything to clean the glass, wipe it with alcohol before applying glue.

Fire Polish

Grinding glass to a uniform finish is relatively quick. Taking it up to a full gloss polish is a lot of work. Sometimes it's easier to just grind down to 100 or 200 grit then return it to the kiln to fire polish edges and surface. The "trick" is to use a firing schedule that will polish the glass without sagging or distorting it. Here's a schedule we routinely use for fire polishing small castings and after sandblasting:

SEGMENT	RAMP	TEMP	HOLD (min)
1	400F (200C)	1000F (515C)	20
2	1200F (650C)	1300F (705C)	4
3	FULL	960F (515C)	60
4	400F (200C)	300F (150C)	0

The 20 minute hold in Segment 1 is to ensure the glass is a uniform 1000°F temperature. This is important because glass won't thermal shock crack above that temperature no matter how fast the temperature changes.

The 1200 degree per hour ramp in Segment 2 takes the temperature up too fast for gravity to have any significant effect on the glass. The 4 minute hold is just enough to fire polish all surfaces but not long enough for gravity to do anything destructive.

I call this the "Commando Raid" technique.

Get in fast - do the job – get out fast.