



# Combing Glass

## Safety

To comb glass, you will be opening the kiln when it's heated to a very high temperature and reaching in to comb hot molten glass. The heat escaping from the kiln can do serious damage. It's important to be sure that escaping heat doesn't burn anything near the kiln – especially you. Take special care to be certain there is nothing flammable too near the kiln and that you wear good protective gear.

**Turn the kiln off.** Accidentally touching your combing rod to an electrified kiln element will be a shocking experience.

**Zetex gloves** – rated to 2000° F. Long ones that come up to your elbow are preferred but the shorter ones that come just to your wrist will be enough if you're careful. Regular welding gloves are not good enough for other than extremely short kiln openings and only if you remain at least 3 feet away from the kiln.

**Heat resistant jacket or leather welder's apron.** A fully fireproof jacket like firefighters have will allow you to work close but such jackets are expensive. Flameproof welder's jackets are relatively inexpensive and will allow you to get close enough to comb and still provide adequate protection. So will a leather welder's apron or jacket.

**Green welder's glasses.** It's important to wear something to protect your eyes from infrared rays. Infrared can cause PERMANENT eye damage. If you choose to use a green plastic face shield instead of goggles, remember, the kiln heat will soften and might even melt it. No. 3 tint is plenty of protection. Darker makes it needlessly hard to see. If you have didymium glasses for torchworking, they work well to remove the glare from the molten glass and allow you to more easily see where you have combed.

**Face Shield.** Any kind of face shield will help protect your face from the heat – but remember, plastic can melt.

**Cotton or wool clothing.** Do NOT wear anything synthetic. It can melt and stick to your skin. There are no "special" prizes for glass artists with scar tissue from melting their shirt to their arm. Remember to cover your exposed neck – either with a buttoned up collar or a cotton scarf.

**Long tools.** The longer the tools you use to comb the molten glass, the further you are from the heat so the less risk of getting burned.

**Hair.** If you have long hair, tie it back. If you want it trimmed, go to a barber. Also, the smell of burning hair can be a bit distracting while you're busy trying to comb a beautiful pattern in the glass.

**Be quick.** The best safety precaution when combing hot glass in a kiln is to work fast. Resist the urge to do "just one more comb". Open the kiln, do a couple of passes, and close the kiln. Come back later to do more. The longer the kiln is open, the greater the possibility you will burn something.

## Type of Kiln

You can use almost any kind of kiln to comb glass but most glass artisans prefer either a clamshell or front loading kiln. When you open the kiln to comb the glass, a lot of heat escapes. A lot more will escape from a top loading kiln than from a clamshell or front loading kiln. Not only is that escaping heat causing the glass too cool so fast you have extremely little working time to comb but it's a lot more heat you need to protect yourself from. There is also a serious concern you can damage your kiln lid from combing in a top loading kiln.



# Combing Glass



*Clamshell kiln*



*Top loading kiln*

## Kiln Location

It's always important to keep your kiln a safe distance from anything flammable but especially important if you plan to use your kiln to comb glass. The usual practice of just keeping your kiln 12 inches away from anything flammable might not be safe when you open the kiln and a blast of super hot air comes racing out. If you can't provide greater distance, it's a smart idea to install a metal baffle or some kind of fireproof material like cement board.



*Front loading kiln*

## Combing Tools

You can use anything stainless steel. You could add a wooden dowel extension to a barbecue tool, fabricate something yourself with a stainless steel end, or buy one of the many combing tools made for combing glass. If you have short tools you'll have to work close to the heat but longer tools will allow you to work farther away and have less concern for getting burned.



# Combing Glass

To comb, the tool must be bent into an “L”. If it’s bent on an angle slightly out, it’s easier to comb pulling. If it’s bent on a slight angle in, it’s easier to comb pushing. You might want to have one of each.



Combing tools

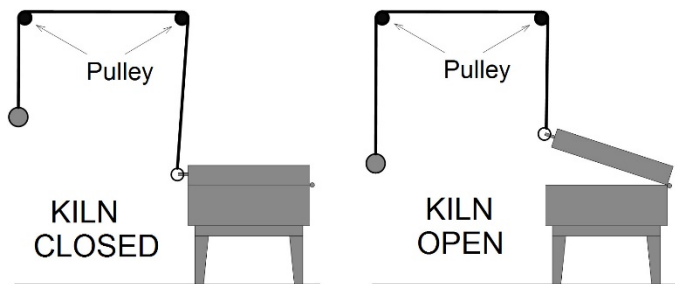
There is no need to fully open the kiln. Just enough to reach in and comb the glass. The higher you lift the lid the faster the glass cools so the less time you’ll have to comb the glass before having to close the lid and reheat the kiln for another pass at combing.

However you plan to open your kiln to comb glass, it’s a good idea to practice a couple of openings before jumping in and doing a comb. Not only is it important that you can open your kiln without getting burned, it’s also important you not close your kiln so quickly you let the lid slam down too fast and blast a bunch of kiln lid bits into the molten glass.

It’s always safest to have an assistant to open and close the kiln for you but with a good pulley system you can do the job unassisted. It just means you’ll have a little less combing time with each opening.

## Opening the Kiln

The closer you are to the kiln when you open it to comb, the more likely you’ll get burned by the escaping heat. The larger the kiln, the more heat comes raging out so the greater the possibility of getting burned. If you can, it’s a good idea to rig some kind of lift apparatus that allows you to lift the lid from a distance.



A possible pulley system for lifting a kiln lid

## Stages

Combing is done in stages. You don’t just lift the lid, reach in and comb the design you want. Each time you open the kiln you do a few combs, then close the kiln, let it heat up again to required temperature, then open it and do so more combs. Small projects can be completed in only a few stages while larger projects will take more stages to complete.

## Timing

When the kiln lid is open, the glass quickly cools and will become so stiff the combing rod gets stuck in the glass. That could be a disaster. Resist the urge to speed up the job by trying to do too many combs with each opening. Be organized and prepared. You have less than a minutes to comb in each opening. Plan what you want to do before the kiln opens.



# Combing Glass

## Temperature Monitor

Remember, the thermocouple reads the air temperature at the tip of the thermocouple. That does NOT mean the glass is that temperature. In a clamshell kiln, the upper chamber is likely to retain heat longer than the open kiln shelf with the glass on it. The glass temperature could be much less than the reading on the thermocouple. If the thermocouple is below the glass, when the kiln is opened, the glass will cool a LOT faster than the thermocouple reading.

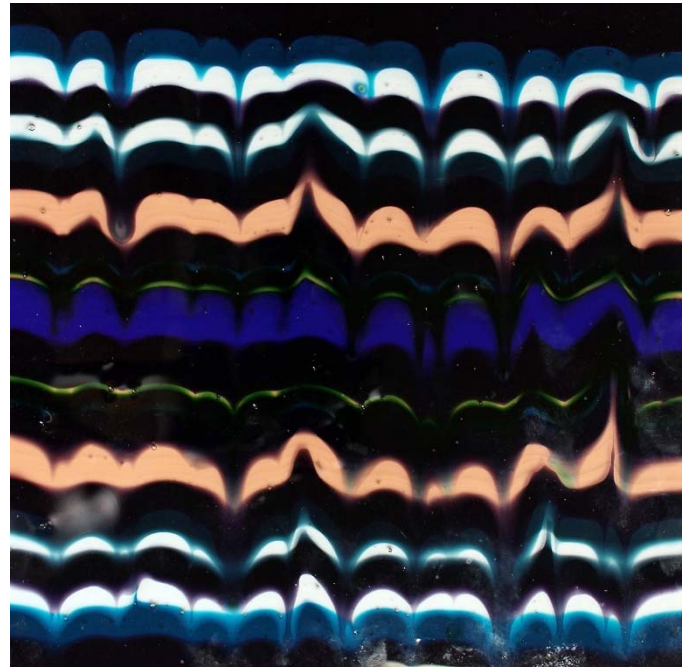
## Comb Two Hand or One Hand

It makes no difference. If you have good enough hand control to get relatively equal combs with each hand, using two hands at the same time will make the project go twice as fast but combing one hand at a time will produce the same results – just takes more kiln openings.

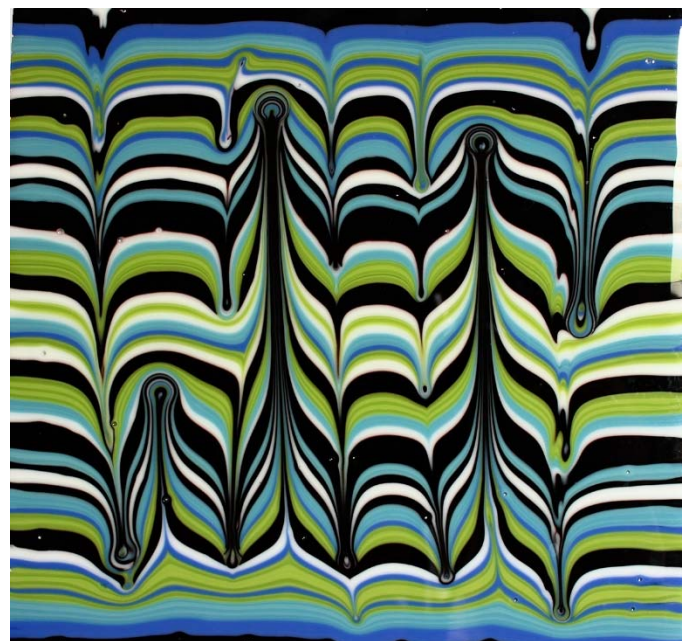
## Combing Pressure

The glass is stiff like taffy. It is NOT like drawing a rod through something like oil or water or even like pancake batter. It's sticky and resists being pulled or pushed so requires some pressure. Take care to not apply too much pressure. Pull or push JUST hard enough to comb into the glass. There is no need to push too deep into the glass. If you push too deep and too hard, there's a good chance you will push or pull the project out of position on the kiln shelf or push the combing tool deep enough to pull fiber paper up into the molten glass.

It will take a few projects to get comfortable with how much pressure is needed and how different combing pressure and different combing speed produces different effects.



Combed with light pressure



Combed with firm full pressure



# Combing Glass

## Kiln Shelf

You can set the glass right onto the kiln shelf, or on a piece of ceramic fiber paper. Kiln paper will not survive the temperatures melts are done at so should not be used.

Firing onto ceramic fiber paper leaves a pretty rough surface on the underside. You'll get a much smoother finish on the bottom if you place your glass strips onto a solid piece of clear iridescent glass with the metallic iridescent side facing down.

## ~ WARNING ~

A number of glass artisans have reported cracked Corelite kiln shelves from using them for combing projects. It's possible the combination of the much higher heat the kiln is fired to for combing combined with the weight of the glass in just a small part of the shelf can cause the shelf to cool significantly faster than the glass thus creating enough thermal shock to crack the kiln shelf. It might be a wise practice to avoid using a kiln shelf that is too much larger than the project on it.

## Glass Thickness

You want to be sure the glass is thick enough you don't accidentally poke right through it. Combs are usually done on glass at least 9 mm thick. Thicker is even better.

The most popular way to achieve this is to use a solid layer of 3 mm clear as a base then place either two layers of 3mm glass on top or strips of 3 mm x 6 mm glass on edge on the base. How you set out the glass ready to comb doesn't matter as long as you can fuse it all together without trapping any bubbles.

## Glass Position

If you're working with a front loading or clamshell kiln, you might think placing the glass to be combed in the front of the kiln instead of the middle or rear will make it easier to comb. You're right it will – but, it will also cause the front of the glass to cool and stiffen quicker than the rear of the glass and make it much more difficult to get smooth even combs.

## Design

The overriding design rule that applies to all glass art applies to combing.

*"If you're doing the work, you're making the rules".*

It can be any color or any configuration you want to try. Most glass artists like to use thin strips but some interesting effects can be created with entirely different designs. Experiment. Innovate. Invent.



*A light comb with black glass on white.*

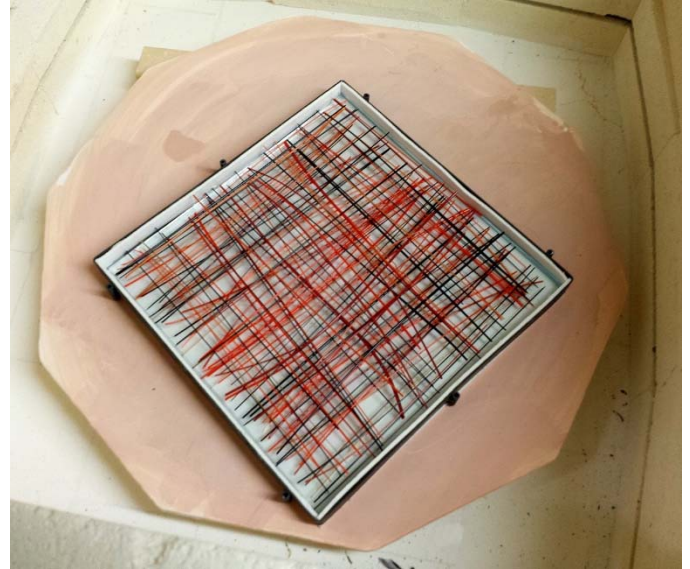


Glass Campus

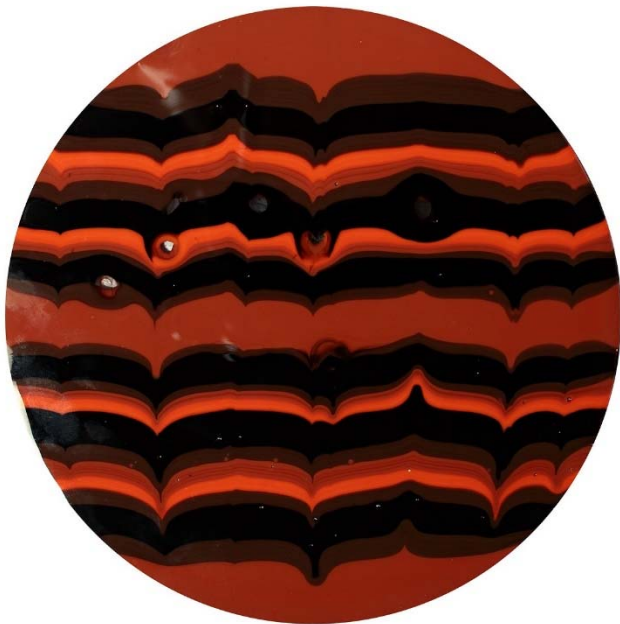
# Combing Glass



*3mm clear glass with 3mm x 6mm strips on top*



*3 layers 3mm clear with stringers on top.*



*Lightly combed*



*Cross combed (north-south & east-west)*



# Combing Glass

## Bubbles

Firing onto ceramic fiber paper allows air to be pushed out beneath the glass so significantly reduces the likelihood air bubbles might be trapped beneath the glass. At combing temperature, any such bubbles are almost certain to blow glass domes through the glass.

If you fire onto the kiln shelf without fiber paper, and your kiln shelf has even the smallest dip, you risk getting air bubbles.

## Firing Schedule with Skip Step

SEG	RAMP °/hr	TEMP °F	HOLD minutes
1	300	1000	20
2	9999	1700	60
3	9999	960	90
4	100	800	0
5	300	300	0

Open the kiln anywhere between 1650 and 1700. If you open the kiln at too low a temperature, it will cool so fast you'll have extremely limited combing time and risk having the glass stiffen so fast the combing tool gets stuck.

Every time you close the kiln after combing, the kiln will continue heating up to 1700. When you finished combing, you can leave the glass to soak for the rest of the hold time or do a "skip step" on the controller to jump to Segment 3 and cool to anneal.

## Firing Schedule without Skip Step

SEG	RAMP °/hr	TEMP °F	HOLD minutes
1	300	1000	20
2	9999	1700	5
3	9999	960	90
4	100	800	0
5	300	300	0

This is an alternative schedule that allows you to not use a skip step but it requires you work very fast and not allow the temperature to drop too far below 1600.

This methods requires you always open the kiln before the temperature reaches 1700 to ensure it doesn't switch to the hold time. Do a few combing passes and close the kiln. The kiln controller will continue in Segment 2 increasing temperature to 1700. When you have finished all the combing you want to do, just let the controller finish the programmed schedule.

The risk with this schedule is if you have allowed the kiln to cool too much, it will be unable to regenerate heat fast enough to prevent the controller issuing an error message and turning off.

## Combing Technique

Combing glass is slow. You can only do two or three passes with each kiln opening then wait for the kiln to heat up enough to allow for more passes. It takes a few hours to complete a combing project.



## Combing Glass



*Ready for the lid lift.*

Most combs are done by pulling the combing rod slowly straight towards you and pushing it straight away from you but there's no reason you can't comb on an angle. in wavy curves, or a combination of lines and curves. Make a "W" in the glass. Make an "S". Whatever you want to try. Experiment with different ways to comb the glass. Experiment with different pressures and speeds.

- Be ready. Be prepared to start combing as soon as the kiln opens. Plan your combing pattern before you start. The glass surfaces starts to stiffen immediately so any hesitation loses combing time.
- Comb steady. Once you start, don't stop. Keep going at a smooth steady speed with a consistent pressure. The same kind of speed and pressure control you use to score glass.
- Comb too fast and you risk getting uneven depth combs.
- Comb too slow and you lose too much heat between each opening.
- Press too hard and you risk pushing through the glass and pulling fiber paper up into the glass.
- Press too gentle and you will get a lot less pattern.
- Change speed or pressure during a comb and you create a distorted pattern.
- Try to get too many combs and you risk the combing tool sticking in the glass.
- "Pool cue" the combing rod. It's not easy to keep the rod steady and get a smooth speed and even pressure pushing through the sticky glass. It will help a LOT if you slide your combing tool along one hand the same way you would a cue playing pool.
- Cool the tool. After each comb, dip the combing tool in water and wipe dry. The metal absorbs heat. Hot metal sticks to glass. If the metal combing tools hasn't thoroughly cooled from the previous combing, the likelihood it will stick to the molten glass is increased.





# Combing Glass



*Pool Cue technique for holding combing rake.*

## **~ WARNING ~** Combing can damage kiln lids

Combing glass can be a lot of fun and can produce many unique and intriguing effects but it comes with risks. Not just the risk of burning something from the heat escaping from the kiln but also a risk of damaging the kiln.

Whether it's from opening the lid to crash cool down to anneal temperature or to open the lid to comb molten glass, the thermal shock of cold room temperature air on the hot bricks can damage them. Repeated shocks can cause the bricks to crumble and collapse. To minimize damaging your kiln, minimize the degree of thermal shock.

- Open JUST wide enough to comb. You do NOT need to fully open the lid.
- Open ONLY for short intervals and close the kiln as quickly as you can.



*Starting the comb.*



*Collapsed kiln lid caused by thermal shock.*