**Spectrum Glass** presents:

System 96®

# Getting Started with Kiln-Fired Glass

## Guide to Materials and Procedures

Beautiful fused glass projects are easy and fun!

# Glass Meets Kiln

> Any kiln with a programmable controller can be used to fuse glass.

There are only a few basic requirements to be a top-notch Fused Glass Artist: a kiln, a creative urge, some "compatible" glass, and a few tools. This booklet introduces you to the tools, components, techniques, and resources common to successful Glass Fusing.

Our approach promises predictable results, basic skill development, and a minimum of surprises. After you become familiar with the basics, we hope you will experiment, stretch, and play—glass is endlessly fascinating and rewarding!


## What is Glass Fusing?

Glass Fusing is simply the process of stacking two or more layers of compatible glass together to make a design, then placing the stacked glass into your kiln, where it melts together.

### Assembly

A project generally begins with a **base layer** (often one or two pre-cut glass Blanks) with a **design layer** on top, including glass accents, border details and focal elements.

### Flat Firing

After assembly, the project is placed in the kiln and slowly taken from room temperature up to 1300-1500 degrees Fahrenheit. Different effects can be created by combining the variables of time and temperature. These are outlined in the "Firing Programs" section.

The resulting flat project could be a tile, trivet, suncatcher, coaster, or decorative art. Stop here, or fire again—"slump"—for a three-dimensional shape.

### Slumping

Once your design is fused into a single flat unit, the project can be returned to the kiln and heated just to its softening point (about 1235° F), causing it to sag **over** or **into** a mold. This transforms the flat project into a functional or artistic 3-D piece, such as a bowl, tray, platter, or vase.

## Special Notes

### Compatibility

Glass expands when it is heated and contracts when it cools. Glass from different manufacturers has a distinct rate at which it expands and contracts, called the Coefficient of Expansion (C.O.E.). When you assemble your projects using only System 96® glass, you are drawing from a family of products that have been "tested compatible." You can trust all products that bear the System 96 logo to work well together.

> Do not add other kinds of glass to your projects and expect success. **Project breakage will result!**

### Degrees, not "Cone"

If you have a ceramic kiln, set it to display temperature in degrees, not "cone."

### Fire Glass Separately

If you also fire ceramics, do not fire glass and ceramics in the same kiln at the same time — glass fires at lower temperatures.

# Glasscrafting Tools & Supplies—Getting Started

This list includes the most commonly used tools and supplies for creating glass projects. They are readily available from the sources listed on the last page of this booklet.

## Nippers

Like "scissors" for glass, the nippers chew up glass with ease, creating a characteristic curvy break that's artistic and versatile. Aim flying nips into a basket or tray, and always wear safety glasses.

## Glass Cutter

The cutter's wheel creates a "score" as it's guided across the glass surface. When pressure is applied to both sides of this score, the glass will break. You can create beautiful projects without ever picking up the glass cutter—but with a bit of glass-cutting skill, a world of design possibilities opens up.

## Running Pliers

These specially designed pliers put presssure on both sides of the glass cutter's score, encouraging a "run" (crack) along the line of the score. Often the glass will break all the way along the score with just gentle pressure from this tool.

## Breaking Pliers

These sturdy pliers act like metal fingers, to grab, pull, and break the glass along the glass cutter's score line. Especially useful for small pieces, or to nibble off pointy spots.

See the System 96 QuickTips for guidance on using the tools above. (Resources p.15)

## Klyr-fire

Use this viscous, slow-drying adhesive for holding Frit in place, or sticking on tiny pieces too small to glue individually. Apply with a cotton swab, brush, or dab from a squirt bottle. It burns away during firing.

## Elmer's Glue

Use just a pinpoint of glue, applied with a toothpick, to hold pieces in place as you transfer your project to a kiln shelf.

### Cutter Oil

Lightweight oil lubricates the cutter's score line and prolongs the life of the cutting wheel. Keep a little in a small jar with a piece of sponge at the bottom, and just dip your cutter in it every few strokes.

### Kiln Shelf Paper

Provides a layer of protection between the glass and kiln shelf. Prevents sticking and helps avoid formation of large air bubbles beneath the glass.

### Slumping Molds

Generally speaking, slump INTO molds to create bowls, dishes and other shallow forms. For prep, see "Preparing Molds for Slumping" section.

### Floral Former Molds

Slump OVER to create vases, candleholders and other interesting shapes. For prep, see "Preparing Molds for Slumping" section.

### Shelf Primer and Application Brush

Keeps glass from sticking to molds.

### Dedicated Glass-Firing Kiln Shelves

A few smooth shelves reserved for glasscraft will keep the undersides of your projects smooth and even.

### Shop Vac with Small-Particle or HEPA Filter

Highly recommended for all glass cleanup chores. Captures tiny glass splinters and harmful dust residue after firings.

### Brushes

Small brushes are great for brushing Frit into place or out of spaces it doesn't belong.

# Glass Fusing Components— How to Use Them

The System 96 Glass Craft Program uses a set of pre-defined components to make project creation easy and foolproof. You may find them pre-cut and ready to purchase on the shelves of a System 96 Glass Fusing Center, or you may choose to cut them yourself from sheet glass.

**Blanks** Base layer for projects. For slumping, choose a Blank that coordinates with an available mold. (See p.12)

**Sheet Glass** Assorted transparent, opalescent, and specialty glass. Cut or nip to create shapes or project Blanks.

**Nippits™** Assorted colors of glass pieces, about 2" x 6". Use with glass nippers to create random-sized pieces, or with glass cutter for specific small shapes.

**Chips** 1/2" squares of various colors. Ready-made design elements with many uses.

**Strips** 1/2" x 12" lengths of various colors. Nip or cut.

**Rods** Various colors of cylindrical, pencil-thick glass. Nip off 1/4" or smaller bits to create "dots" or bumps. Nip longer lengths for borders or bold design elements.

**Noodles** Assorted colors of fettuccine-like strands. Nip to length.

**Stringer** Assorted colors of thin strands like angel-hair pasta. Break with fingers or nippers.

**Frit** Ground glass, in various particle sizes and many colors. Sprinkle, pour, or place with tweezers; use with Klyr-fire.

**Pebbles™** Small, pre-formed droplets of glass in assorted colors. Versatile design or border elements.

**CutUps™** A variety of pre-cut glass shapes in assorted colors. Use as design elements or inspiration.

**Dichro Shapes** Metallicized color-shifting sparklers in pre-cut shapes. No cutting necessary; use as design elements.

**BorderRounds™** Pre-cut curved glass sections. Use in sets of four to create rims for round Blanks.

**Dichroic Glass** Small pieces of metallicized color-shifting sparklers. Nip or cut to desired shape.

# Making a Project

Projects are assembled by stacking glass pieces in layers. The bottom layer is often a single glass circle or square, called a "Blank." Atop the Blank we place other glass pieces to create a design ("design layer"). Sometimes we place a few additional accents atop the design layer ("accent layer") for added effect.

Blank | Design & Accents | Finished Firing

**IMPORTANT:** Each layer adds thickness to the finished project. The overall thickness dictates the kiln settings for successful firing. The firing guidelines in this booklet will successfully fire projects up to about 3/8-inch (3 glass layers) thick.

## Step 1: Planning Your Design

Here are a few approaches:

- **Follow a Project Guide**

  Choose from numerous System 96 Project Guides to create specific projects. You'll be learning techniques, discovering your firing preferences, and improving your skills—while creating projects that have been proven successful. (See Resources p.15)

- **FreeStyle Design**

  Start with a glass Blank, then simply decorate it with various shapes and sizes of smaller glass pieces. Dive in with no preconceptions. Use Chips and CutUps, layer transparent pieces to create overlay colors, nip random pieces and scatter them, play with Frit. Be unattached to the results. Each project will be your teacher.

- **"Frame, Focus, Fill"**

  FRAME: A border around the edges lends style and helps preserve the project's overall shape during firing. Create the frame from pre-cut BorderRounds, glass Strips or Chips, lengths of Rod, nipped triangles, or other repeating shapes.

FOCUS: Good design benefits from a focal point—a central design element that draws the eye. Use CutUp shapes, a dash of dichro, a contrast in color.

FILL: Fill the interior space with interesting texture—as simple as a few well-placed dots of Frit or scattered Stringer, or as intricate as a tightly-fitted mosaic.

Frame

Focus

Fill

## Step 2: Assembling Your Project

### Glue Sparingly

Glue pieces onto your project only as necessary to prevent shifting as you transfer it into the kiln. We use two types of adhesive:

Elmer's Glue: Apply PINPOINTS with a toothpick. (Too much will char.)
Klyr-fire: Allows lots of working time and always burns off. Apply with a cotton swab, brush, or dribble on.

### Support Your Project

You may need to move your project several times before it is fired. A full-coverage base Blank will support your project as you assemble and move it. Otherwise, assemble either on your kiln shelf or on a flat, unglazed tile that will go directly into the kiln.

### Prevent Sticking

In either case, **use kiln shelf paper under every project**. It prevents sticking, provides a consistent surface, and helps avoid bubbles under your project. Size the **kiln shelf** paper to extend about 1/4" beyond the edges of your project, to allow for expansion.

## Step 3: Loading the Kiln

Whether you have a kiln that accommodates one project or several dozen, your goal is to **heat the glass as evenly as possible**. Here are some guidelines to achieve even heat distribution.

- Position projects at least 2" from kiln elements.
- If using a single shelf, position it centrally in the kiln.
- If stacking shelves, position them so that at least one side-element freely radiates between each shelf. Post the lowest shelf off the kiln floor, and the highest shelf well below the lid.
- **Do not stack shelves in kilns equipped with lid elements only.**
- If your kiln controller is equipped with "Zone Control," use it.

> On the kiln shelf, always leave 1/2" between projects and 1/4" between the project and the edge of the shelf, to allow for expansion of the glass.

Load the kiln shelf with your project(s), then place the shelf into the kiln carefully, so the design pieces will not shift.

## Step 4: Programming Your Kiln

### "Ramp and Hold"

Heating glass to fusing temperature and cooling it, without introducing internal stress, is accomplished in your kiln with a time-temperature cycle called a Ramp & Hold firing program.

Entering a Ramp & Hold program into your controller is easy. Consult your kiln manual if needed, but don't be intimidated! Once entered, you need only recall it from (your kiln's) memory for future use.

A Ramp & Hold program is made up of several segments. Once started, your kiln will execute each segment, in sequence, until the firing program is complete. Our recommended firing schedules have four segments, each with three parts: The Ramp, the Goal Temperature, and the Hold Time. The diagram that follows explains this.

| Segment | | Ramp | Goal Temp | Hold Time |
|---|---|---|---|---|
| # | Purpose | (ºF per Hr) | (º F) | (Minutes) |
| 1 | Glass temperature is raised slowly to prevent thermal shock | The rate, in degrees per hour, that kiln temp will rise or fall during each segment | The temperature that the kiln will seek during each segment | The number of minutes the kiln will stay at the Goal Temperature, once it is reached |
| 2 | Glass is more rapidly heated to its Goal Temp | | | |
| 3 | Glass is rapidly cooled to its anneal point, then held there to equalize temperature throughout | | | |
| 4 | Glass is slowly cooled through its annealing range | | | |

# Firing Programs

**THE PROGRAMS THAT FOLLOW ARE DESIGNED FOR PROJECTS UP TO ABOUT 3/8" THICK. FOR MORE FIRING OPTIONS, VISIT SYSTEM96.COM**

## **TACK** FUSE

*Glass pieces are fused together with little deformation beyond softening or rounding of edge*

| Segment | Ramp (ºF per Hour) | Goal Temp (º F) | Hold Time (Minutes) |
|---|---|---|---|
| 1 | 300 | 1150 | 30 |
| 2 | 400 | **1370** | **0** |
| 3 | 9999* | 950 | 60 |
| 4 | 150 | 800 | 10 |

*as fast as possible

## **CONTOUR** FUSE

*Glass pieces are fused together, edges are soft and rounded, project surface retains a degree of dimension.*

| Segment | Ramp (ºF per Hour) | Goal Temp (º F) | Hold Time (Minutes) |
|---|---|---|---|
| 1 | 300 | 1150 | 30 |
| 2 | 400 | **1440** | **5** |
| 3 | 9999* | 950 | 60 |
| 4 | 150 | 800 | 10 |

*as fast as possible

**FULL** FUSE

Glass pieces are completely conjoined into a single uniform layer, top surface is smooth and void of dimension or relief.

| Segment | Ramp (ºF per Hour) | Goal Temp (º F) | Hold Time (Minutes) |
|---|---|---|---|
| 1 | 300 | 1150 | 30 |
| 2 | 400 | **1475** | **10** |
| 3 | 9999* | 950 | 60 |
| 4 | 150 | 800 | 10 |

*as fast as possible

## Tack, Contour or Full Fuse?

Though the intricacies of kilncraft offer a world of different firing effects, we recommend starting with the firing programs outlined here. Note that, except for the Goal Temp and Hold Time in Segment 2 (shaded), all three firing programs are identical. Segment 2—PROCESS temperature and time—defines the difference between Tack, Contour, and Full fuse levels.

As you become familiar with the results at these three fusing levels, you may choose to adjust the process time and temperatures.

> When in doubt, Tack or Contour fuse. Projects can easily be returned to the kiln and re-fired for a more "melted" result. Obviously, the opposite is not true!

## Don't Peek!

Glass is sensitive to temperature changes, and cooling from the goal temperature is carefully regulated by the firing programs. While the glass is cooling, it is going through an annealing phase, in which the glass adjusts to its new form.

> Don't interrupt cooling by opening the kiln and shocking the glass with a blast of cold air. Project breakage will result!

After the firing cycle is complete, **leave the kiln lid closed.** Use the peephole if you must, briefly. Otherwise, demonstrate patience, and don't open until the internal temperature is below 100°F....

**Then Admire Your Fused Glass Art!**

## Slumping (Optional Step 5)

Most glass projects can be fired a second time to form a functional or artistic three-dimensional shape. In this firing, you will re-heat the previously fused flat project to the point of softening, and it will "slump" **into** and take the shape of the mold you've selected. Or, you may choose to place the project on top of a mold (usually stainless steel) and let it slump **over**.

### Planning Your Design to Fit

To create a piece that you plan to slump **INTO** a mold, make sure your assembled project is no larger than about 1/4" outside the perimeter of the mold.

To create a piece intended for slumping **OVER** a mold, make sure the project is not so large that it will sag completely down and flatten onto the kiln shelf. Keep in mind that the piece may stretch a bit as it softens, so leave some extra space.

## Preparing Molds for Slumping

Ceramic (Bisque) Molds:

1. If not already done, drill a few small air holes where the glass will sag down into the mold. This will let air escape from beneath the glass as it slumps.
2. Brush on a smooth, thin coat or two of Shelf Primer—reapply when it shows wear or imperfections.

Floral Former and Stainless Steel Molds:

Pre-fire steel molds so they'll more readily accept the Shelf Primer.

> Ceramic and stainless steel molds are re-usable. Just re-apply Shelf Primer as needed.

## Centering

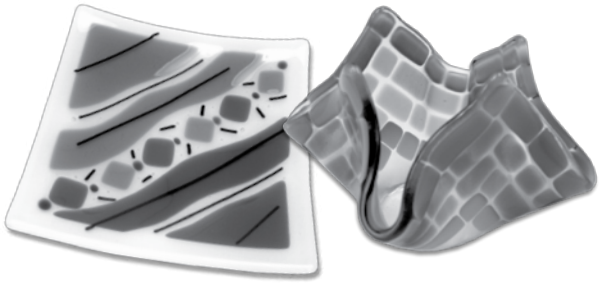
Place the flat fused piece on or into your mold, aligning the project's center point with the center of your mold.

### *SLUMP* FIRING

Previously fused project softens and slumps to take the shape of selected form or mold.

| Segment | Ramp (°F per Hour) | Goal Temp (° F) | Hold Time (Minutes) |
|---|---|---|---|
| 1 | 150 | 300 | 15 |
| 2 | 300 | **1235** | **15** |
| 3 | 9999* | 950 | 60 |
| 4 | 150 | 800 | 10 |

*as fast as possible



# Important Safety Notes

Just like getting a ding on your shiny new car, it won't take long before you are "initiated" by cutting yourself with glass. Use common sense, keep a supply of Band-Aids, and take minor cuts in stride.

> For your protection, always use gloves and safety glasses when working with glass.

Here are a few other things to keep in mind:

## Hot Glass

Be cautious about touching glass in the kiln, even when the controller reads room temp. The glass itself may be much hotter.

## Dust

After firing, kiln shelf paper leaves a dust that can be harmful over time if inhaled. Use a vacuum with a small-particle or HEPA filter (available at any home center) to remove paper dust from each kiln shelf and project as the kiln is unloaded. Then wash any remaining dust off the projects with tepid water. Wear a small-particle dust mask when emptying the vacuum.

## Cleaning Up

- Never brush glass off your work area with your hands. Keep a bench brush handy, or use your vac.
- If you save remnants of unused glass, it's safest to "square up" the pointy pieces.
- Don't put glass remnants into your regular trash without covering with a heavy protective wrap, so the unsuspecting trash bagger will not get cut.

# Resources

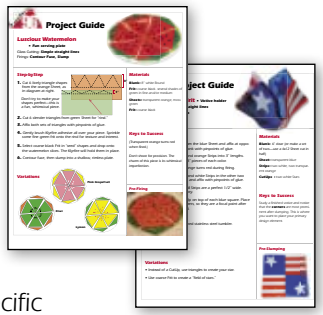
System96.com has supply information, tutorials and a continuously updated Knowledge Base to further your Glass Fusing experience. The Craft Corner on the site contains the following specific support:


## System 96 Quick Tips

How-To tip sheets illustrating techniques for successful glasswork.


## System 96 Ideabook

Inspirational photos of fused glass projects at various levels of artistry and technical skill. Browse through the pictures and let your creativity take off.




## System 96 Project Guides

Step-by-Step specifics on project creation, featuring techniques to expand your abilities and knowledge.

## Tech Support

You may email us with technical questions specific to System 96 products at hotglass@system96.com

## Glass Craft Suppliers

Find authorized suppliers of System 96 products and other fusing materials on System96.com

System 96® is a family of heat-compliant products designed and produced to work together, then tested to ensure their harmony. The products are materials for the Hot Glass Arts—user-friendly and forgiving for the beginner, versatile and predictable for the professional.

Spectrum Glass Company and Uroboros Glass Studios bring a combined 50+ years of art glass manufacturing expertise to the hot glass community. Coatings by Sandberg is a highly specialized maker of the 21st century phenomenon called Dichroic Glass. In cooperation with other carefully chosen companies and individuals around the world, we manufacture the System 96 tested-compatible family of art glass products. Learn more at System96.com

Many System 96 components can be purchased directly from the shelves of the Glass Fusing Center, a one-stop resource for fusing tools and supplies.

Spectrum Glass, Woodinville, WA
SpectrumGlass.com ▪ 425-483-6699

Coatings By Sandberg, Orange, CA
CBS-dichroic.com ▪ 714-538-0888

Uroboros Glass, Portland, OR
Uroboros.com ▪ 503-284-4900