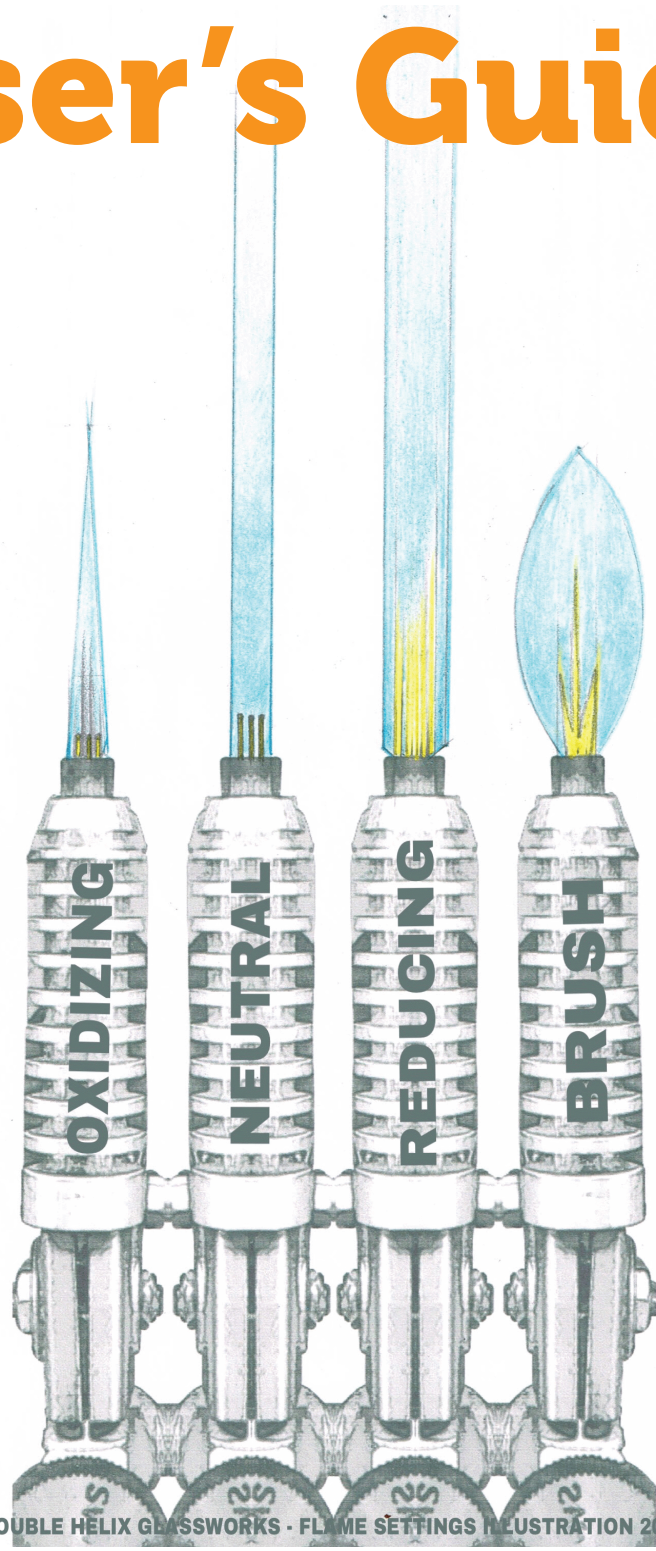
DOUBLE HELIX GLASSWORKS | *Made for the Flame*

User's Guide



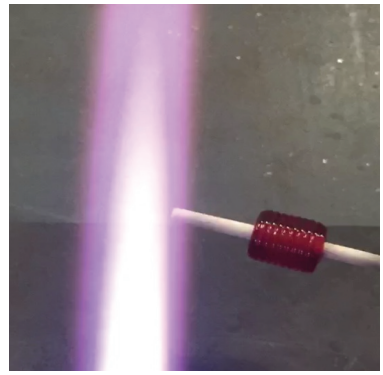
DOUBLE HELIX GLASSWORKS - FLAME SETTINGS ILLUSTRATION 2018

Working with Reduction Glasses

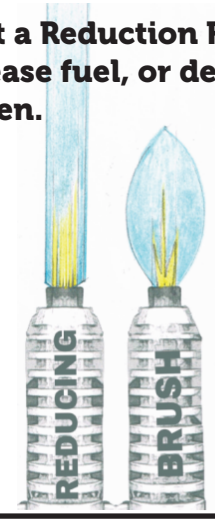
The Reducing Process

1. Work in a neutral flame

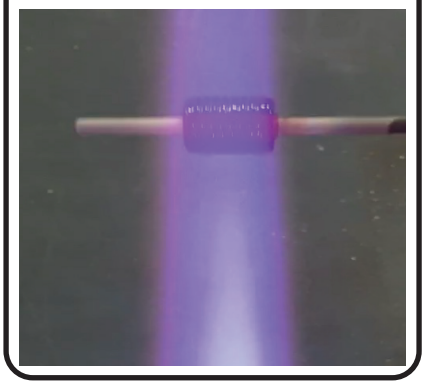
2. Cool until the glow is gone.



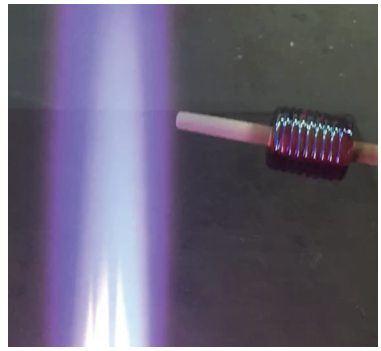
3. Set a Reduction Flame; increase fuel, or decrease oxygen.



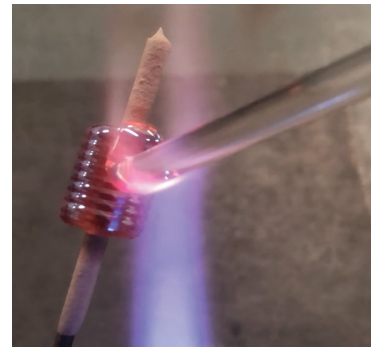
4. Briefly, expose the glass to the reduction flame. (5-10 seconds)



5. If more reduction is desired, repeat step 4, with cooling between exposures.



6.For the pearlescent effect, encase in clear, without exposing the luster to the flame.



Working with other Reducing Glasses

For Reset and Reduce colors, you'll need to reset in a neutral flame (see reset instruction is Striking section) and then follow the reducing process. Reset and Reduce colorse include Clio, Hyperion, Kalypos and Phaeton.

For Brush Flame colors, the process is the same but you want a short, low velocity reduction flame and you'll be using the yellow candle flames as your paintbrush. Brush Flame colors include Arke, Iaso, Iris and Melia.

Reduction Color Theory

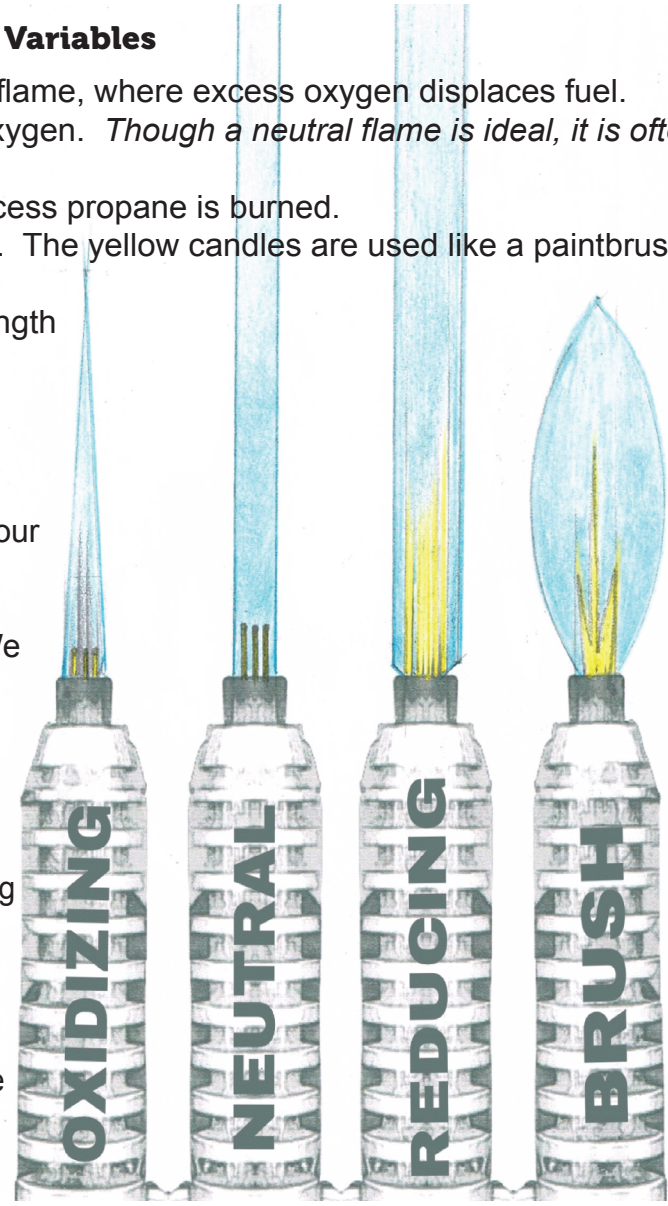
Reduction colors contain silver dissolved in the glass matrix as silver oxide (Ag_2O). Upon exposure to a flame deficient in oxygen, the Ag_2O gives up its oxygen to the flame, leaving behind a thin layer of metallic silver. This metallic layer can be left on the surface or encased in clear glass. A neutral or slightly oxidizing flame should be used during gathering, working, and shaping to preserve the silver in its oxide form. When the glass is ready to be reduced (after cooling) the flame is adjusted by increasing the fuel or decreasing the oxygen. The glass is then briefly exposed to this reducing flame.

Controllable Variables

1.Flame Chemistry

- Oxidizing Flame - displays hollow areas inside the flame, where excess oxygen displaces fuel.
- Neutral Flame - has an even balance of fuel and oxygen. *Though a neutral flame is ideal, it is often simpler to adjust the torch to slightly oxidizing.*
- Reducing Flame - has stretched candles where excess propane is burned.
- Brush Flame - a short, low velocity reduction flame. The yellow candles are used like a paintbrush.

* The chemistry of the flame also varies along the length of the flame,with areas closer to the fuel jets being more reducing than at the tip.



2.Different Torches

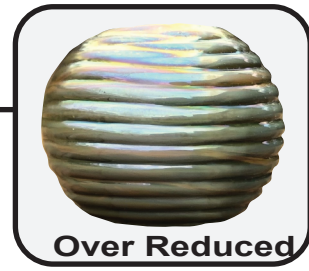
Different torches have a range of possible flame settings. Spend some time exploring the settings of your torch and get comfortable dialing them in. The more control you can have over your oxygen and your fuel, the better. We do not recommend using a hothead. We most frequently use Nortel's Arrow or GTT's Lynx with propane and an oxygen concentrator.

3.Heat

Though reduction is a chemical process, heat plays a role. The glass must be cooled before reducing or the luster can muddy. Limiting the beads thermal gain during the reduction process will result in a cleaner luster.
You can limit the heat by;

- Cooling the bead before reduction and
- Using a cool reduction flame or
- Using repeated brief exposures to the reduction flame with a few seconds of cooling between exposures.

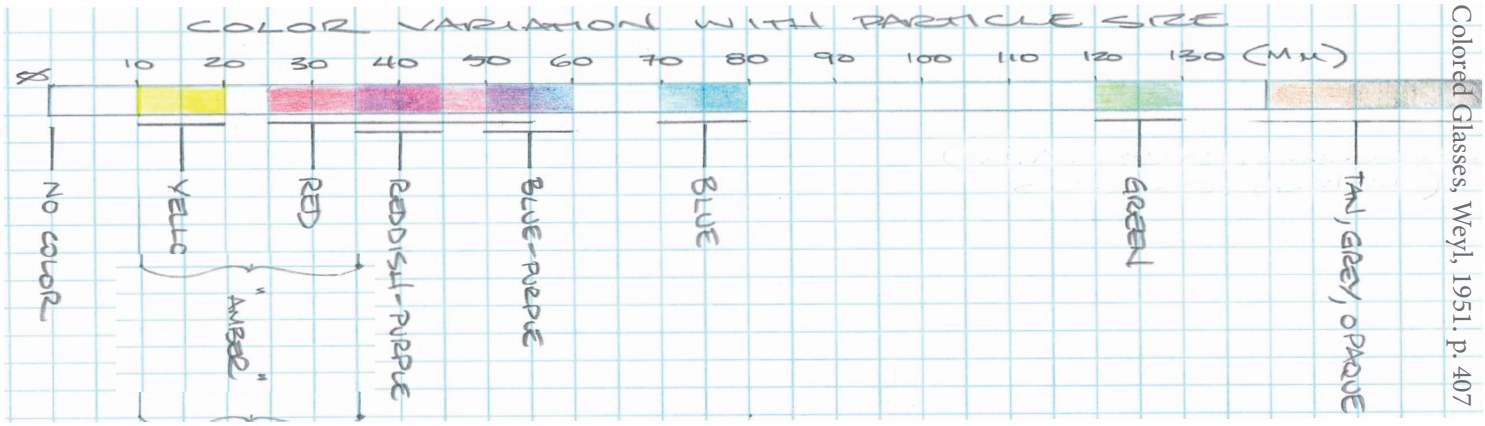

Reduced


Over Reduced

Trouble Shooting Reducing Glasses

1. No Reduction – not cooling the glass long enough before reducing or too weak of a reduction flame.
2. Muddy colors- too much reduction or too much heat.
   a. Test your neutral flame. Hold a rod of reducing glass in it for a few seconds. If it develops a metallic sheen on the surface, then it is not neutral. Adjust by increasing your oxygen or decreasing your fuel.
   b. Reduce for shorter periods, at the tip of a cool reducing flame with enough cooling between reductions to prevent the glass from glowing again.
3. Losing the luster in the kiln –annealing temperature is too high. We anneal at 920-950°F. You can also try putting activated charcoal in your kiln.
4. Erasing the luster – you can burn off the metals from the surface of the glass if it isn't muddy yet. Adjust your torch to an oxidizing flame and erase the luster.

Working with Striking Glasses



Colored Glasses, Weyl, 1951, p. 407

Striking Color Theory

Metals, such as silver, gold and copper are dissolved in the glass. When the glass is cooled, then reheated, the metals form crystals, inside the glass. As these crystals grow, they cause the glass to transmit and reflect different wavelengths of light.

1. Crystal Growth & Nucleation

Crystal growth begins at a nucleation point. Striking colors can be homogeneously or heterogeneously nucleated. In homogeneously nucleated glasses, the metal itself forms aggregates that act as nucleation centers. In heterogeneously nucleated glasses, additional materials have been distributed throughout the glass. These materials act as nuclei, (seed locations for crystal growth). Our silver striking colors are heterogeneously nucleated.

2. Crystal Size and Color Transmission

As the crystals grow, different colors are transmitted. For silver-based striking colors, see the chart on this page. Variations in glass microcomposition, thermal history and heat application throughout the processes creates a polychromatic effect. Overstriking, the development of oversized or disorderly metal crystals can produce dull, muddied tones.

Striking Color Process in Words

Striking a glass is a three part process: **Reset, Cool, and Warm** (RCW). Of the three steps, only the warming step should be repeated to continue the color development.

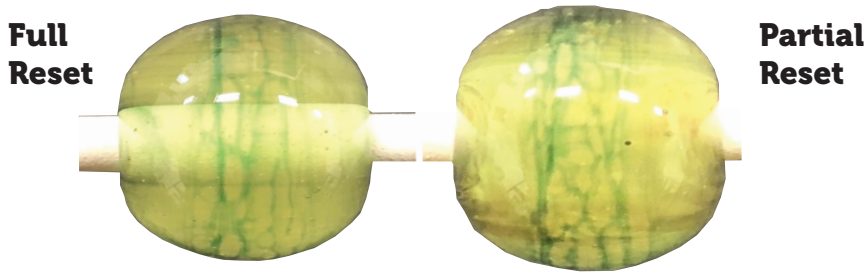
1. Reset

a. Erasing the Thermal History

During production, the glass has been held at striking temperatures for several hours, resulting in crystal growth. The rods are in an overstruck state looking opaque or misty. When the glass is heated above a certain temperature, the metals re-dissolve, yielding a clear glass. We refer to this process as the reset. The reset erases the thermal history of the glass, allowing the controlled intentional growth of the metal crystals. It's best to reset in a separate step. This eliminates variables and provides a more consistent outcome. At the temperatures that silver glasses reset, 104^{coe} glasses are soft enough to move. This does not mean the glass has to be "sloppy hot" to effectively reset the silver. A more judicious application of heat can reset the glass while allowing the viscosity of the glass to remain controllable.

b. Surface or Full Reset

The visual cue for reset is transparency. In some colors this will be crystal clear, in others a clean transparent color, tinted by other metals in the glass. Skylla resets to a transparent light green. In a full reset, the mass of glass would be heated until the entirety of the glass was transparent and the mandrel is visible through the glass. In practice, we often end up with a surface reset, in which the transparent layer only extends to a certain depth, with the core of the bead remaining opaque, swirled, or translucent. For some applications this is adequate.



2.Cool

The cooling cycle is a critical step in achieving repeatable color outcomes. If the reset glass is not allowed to cool before striking, the process does not yield the desired crystal growth. There is a range of cooling times that produce desirable color outcomes. Generally, shorter cooling times will yield lighter pastel colors and longer cooling times will yield darker colors.

a. Determining Cooling Times

I. The earliest appearance of light yellow or amber colors can be a cue that the cooling cycle is complete and the glass is ready to strike.

II. Use known times (gained through experience) to count off the correct cooling time. A clock, stopwatch, metronome, or steady repeatable count can be useful. Keep notes on the times you've tried to adjust in the future or repeat.

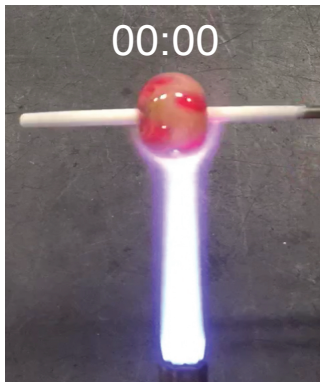
Effects on Cooling Time		
+ Time	Variable	- Time
bigger	glass mass	smaller
air	cooling method	heat sinks
encased	depth of application	surface
hot	temp of glass at start of cooling	warm

3. Warm

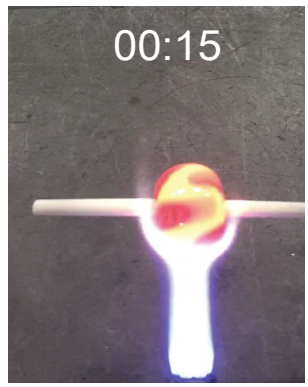
Once the bead has been reset and appropriately cooled, the glass is warmed by gently heating in the furthest reaches of a neutral flame. This reheating temperature needs to be cooler than the reset temperature; warm enough to move under pressure but not hot enough to flow with gravity. If the reset and cooling stages have been sufficient, then the warming process is when you should see the glass striking. Visual cues include, a faint orange glow indicating appropriate temperature, as well as direct observation of the change in glass color. It is ok to take the glass out of the flame for a few seconds and check it's color process. If the color appears too dark, return the glass to the warming flame. Longer warming times tend to produce lighter, more pastel colors. Excessive warming times can develop more opaque, neutral tones.

Striking Color Process in Photos

Reset, Cool, and Warm (RCW). We like to use a stopwatch during this process and our elapsed time is shown iin each photo.



Resetting 1



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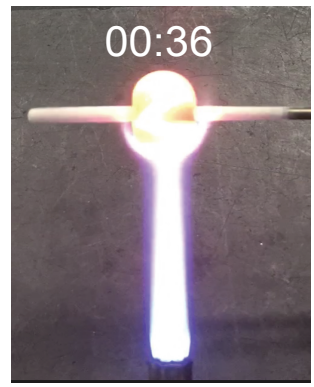

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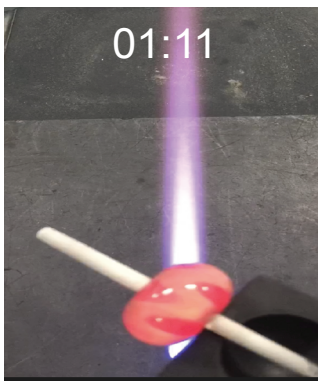
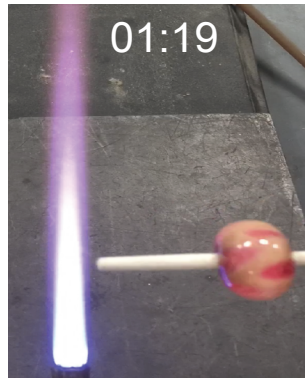


Cooling 1



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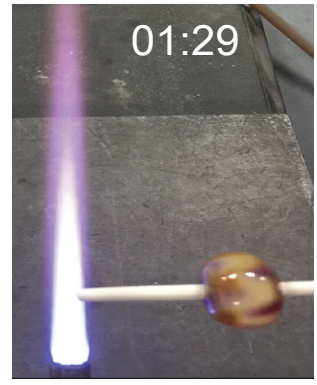

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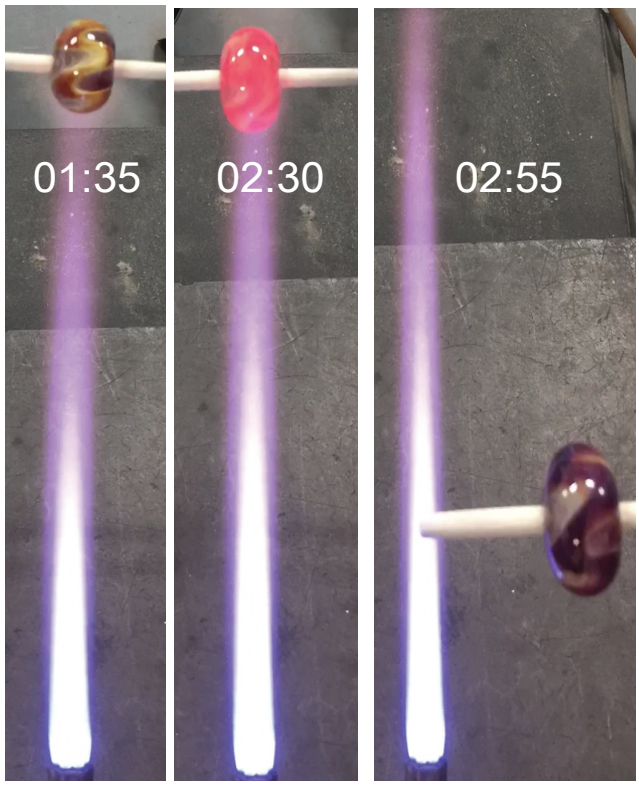
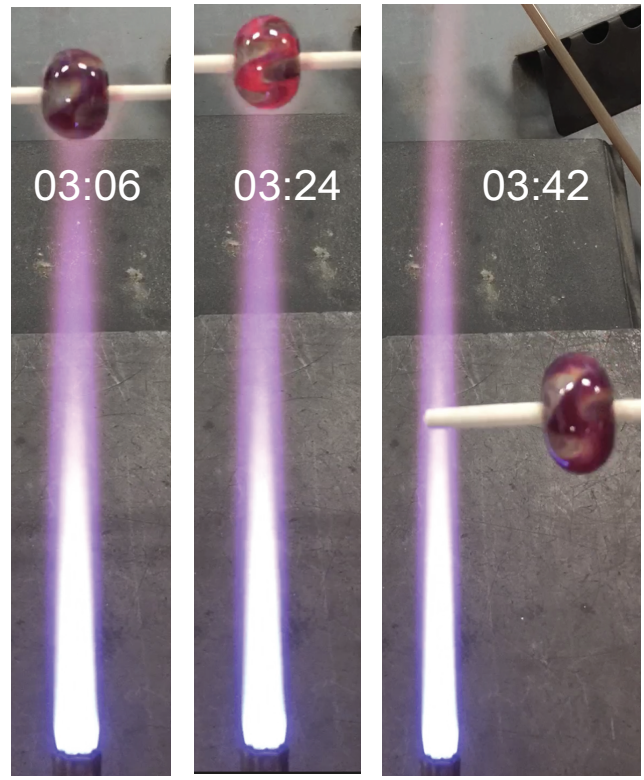


1st Warming



2nd Warming

Trouble Shooting Striking Glasses

Problem	Reset	Cool	Warm	Solution
Failure to strike or stuck in amber phase	none or inadequate	none or inadequate	too hot	Reset again, cool & work further out in the flame when warming
Muddy Colors	none or inadequate		Cooling between warmings or too many warmings.	Reset again, cool & warm without re-cooling between warmings.
Pale colors		none or inadequate	too long or too many	Reset again, + cooling time &/or - warming.
Dark colors		too much	none or inadequate	Reset again, -cooling time &/or + warming.

Skylla Controlled Tests

-Nip off 75 mm from a rod of Skylla and flame weld it to a punty.
-Make a simple bead using all the Skylla on the punty and reset it.
-Use 45 seconds of air cooling time and 45 seconds of gentle warming.

-Nip another 75 mm and repeat but use
-25 seconds of cooling with a bead rooler
-and 45 seconds of warming.

-Continue expirementing with different cooling variables and times while keeping the same mass, shape, and warming time.

Working with Neutral and Technical Glasses

Neutral Glasses: have no special working requirements.

Zephyr- non-reactive clear.

Technical Glasses: do not require the full reduction or striking processes but they do have other specific working characteristics.

Aether-reactive clear. Reacts with reducing glasses, usually by adding a yellow tint.

The Gold Rubies:

Rhea and **Lotis** have been preset to strike red or pink during normal working conditions. Do not overheat. Non-reactive with reducing colors.

The Oracle Project: low toxicity essential glass colors, made in the USA, without Antimony, Arsenic, Cadmium, Chromium, Lead, Nickel or Selenium. Balancing viscosity curves, opacity, tonality, surface tenstion and thermal shock resistance.

Oracle-Black- briefly flame strike before annealing. No reset or cooling is required. We anneal at 950F for 2+ hours. Reactive with reducing glasses. Non-reactive with striking glasses.

Oracle-Opal- to prevent opacifying in the annealer, use lower temperatures and times.

Oracle-Ruby- kiln striking copper ruby, reset right before annealing. Anneal at 950 for 90 minutes.

Oracle-White- avoid overheating to prevent seperation.

Double Helix Glassworks manufactures soft glass colors in Charlottesville, VA. Jed and Julie Hannay run the company together with Tim Peterson. Jed has been a flameworker since 1999. Through continual experimentation he has created our reactive silver glasses, premium clear glasses and is now working on his Oracle project, an extension of his dedication to making glasses for the flame.

Our products will expand your soft glass palette, they will inspire you to create new things and they will challenge you to master new techniques.

- **Tested** – we test every batch of glass for compatibility, consistency and quality.
- **Made in USA** using electric furnaces.
- **Selected Ingredients-** We choose every ingredient that goes into our glass with the intent of avoiding toxic materials and hazardous work environments.

For More Information; Complete Color Chart, Glossary, Tutorials and Videos, go to HOW TO on our website, https://doublehelixglassworks.com/howto/

doublehelixglassworks@msn.com.

(360)-754-9555

or message us on Facebook.

Words of Advice

1. Use forced air ventilation when melting any glass at the torch.
2. Use proper protection when handling glass frit and powder.
3. Most of our glass does not etch.
4. Do not pickle.
5. We do not recommend using our glasses with a hothead.
6. We recommend annealing at 920°F.