Category: Student Work

Project: Striking of Red Ruby Glass

What was the challenge?

It is a common notion in the glass-welding community that making ruby red glass is a notoriously difficult task. Despite being one of the most aesthetic and emotion-evoking colors, its complexity often discourages its creation. It was rediscovered by European alchemists and glassmakers in the late 17th century, long after the ancient world had given up. The red glass piqued the interest of Hamburg physician, Andreas Cassiuse, who discovered the red coloring properties of gold chloride and inspired glass technologist Johann Kunckel von Lowenstern to successfully produce the colored glass.

The challenge of producing this red color lies in the fact that the glass initially appears grey and turns red only after re-heating. Its distinctive colors come from a "striking" process, where light reflects off gold nanoparticles of just the right size when reheated. The addition of colloidal gold to molten glass must be precise in order to achieve the ruby shade. The intensity and distribution of heat affect how the gold salts mold into the glass, hence the constant turning and flipping. Despite all of this, the red glass may still not heat evenly. As it heats and cools, the glass could change colors unexpectedly -- turning orange or leaving bright streaks in the darker glass.

A glass entering the kiln for heating process.

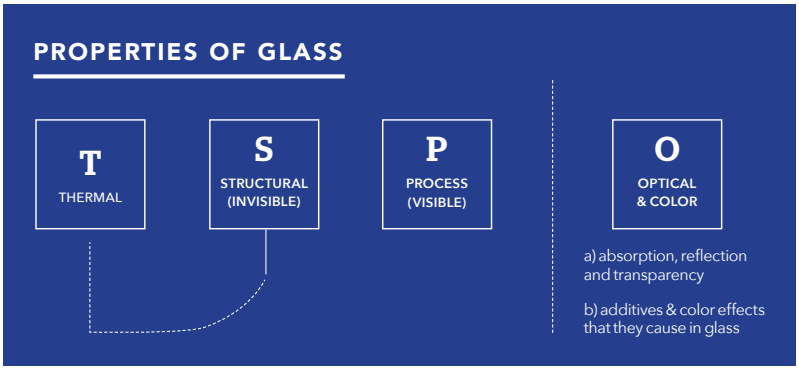
Image Credit: Adobe Stock

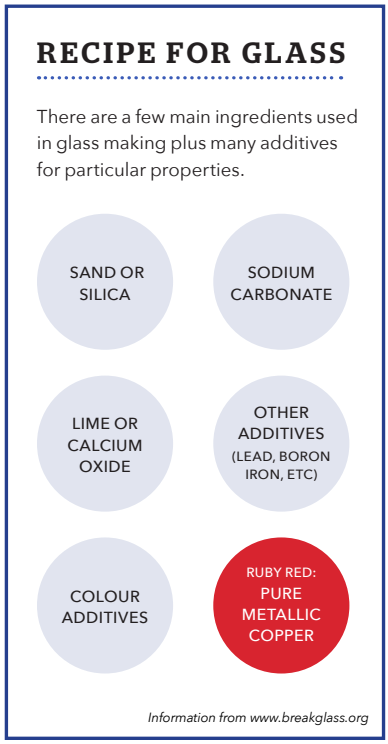
What was the solution?

Inspired by the intricate history of ruby red glass and the present challenges of glass making, I created an infographic detailing the manipulation of temperature to achieve a desired color. In essence, the glass must be evenly reheated at increasingly warmer temperatures to avoid malformation. This infographic acts as a systematic approach, which aims to alleviate the challenges of producing colored glass. As a visual concept of the relationship between heat and color, the infographic both literally and metaphorically strikes gold in gold ruby glass making.

What was the effect?

By combining typography, color subsequency, and tone hierarchy, this glass infographic offers a systematic approach to a complicated procedure that has stumped the world for centuries. A first of its kind, the diagram was displayed at the 2020 Corning Museum of Glass exhibition as a pioneer in the field of visual narratives for glass making.





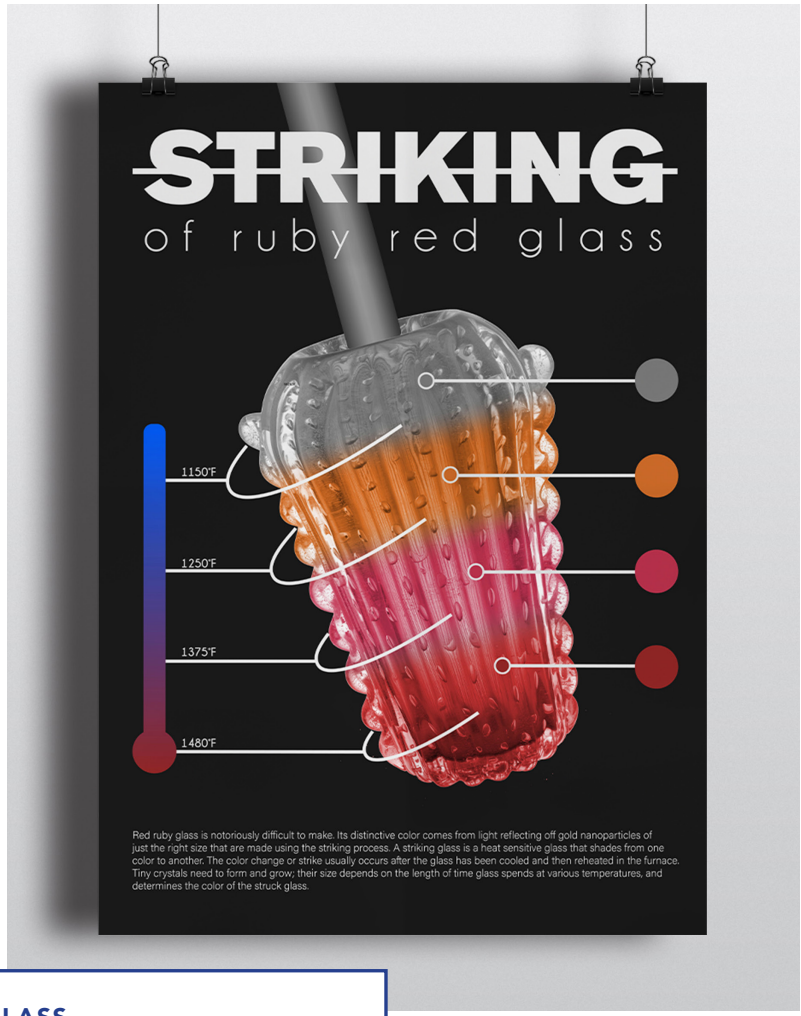
STRIKING PROCESS

NOT ENOUGH HEAT VS. **TOO** MUCH HEAT

Glass undergoes a striking process to achieve its expected color through molecular realignment. In a ruby glass, copper is responsible for color change. As the glass melts, the copper molecules and the associated oxygen molecules break apart and join with other molecules in the batch. Rapid cooling of the glass causes these high-temperature bonds to become permanent and leaves the glass clear. The magic of the ruby color is that these bonds can be broken at the annealing temperature.

Not enough heat- *Not fully 'struck'*
Problematic if the glass is annealed in the kiln. The prolonged heat exposure could finish the striking process.

Too much heat- *'Overheat' glass*
The glass blackens and may appear burnt. In this case, the chemical reaction fails.

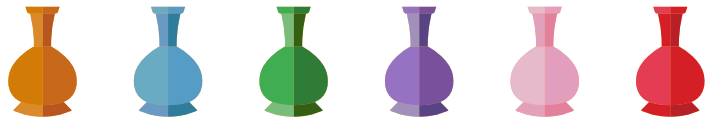


CHEMISTRY OF COLORED GLASS

Glass can be colored in these ways:

1) It can have transition or rare earth metal ions added
2) It can be due to colloidal particles formed in the glass
3) It can be due to particles which are colored themselves

Here are some examples of typical chemical elements that are used to color glass:



IRON-SULFUR	COPPER	CHROMIUM	MANGANESE	ERBIUM	COPPER-TIN
Fe-S	Cu^{2+}	Cr^{3+}	Mn^{3+}	Er^{3+}	Cu-Sn

Report from Compound Interest 2015

DID YOU KNOW...

Color doesn't appear until the glass is reheated to over
1,000 °F

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