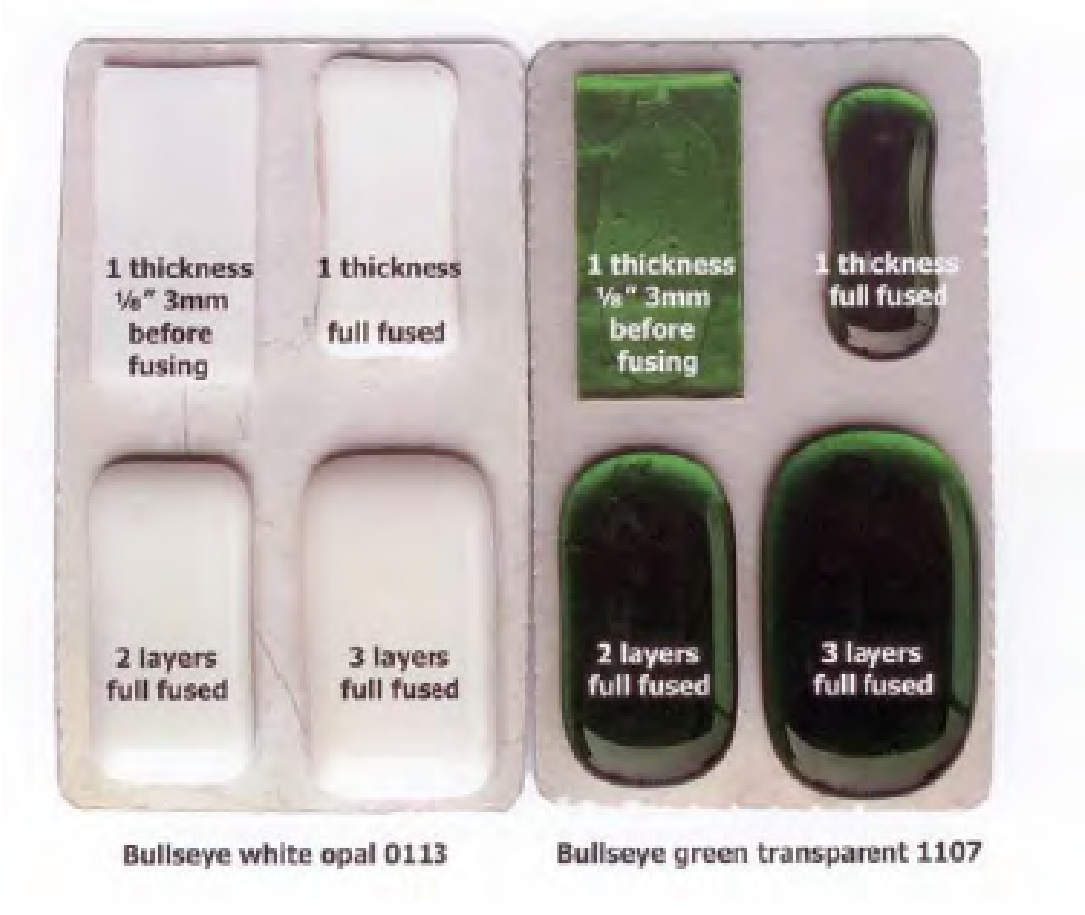
Glass Thickness & Volume Control



The above glass samples are from my 1983 teaching kit and show the effect of volume control. The white and green samples were fired in the same kiln, right next to each other at the same time. You will see the original size in the upper left hand corner for both the white and green glass.

Observe the effect of surface tension and gravity.

One thickness tries to pull up to the magic 1/4 in. (6 mm)-plus thickness and, in the process, rounds the corners and thins the middle. The surface tension is greater than the pull of gravity and consequently pulls on glass.

Two layers stacked one on top of the other full fuse to almost the same size as the original piece except the corners are rounded. Surface tension and gravity are equal.

Three layers stacked on top of each other full fuse to a larger size than the original piece, trying to achieve that 1/4 in. (6 mm)-plus thickness. Gravity is greater than surface tension, and the glass flows until tension and gravity are equal.

Note that the green transparent is more rounded and that it moved more than the white; the green glass is less viscous than the white.

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Big hole from a popped bubble.

Big bubbles are not caused by wet kiln shelves!

When I was first trying to figure out what fused glass could do, huge bubbles, some as big as 3" (7.5 cm), appeared when the glass reached full fuse temperature. Getting angry didn't eliminate bubbles, so I turned the mistake into a technique: I opened the kiln and popped the bubbles with a pointed metal rod; the glass pulled back, and the edges of the hole became round.

I backed the holes with surplus titanium that I purchased at Boeing Surplus (the airplane manufacturer in Seattle). I colored the titanium by heating it with a torch. This became a series of glass art.

At the time, I thought that wet kiln shelves were the bubble-creating culprits. I prefired the kiln shelves, but bubbles continued to form. Finally, I eliminated the bubbles by firing on 1/8 in. fiber paper.

Eventually, I reasoned that the bubbles formed because air, trapped between the shelf (covered with the shelf primer) and the glass, expanded as the heat increased; the air couldn't escape because, as the temperature rises in the kiln, the glass becomes soft, sealing against the primered kiln shelf. As the temperature continues to rise, the thin layer of trapped air begins to expand and to move toward the area where surface tension has begun to pull and thin the glass. The expanding air forms a bubble. Fiber paper allowed the air to escape. Later, I figured out how to use chips of glass under one edge instead of fiber paper.

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"Shift Right," 1981, H. 21 in. (53 cm) x W. 19 in. (48 cm). Fused multiple layers of Bullseye glass with glass threads pulled in a small glory hole and backed with torch treated titanium surrounded by a gold anodized aluminum frame. I created a series of 10 of these panels.

Air must be the bubble culprit – water, at sea level, turns to steam at 212°F (100°C) and couldn't exist inside of a kiln at 1400°, around the temperature at which the glass seals to the shelf. This proves that bubbles aren't caused by a wet kiln shelf or water trapped between the glass and the shelf. It all had to do with volume control and not wet kiln shelves.

My suspicions about volume control issues are confirmed by studying my art piece, "Shift Right." The large holes happen only in the area with one layer of a very soft black glass. Where there are second layer elements, bubbles are less likely to occur. Also, notice the pink glass where it meets the black on the top and right side; these started out with a flush edge, but the single layer black pulled away trying to get to that magic 1/4 in. (6 mm)-plus thickness, which is the same as two 1/8 in. (3 mm) pieces of glass stacked on top of each other. The edges of the single layer black glass also have a sharp saw-toothed edge, rather than the rounded edge and corner of the pink glass.

It's all about volume control!

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