



THINKING ARCHITECTURALLY



LAMINATED GLASS

When I was teaching glass fusing classes in Italy, I was surprised by how differently my students thought about scale compared to my U.S. and Japanese students. Where most of my past students had embraced using fused glass for jewelry, tiles, plates, sculptures and windows, the Italian students were primarily focused on making large-scale architectural fused glass elements. I was used to using kilns as small as 5- by 5-inches, but they viewed a kiln with an interior dimension of 2-feet by 3-feet as a small hobby kiln, because many of them were using kilns 4-feet by 6-feet or larger. I was taken back a bit because there are some inherent issues that come with fusing large, single panels. Any time the dimension of the glass exceeds 20- by 20-inches, it seems that annealing and compatibility issues start compounding exponentially. The tolerance that we enjoy when working small is almost nonexistent when we substantially increase the scale of our work.

But maybe the Italians were ahead of the game a bit. Large-scale architectural installations are becoming more prominent and they are a great format for glass artists to pursue. Although there will always be a growing crafts/art market for fused glass, getting art glass “on the wall” and “in the openings” of buildings represents the fastest growing segment of our market. Working big, whether it is modular - like covering a wall with 50 16- by 16-inch tiles, or single large floor-to-ceiling walls of glass - the fusing movement is going big.

Besides figuring out how to make large pieces of fused glass, there is a need to address the durability and safety of the artwork. Many glass installations such as panels next to a doorway, overhead, storefronts, balconies, stair railings, skylights, sun-spaces, sloped glazing and curtain walls need some form of safety glass if they are to meet code. The two recognized forms of safety glass are tempered and laminated.

Tempering a piece of fused glass is very difficult. All of the tempering plants that I have had contact

with say the same things - “no variations in the glass thickness” and - “temper at your own risk.” If it breaks during the process, well, too bad.

Fortunately, the art of laminating fused glass to a secondary piece of glass has grown in leaps and bounds in recent years. Laminating meets the strictest building codes including those in hurricane-prone Dade County, Florida. It is considered by many artists to be the best way to incorporate kiln-formed glass into an architectural setting.

Automakers began using laminated safety glass windshields in 1927 and it continues to be the most common type of glass used in automobiles. Laminated safety glass is made by either sandwiching a thin layer of clear, plastic film - called polyvinyl butyral (PVB) - between two or more layers of glass, or injecting a liquid resin (either polyester or polyurethane) into a space between two layers of glass. For fused glass, the injected resin technique seems to be the best way to go because it can handle textures and slight variations in flatness of the backside of the glass.

(Front page and right)
Six walls 12 -feet by 12
-feet for Elevator Lobby
at S.W. Medical Center,
Vancouver, WA.. Six 3/4
-inch thick wavy fused
glass panels laminated to
one 1/2 - inch laminated
mirror. Manufactured by
Savoy Studios, Portland,
OR



The center clear bonding agent in the laminated glass “sandwich” holds the glass in place when it breaks, thus minimizing injuries from flying glass. Although cracks in either of the pieces of glass may occur, laminated safety glass still remains intact and stays in its frame.

Besides eliminating the flying shards generated by broken glass, laminated safety glass reduces noise and can be tinted to reduce sunlight, heat and ultraviolet (UV) radiation.

Although some people have spent the time and money needed to learn how to laminate their own glass, most artists send their work to a professional laminator.

One of the best around is Rich Lamothe of Glass Strategies, LLC, in Portland, Oregon. He has done the laminating for many of the major art glass installations around the country. I visited him at his studio and he shared some thoughts on having your art glass laminated.



Three, 6 -foot diameter light fixtures for Millinium Plaza Hotel, Conference Room, New York, NY. 3/8 - inch kiln textured laminated to 3/16 -inch clear tempered. Manufactured by Meltdown Glass, Chandler AZ.

You can Email Rich at lam_man@comcast.net

GR: How did you get started in art glass?

RL: I started sandblasting in Puerto Rico in 1986, working for the largest glass company in the Caribbean. In 1988 I moved back to Portland and got a job with Savoy Studios and have been there ever since. That is where I started working with laminating. About 10 years ago they were experimenting with UV curing using silicone and clear E615 and then safety-rated laminates.

GR: So the process you are doing now produces a safety-rated glass?

RL: Right.

GR: Is this an alternative because it is difficult to temper fused art glass?

RL: If not impossible. There are a lot of people that won't run it though their furnaces. There are a few places that will do it, but there aren't very many that will even try it.

GR: And if you do find someone to do it, it is try it at your own risk?

RL: Yes, it always is. But it is like that with laminating, too. No one can take a job and assume full responsibility for the art glass. That is kind of an industrial standard when you are working with other people's glass. We take as many precautions as possible and we have a really high success rate, but problems do arise.

GR: Well, you can't control their annealing cycle or the compatibility of the different glasses they used. Whatever they send you is what you are stuck with?

RL: That's true.

GR: So basically, the lamination process is the placing of a special polymer between two layers of glass?

RL: Correct.

GR: And usually one layer is a tempered clear?

RL: No, not necessarily. You don't really need a tempered piece of glass unless you have an uneven heating issue, like if the glass is exposed to a severe enough thermal gradient, just like when you fire glass in a kiln. For example, this project which has a transparent red tint to the resin - they specified tempered so it would withstand some of the red areas absorbing heat faster than other areas, thus creating uneven temperatures within the piece of glass. I wish we didn't do that with the colored resin because the tempered pieces are kind of bowed. And where they come closer together, the resin is thinner so the color is thinner and you can slightly see the difference. If you back it with a float glass it's even all of the way across.

Another situation might be when you have an overheat installation. Then you might want to use tempered



Rich "The Lam Man" working with his \$60,000 pumping system.

glass so it is bearing all of the weight. Besides that, you don't really need it to meet code.

GR: Do you actually have all of the different codes available so you can make pieces for different standards?

RL: It all depends upon the makeup of the inner layer. I am a certified laminator in Dade County (Florida).



18 feet by x 6 feet traveling bar for St. Paulie Girl Beer. 3/16 -inch green fused glass laminated to 3/16 -inch clear. Glass by Savoy Studios, Portland, OR.

I can do hurricane-rated glass. The variables are which of the two different resins I use and the thickness of the resin between the layers. I have polyurethane and polyester. Polyurethane at a .090 inner layer would be the minimum requirement you would need for Dade County. The .090 is about 3/32 -inch thick. The standard .060 (about a 1/16-inch) is the minimum you would probably want to use with any kiln-formed glass.

You can actually do float-to-float in .040, but with kiln-formed you wouldn't want to go less than 1/16-inch.

GR: If someone wants to have their artwork in an architectural situation, would they contact you first to make sure that they understand all of the variables that need to be addressed?

RL: Yes. That is a good idea.

GR: What are some of the basic things they should be aware of?

RL: One consideration is that there will be a 1/4-inch-wide black border. The piece can be made oversized so the

black can be cut off with a water jet or diamond saw. There are people around that will run it through their polisher if you want flat, polished edges - provided the piece is flat enough to go through the machine.

GR: If someone is making a thick enough cast piece do they still need to consider laminating or is it still a good idea to laminate anyway?

RL: It really depends. A lot of people have done floors and such with glass that isn't laminated and it passed all of the engineering specifications because it was thick enough. But it seems kind of risky to me. In addition, as a laminator I'd like to see it laminated because if the piece ever did break, the laminating will hold it all together

and keep it from falling through an opening. Codes to vary from place to place, but typically any overhead has to be laminated. They don't allow tempered alone because tempered can spontaneously shatter into a lot of little pieces.

GR: How big can you go in a single panel?

RL: The biggest I've done so far is 4-feet by 10-feet, but I work with a table that can handle a 5-foot by 13-foot panel. I'm going to be doing a job that involves laminating a huge, thick, cast piece that is 6-feet by 9-feet and weighs more than 800 pounds. We will add a piece of 3/8-inch float that weighs 275 pounds. When it's done, it will weigh more than 1,000 pounds.

GR: Wow. How do you move it?

RL: Well, we have a forklift over here with a beam and lots of suction cups.

GR: What's another consideration for kiln formed glass?

RL: One thing to keep in mind is how the resin clears up the textures that it touches. If you have a kiln-washed texture on the back



of a piece and you turn that side to the center of the sandwich, the texture will disappear. The clear resin fills in all of the little voids and the texture can't be seen. This can be a good thing if you have devitrification on one side of the glass. If you put the "devit" side to the center, the resin will clear it up and make it so it's not visible. The same thing happens to sandblasted areas. They just go away. This can be a problem if someone is hoping to have a backside texture or sandblasted element as a part of the overall design. Although, there are special coatings that we can use to preserve the sandblasting if needed.

Another consideration is if you are wanting to have a piece of undulated glass, you need to be sure that the edges are flat. You can undulate in the center of the piece, but the perimeter area that seals around the edge needs to be as flat as possible. Also, the undulations can't exceed the height of the edge. You can not have undulations that protrude up and touch the flat glass. Nothing can be closer to the float than the edges. A flat back is the easiest to laminate.

GR: If you are laminating two curves, do you need a space between them?

RL: Yes, it is best to bend with a layer of 1/6-inch fiber paper between them so the pieces of glass a slightly different radius and there is a space between the two pieces of glass to accommodate the resin.

GR: What kind of costs are we talking about here?

RL: You will have crate and shipping costs both ways plus the cost of the laminating. I give a discount as the volume increases. The laminating

can run from \$15 per square foot to \$30 per square foot for some of the super-undulated pieces which use polyurethane, which is more expensive than the polyester. The resin is about \$70 a gallon and if the piece has a lot of undulations,

I CAN DO HURRICANE-RATED GLASS.

it can go through the resin pretty quickly. Also, my machine is a little expensive.

GR: Will these resins yellow over time?

RL: No, these are the best products on the market today. The polyester has been around about 20 years and has a proven track record. They put a UV block additive in the resin to keep it from yellowing. That additive creates the slightest bit of a yellow tint that is really only noticeable when you look at a piece on edge. The polyurethane, on the other hand, is optically clear in any thickness.

GR: Is glass compatibility an issue?

RL: No. The resins, especially the polyurethane, can be used to laminate any glass to any glass or even dissimilar materials like glass to metals like stainless steel, copper and polycarbonates like Lexan™ and Plexiglass™. These are materials that have very different coefficient expansions than glass.

GR: What about wood?

RL: With the polyester, you can laminate wood and place other

organic materials between the layers of glass. Also, the polyester can be tinted to just about any color imaginable both in opalescent and transparent.

GR: Can laminated glass be used in exterior applications?

RL: Polyurethane is the ideal product for moist environments, like exterior applications with exposed edges and it can even be in immersed in water. It's not affected by moisture once it has set. When it is setting up, it has to be away from moisture because that will cause bubbles in the laminate.

GR: This is exciting, thanks you for your time.

RL: You are welcome and thank you.



Sliding pocket doors and transom 60 -inch by 96 -inch, for Zora Jewelers, Portland, OR.. 3/16 -inch micro ribbed glass laminated to 1/4 -inch clear with white rice paper interlayer. Manufactured by Glass Strategies LLC, Portland, OR

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