Ultraviolet Fusing of Art & Technology

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I have been working with glass laminating for 30 years. I was trained as an artist and glassblower in college, and while there I was drawn to glass sculpture, which lead to an interest in the construction and fabrication mainly with plate glass. My early sculpture[i] employed both blown and plate sections. Initially I used epoxy, but found it to be slow setting. Subsequently, I started using an anaerobic adhesive, which was used to glue mirrors to car windshields. This adhesive made it easier to do multiple laminations because it set quickly. I continued my studies in graduate school, and experimented more with the use of adhesives making larger pieces that consisted mainly of plate glass.[ii]

In 1979 I developed the idea of plate glass vases, which have become my signature pieces.[iii] I have since made well over 500 pieces, the work evolving with the technology available. My experiences and learning have grown along with Ultra Violet technology. Initially introduced to UV adhesives made by Loctite in 1982-83, much of what I have learned is self-taught through trial and error experimentation. This is somewhat problematic since the goal is to make artwork using an evolving field of technology, yet being an art related business there is no research and development funding, so mistakes are at my expense.[iv]

My first UV light source was a fluorescent circline black light bulb, which had a very weak nanometer output. It did work well enough to hold the pieces of glass together. These early laminations were 1" wide by 6-8" long in either transparent green, bronze, or grey plate glass stacked in a horizontal orientation.[v] Some challenges of the material occurred in the Verti Fan series as parts were both vertical and canter livered which added stress and shear to the adhesive joint.

As the demand for my work increased, the need arose for ways to make more faster and a concept evolved of temporarily adhering using an optical stacking wax to bond the glass. This would later lead to using the technique with UV adhesives.[vi]

One of the most important discovers during early UV adhesive experimentation was the issue of health and safety. The protection of eyes was well documented, however concerns for skin safety were not. After developing a severe case of contact dermatitis,[vii] I explored the options available and determined that Nitrile gloves and a good barrier cream are essential to safely handling methaycrylate materials. With the advent of Material Data Safety Sheets and many sources of safety supplies, dermatitis exposure is certainly controllable.

Because of the dermatitis my working style was altered to use less adhesive.[viii] I incorporated the use of aluminum and glass structures that had some lamination between the metal and glass. After receiving several requests for commissions and feeling confident in the protection nitrile gloves offered, I returned to all glass laminated sculptures. I then made the largest and heaviest sculpture, a 38" high 24" in diameter glass vase that weighed over 100 pounds for a hotel in Hong Kong.[ix] With the uncertainty of shipping a sculpture this large overseas it was decided to make two similar sculptures. This was fortuitous in that one of the sculptures' bases was broken during crating. The damages to this object led to technical developments in the process of repairing breakage or defective laminations in UV adhesive.

A nuance of the glass adhesive is that if properly polymerized it can adhere so well as to dig in and chip the glass on cleaning. Several techniques have been developed to separate or delaminate the adhesive. Soaking in a bath of methylene chloride was the first one I attempted. It worked well on small surfaces, however there are issues of containing the highly toxic material. Finding the right container while being able to balance the object can be problematic. A larger adhesive area is also an issue since stresses are created which can cause unwanted cracking and more damage than intended. An alternative way to separate defective laminations is through the use of heat. Heating a metal strip with a nichrome element, which reaches a subsequent temperature of 600 degrees placed on the glass or by placing the object in a ceramic kiln, can melt or vaporize the adhesive. There are, however, several draw- backs to this technique. Most importantly are the health risks of the vapor created, and the damage to sections of the glass not intended to be altered. Another technique is to grind or diamond saw within 1/16" of an inch of the adhesive desired to separate, and then by using a razor blade, levering the lamination apart.

For certain pieces the viscosity of the adhesive is critical. As a rule, smaller joints require thicker adhesives and larger joint require thinner adhesives.[x] The Cubic Heart Vase was constructed like a log cabin with layers of two flat bars stacked at right angles to each other. The decision to use a thicker adhesive was made for several reasons. First was the desire for a stronger transmission of color through the piece. Secondly, the thicker adhesive had a better ability to move with the four separate laminations in each layer that could be of slightly different thicknesses.

As I continued the evolution of using UV adhesives I began trying to laminate larger surfaces.[xi] I then discovered the need for a more intense light source. Acquiring a B100 long wave UV lamp which cured a 1" diameter area at 10 nanometers per square inch, proved to be better but it was still not sufficient for the large areas that were being attempted. I acquired a higher intensity 400 Watt mercury vapor lamp which cured a 9"x9" area with a lamp output of 40 nanometers per square inch. A technique was developed that was sequenced with a primary fixture cure under the B100 followed by removal of excess adhesive and then a final curing under the high intensity light source. Another significant addition to proper adhesive curing is knowing the lamp output. Purchasing a radiometer which gives accurate readings of lamp output is essential to proper curing.

The ability to cure larger areas led to a new series of sculptures called Solid Vase Forms.[xii] These sculptures consisted of 72 circles of ¼" thick plate glass with diameters varying from 3" to 10". Using the increased intensity of the curing system had resulted in an unexpected problem: the proper cure at higher intensity caused severe shrinkage of the adhesive being used, and cracked the plate glass. A search of other manufacturers of similar UV glass bonders led me to a line of Dymax adhesives which did not seem to shrink as extensively as the adhesive I previously used. While researching to find the proper adhesive I experimented with different formulas and discovered that higher levels of polyurethane or soft flexible adhesives are not an advantage. Since they are so soft and move at different rates of expansion and shrinkage than the glass, they eventually show signs of adhesive cracking making a white non transparent surface. [xiii]

Other significant developments occurred in the early 1990s, the first being the development of a new line of optically clear plate glass. AFG manufactured a more crystal like less green glass that they marketed under the trademark Krystal Klear. [xiv] In addition, I became aware that you could add colored dyes to the adhesive. Another period of research and sourcing led me to the Orasol line of dyes manufactured by Ceiba Geigy. I could now make my own colored glass laminations. At this time I also researched pigments but found them to be insoluble in the preferred adhesives that I used. I

continued research with the colored adhesives to find which colors cure faster, how large a concentration of dye to add, and most important the light fastness of the dye. It is my understanding that there are new UV stabilizers and photoinitiators, which should extend the life of these dyed adhesives. One of the attractions to collecting glass is the way it interacts with light. Melted glass has the color oxides homogenized within the melting, while the dyed adhesive is much more sensitive to sunlight. Conserving these colored laminations can be problematic. An explanation I use is that glass sculptures are fine art as are paintings. You would not want to place a painting in direct sunlight and risk fading the color, and the same is true of these glass sculptures.

With the increased power of the curing lamps and the preferred adhesive, several new techniques were attempted. One was diamond sawing a section of 6 ¼" circles and later larger sections of 42 ¼" circles of varying diameters that had been laminated together. These parts were then run on a series of glass machines, which ground and polished the sawed sections to a bright polish.[xv] The important considerations in facilitating these pieces are the proper curing intensity and the resting or stabilizing time over a few days for any non-UV light post cure or setting of the polymerized material. Since glass is an organic fluid material, a super cooled liquid adhering or fusing with a UV adhesive can be susceptible to drastic temperature variations. Sine I live in the northeast, I have noted through experience that cold can affect the mechanical cutting, grinding, and polishing of the objects. Delaminating or surface separation can occur if these procedures are not followed. Another technical concern that can also cause delaminating is using too much pressure when sawing or grinding the laminated glass. Testing to find the right amount of pressure to hold the glass during sawing and grinding is critical. Resting the object after each machining process is also important to insure the continuous integrity of the adhered surface.

Another technical development that has evolved over time is the use of dyes. I have over the years transitioned from the using one color per piece[xvi] to alternating colors on successive layers i.e. blue yellow blue yellow.[xvii] In 2000, I was asked to create a piece to celebrate the millennium. I created a vessel that rotated from red to yellow to blue several times. It was a melding of the primary colors and conceptually a fusing of our many cultures. The visual impact in this piece[xviii] led to even more experiments with the use of multiple colors. The technique of applying more than one color on each plane was attempted. Triangles of liquid colored adhesive were applied and cured to each plane. As successive layers were added the colors were rotated to create a swirling pattern much like a light show at a Grateful Dead concert. Thus the Jerry Vision series of pieces was born.[xix] The next experiment to be perfected was adding clear adhesive into these colored sections. The problem with this technique is the curing time difference between fast curing clear adhesives and slow curing colored adhesives. This can cause cracking to occur along the lines of clear to color due to shrinkage at different rates.[xx]

The most recent technical experiments have dealt with grinding sets of 3 laminated circles, some with angles as great as 45 degrees, from a rough edge to a completely polished surface using a method similar to earlier waxing techniques. The goal was to be able to create my signature Plate Glass Vases with colors dispersed throughout the piece. To accomplish this technique[xxi] I had two machines made for me which are much like the machines used to make circular table tops in the glass industry. The grinding machine uses a series of 3 different diamond metal bonded or diamond resin bonded wheels to shape the glass and then bring it up to a surface ready for grinding. The other machine polishes these prepared parts to a mirror like polish. The adhesive must not only hold the glass together but also show no signs of tearing or shearing on the side view. Methacrylate adhesives, unlike epoxy, do not harden like glass so this accomplishment I consider quite a technical feat and success. This technique has evolved to the point now of grinding circles up to 12" in diameter.[xxii]

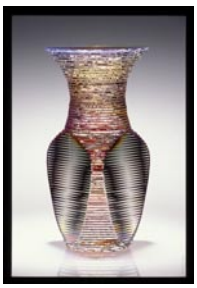
The evolving technology of UV adhesives has enabled me to create a large variety of objects that could not have been constructed using other adhesives such as silicone and epoxy, or mechanical wood, metal, and rubber fixtures. The future of this evolving technology seems limitless. I look forward to realizing my creative possibilities as they are enabled by the growth and development of ultraviolet adhesives.

Visual Examples

Twisted Abstracted Vase #1

Twisted Abstracted Strip Vase #23, Vase 70/81

Solid Vase Form #113



90 Degrees of 5 Color Wheel Solid Vase Form #205

Rainbow Dot Polished Laminated Vertical Vase #17

[i] Lamp, Disc 1

[ii] Untitled, Steereo
[iii] Early Vases
[iv] Verti #13, Vase #53, and BPGV #7 are early examples of the first uses of adhesives
[v] Verti #20
[vi] Vase #85/54, PLPGV, PLVV
[vii] Quasi Modern
[viii] CCAYTTM, F-Stop Lamp, and CCCT
[ix] TAV
[x] CHV, PLPGV
[xi] Menorah
[xii] SVF #1
[xiii] Bet Tzedek, SVF
[xiv] TASV #23, Vase #75/80
[xv] SVF #43, 73, 78, 113, 167
[xvi] SVF #32
[xvii] SVF #69
[xviii] SVF #72
[xix] SVF #99
[xx] Rainbow SVF
[xxi] TSVF #1, PLPGVs
[xxii] PLVV #1,4,12,17