Fine Art Applications Using Pigmented UV Adhesive

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Introduction

Thirty five years ago I began creating glass sculptures using plate glass and adhesive. It was then that I learned about UV adhesives and my interest and relationship with UV technology began. Since then my designs, which are sculptural interpretations of historic vessel forms, have evolved and led to my experimentation combining adhesives and various color technologies. As a glass sculptor my interest is in the effects of light reflecting and refracting off and through glass. By laminating layers of glass I am able to emphasize and manipulate the effects of light using color, shape, and surface treatments.

In those early years there was limited information about the uses of UV technology for adhering glass to glass and few materials were available to me, especially on a small studio scale. As advancements in color technology grew, so did my designs. From that point on my pieces began to incorporate an array of available, vibrant colors.

As you will see throughout my years of research, each new material brought about great opportunities but there were also an equal number of problems to solve. Due to the fact that I was employing new materials in non-traditional ways, trial and error became my scientific method. In previous RadTech presentations I have described problems with adhesive failure, color instability, and insufficient light-facilitated curing. Along with a brief explanation of my initial working methods I will review past issues and solutions using UV stabilizers, photo initiators and fluorescent dyes as it applied directly to my glass work. I will then segue into my recent discoveries using pigment technology, special-effect pigments, dispersing and suspension agents, and a re-investigation of photo initiators used to create my unique adhesive recipes.

In the Beginning...

The first plate glass sculptures I created used recycled plate glass and epoxy glue. At that time there were only a handful of artists using similar techniques -- the contemporary glass art movement was at its beginning stages. I switched to an anaerobic adhesive for its faster curing properties and its ease of clean up. Years later I was introduced to the first generation of UV curing adhesives. By trial and error this led to an eventual evolution in my construction techniques. I had limited information about this technology and curing issues quickly developed.

Lights

Initially I started using a Circline fluorescent black light bulb. This had a low UV output and created both a lengthy cure time and an inability to cure multiple layers. To solve these issues I developed a two-stage light system using both low and high intensity UV lights. This pre and post cure system allowed me to spot cure multiple layers using the low intensity UV light (UVPB 100). I could then clean the fixtured adhesive before full curing with the high intensity UV light (AETA 7400 or EC 2000).

Adding Color

In the early 1990s, concurrent with research and development in the UV adhesive industries, the glass industry went through changes and new low iron, clear glass was being manufactured. Until that point the only color in my work came from the limited colored commercial plate glass available which I laminated with clear adhesive, or opaque antique architectural glass which would not transmit light. The ability to add color into the adhesive between the layers of glass opened up many possibilities.

Initially I started using Pylam and Morton dyes primarily made for the fabric industry, which were too weak and faded quickly. Then I became aware of Orasol dyes used in the art restoration fields. These dyes allowed me to incorporate a variety of colors in my pieces which created three-dimensional paintings with rich pools of color. This advancement led to new series of work. The interior of the pieces was becoming as compelling as the exterior, and I began cutting and polishing 'windows' into my vessels allowing a look inside.

Figure 1 - Example of colored commercial glass & clear adhesive (left), clear adhesive & clear glass (center) and dyed adhesive & clear glass (right)

Fluorescent Dyes

Adding dye created an almost unlimited pallet for me to work with. Later, at a RadTech conference I was made award of fluorescent dyes which added yet another dimension to my pallet. Fluorescent dyes are more vibrant and are slightly opaque. This effect puts more emphasis on the dye in the piece rather than the play on clear glass and transparent dye. Because each fluorescent dye can be combined in small quantities with a regular color dye or dye mixture and with adjustable ratios, the combinations are unlimited. The self-illuminating properties made the pieces pop!

Figure 2 – Polished Laminated Vertical Vases -Comparison of Non-fluorescent (Left) and Fluorescent (Right)

UV stabilizer

As previously noted, adding color opened opportunities in the work but came with new issues. I learned that the light fastness of the dyes was diminishing over time and I needed to control the fading. At that time I worked closely with Stephen Cantor at Dymax to resolve the issue. He added a UV stabilizer called Tinuvin into the adhesive. After many trials and formulations with different levels of UV stabilizer it became apparent that approximately 1 percent UV stabilizer was enough to partially control the fading of colors post cure. Figure 3a and 3b are examples of the difference between the adhesive containing UV stabilizer (Figure 3a) and without the UV stabilizer (Figure 3b). Figure 3a shows the retention of “Our Mix: Red” compared to Figure 3b. After 10 minutes of direct exposure to UV light, the Red Dye in Figure 3b completely faded, whereas the red dye in Figure 3a underwent little change, even after 10 minutes. Thus, the UV stabilizer increased the longevity of the color in the artwork.

Figure 3a – Adhesive with Red Dye and UV Stabilizer Exposed to UV Light in 2 Minute Intervals

Figure 3b – Adhesive with Red Dye without UV Stabilizer Exposed to UV Light in 2 Minute Intervals

Although the UV stabilizer was helpful in preserving the color in the artwork, it lengthened the cure time significantly. And longer cure time created more problems. Slight movement of the glass during the curing process caused adhesive cracks, as seen in Figure 4a. Also, trying to hold the glass in place during longer times caused uneven pressure on the two sheets of plate glass. This caused a separation, which is seen where air is sucked into the adhesive, Figure 4b.

Figure 4a – Example of Cracks During Curing Process

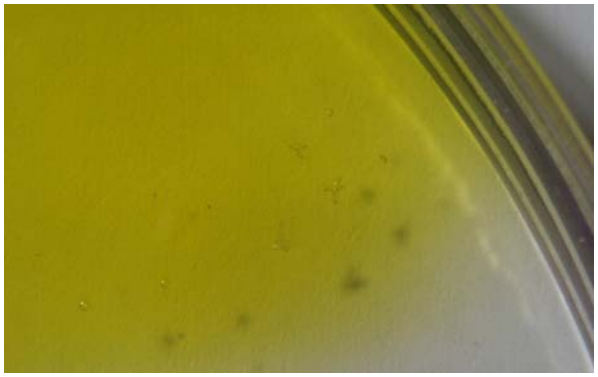

Figure 4b – Example of Separation During Curing Process

Photo Initiators

In an attempt to solve the longer cure time our adhesive package soon grew to include enhanced photo initiators. This addition came about as the concept of using visible light to cure the adhesive became prevalent in the industry. New photo initiators helped decrease the cure time and increased the cure through denser colors. The photo initiators add a pre-curing process with incandescent light in order to "set" the adhesive before the UV curing process. This was important because often, my pieces used several colors laminated next to each other on one plane. I was developing 'cracks' between colors as some were curing faster than others, causing a 'pulling' or 'cracking' of the adhesive. But when multiple dyes are used in one piece, low powered halogen lights help pre-cure the adhesive before full UV curing, thus solving the 'cracking' between colors.

Today

This brief history brings us to our current conversation. My art and interests in technological advances in UV technology, color, and commercial plate glass have led me down exciting pathways of research, leading to new ideas and techniques. Most recently my research led me to attend technical conferences like the American Coatings Show and Glass Build. At the American Coatings Show I was reintroduced to the world of pigments and to the new special effect pigments. I later acquired samples and found the colors more intense and opaque than dye. I began experimenting with the new materials in conjunction with my UV adhesive formulas and as you can imagine I encountered more problems. The three main issues I encountered during my investigation into using pigments were knowledge of my specific applications with glass, product availability ,and improper dispersion. The pigment sank to the bottom of the adhesive, tiny bubbles formed throughout the mixture, cure times lengthened significantly, and glass on the bottom layers was not being cured.

As previously stated, I am an artist in a small studio looking for small quantities of products. When I was looking for a pint of pigment, companies usually wanted to sell me 5 gallon buckets or 50 gallon drums. And while I once had chemists helping me create formulas specifically for my needs, I was now trying to work with chemists who create coatings and products for million dollar industries. I continued educating myself through the internet, attending industrial conferences, cross referencing MSDS sheets, and making phone calls to over 20 companies to help understand UV adhesive formulations and additives for pigment use. In addition I tried increasing my knowledge of material chemistry through classes in the SUNY/RadTech program. I did find significant help from people who encouraged the use of dispersing agents, de-foamers and new Photo Initiator packages in my adhesive mixtures.

Pigments and Special Effect Pigments

Pigments and special effect pigments have different properties than dye. They 'look' different, are opaque, and have a larger particle size. Identifying them by name became my first challenge. A red, for example, that I liked in dye, was not the same 'look' in pigment. Although common language in the coatings industry, I found the Color Index for Pigments a new and necessary tool in understanding and identifying the common and marketing names of colors, the color descriptions and chemical compositions, as well as the opacity/transparency and light fastness rating of each pigment. Over time the Color Index chart proved useful in determining which pigments were more appropriate for specific uses.

This difference between dye and pigment are also like the difference of mixing salt with water and pepper with water. The salt, like the dye, will dissolve in the water. The pepper will remain separate and sink in the water. The new special effect pigments acted similarly and further widened my color pallet to include a shimmering effect created by the alumina and mica flakes. They are compatible with methacrylate systems and when suspended in a liquid the particles catch the light and sparkle. I was aware of this sparkle in car paint and was excited about its possibilities with my glass sculptures. But they, like the colored pigment, had issues.

Dispersing and Dispersing Agents

The pigment had two issues. The weight of the colored pigment and special effect particles caused the pigments to sink to the bottom of the adhesive and clump revealing a poor dispersion of the pigment. This created a spotty plane of color between the glass layers.

I remembered that years ago, when I was first introduced to pigment they were mostly incompatible with methacrylate. Through research I had discovered and acquired a limited quantity of colors that were dispersed in a TMPTA which was compatible with methacrylates. Unlike dyes that went into solution with the adhesive, the pigment needed to be pre-crushed and liquefied in order for it to work. The pigments I was ordering were both dispersed and not dispersed.

To create better dispersion, I tried changing my mixing method from a propeller type mixer attached to my drill press which has worked forever, to a Cowels blade. It was suggested to me that I needed that blade to increase the shear level which would prevent clumping of pigment and disperse the mixture more effectively. Unfortunately I found it heated the methacrylate and caused too many bubbles. I then used a de-foaming additive, BYK 1790, to help eliminate bubbles. I was aware of special ball mills that that could crush and disperse the pigment in a dispersing agent to help mix with the methacrylate more effectively. But once again, the small quantity proved problematic and not cost effective for large companies.

Around the same time I started experimenting with UV adhesives from different companies based on availability, price, customer support, viscosity etc... This is important note, because it was when I began adding dispersing agents and de-foamers, I noticed differences between the adhesives. When I added a dispersing agent, BYK 410, for example, to one, it worked well. In another it was ineffective and thickened the adhesive -- almost into a paste.

After months of research, trouble shooting and product selection, I went back to the propeller type mixer which eliminated the foaming bubbles, which eliminated the need for a de-foaming agent. In one adhesive I continue to use the dispersing agent which helped keep the particles in suspension. In the other, I eliminated that additive which causes the pigment to sink over time. So I re-mix the glue every couple of days or before reusing after downtime.

Photo Initiators

After a long process of selecting adhesives and adding dispersing agents, the cure time increased significantly once again. In the past I was able to laminate up to six layers of glass circles or strips together before cutting and polishing sections. The sections were then laminated into sculptural forms. The pigment changed this process significantly. The lamination joints on the bottom of the packs were uncured while the top layer could be so hard as to cause chipping when cleaning the glue from the surface or seams of the glass. To solve the issue I added photo initiators in varying quantities until I found a formula that worked. The solution for my adhesives is to add both Igacure 1173 which aids in surface cure and Igacure 819 for curing depth. I found that 2% of the Igacure 1173 and .5% of the Igacure 819 seems to cure the pigmented adhesive within a reasonable working time. I can cure up to 2-3 layers at a time although I often opt for one at a time.

In Conclusion

It often feels like I am constantly running into brick walls. But doors soon open and my research brings me to new advancements in my sculptures that keep me excited to incorporate more new methods. The following are examples of series that demonstrate how my work evolved with advancing technologies.

Figure 5 shows an example of a Polished Laminated Vertical Vase which uses dyed adhesive between the layers of clear plate glass. With dye, the colors are transparent and mix throughout the layers depending on the viewers angle. This allows for intricate patterns throughout the colors in the piece.

Figure 5 - Example of piece using dyed adhesive

Figure 6 shows an example of a Polished Plate Glass Vase which uses pigmented adhesive between the glass bars and circles. With pigment, the color stops the eye from traveling through the colored layers and the silhouette, or overall design of the piece becomes equally as prevalent . When the piece is turned to reveal the side of the glass edges, or the viewer changes angle, the piece takes on a completely clear feel until the angle of view is once again changed to reveal a vibrant color pallet.

Figure 6 - Example of a piece using pigmented adhesive from slightly above (left) and from side (right)

Figure 7 shows an example of a Middy Solid Vase Form which uses two gold special effect pigments mixed together. Special effect pigments come in different micron sizes which create different effects. The larger size adds bigger sparkle where the smaller micron sizes add opacity and color glow throughout the piece. These pigments can also be added in different amounts to any color. The sparkle effect can be subtle or intense depending on the viewing angle. When viewing the clear edges of the glass piece, the sparkle disappears but a faint glowing of the sparkle color mixture can remain in the edges of the piece.

Figure 7 - Example of piece using special effect gold pigments from front view (left) and slightly higher view (center) and a third view (right)

Figure 8 - Examples of Shifting Transmission series inspired by use of special effect pigments

As my artwork has evolved over the years, so too has my interest and knowledge base of the UV adhesive, commercial glass and industrial coatings industries. The two have formed a symbiotic relationship in my life and one can no longer exist without the other. As I look forward, I will continue to research and reach out to others to find new approaches and application. I have, for example, begun investigations into new LED technology using lower energy levels.

I appreciate the opportunity advancing technology has provided me and my work. And I thank the many kind individuals and companies who have helped me source materials and knowledge. I hope my Groundhog Day - Catch22 like trial-and-error methods inspire others to experiment with not-traditional approaches like I have in my studio practices.