DOUGLAS and STURGESS

Ingredients for ART

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Which Resin is Right For Me?

When one has come to the conclusion that a polymer resin is appropriate for a project, there are still many questions that must be answered before the "right" material is chosen. Because of the fact that there are so many different types of resins available in the marketplace it is of the utmost importance that all of the parameters with regard to a specific project or product be evaluated. One might look at cost, clarity, durability, UV resistance, density, surface quality, hardness, toxicity, ability to hold fillers, color or the ability to be colored and so forth. Once these criteria have been evaluated and prioritized, it may then be possible to make a final decision and pinpoint the "best" resin for any given endeavor.

If we look at the primary types of resins available in the market place today, there are essentially three families of resins that are offered. These are polyester, epoxy and polyurethane. Within each of these families there may be innumerable variations designed for some very specific applications. For the sake of this discussion we will use somewhat generalized characteristics with regard to each resin type. In each case, the resin in question will be what is called a "thermoset" resin and will consist of two essential components; a base resin and a hardener, or catalyst, to initiate a reaction whereby the liquid material(s) will solidify into a hard, durable plastic.

The first family of resin and probably the most common type of resin is polyester. This is sometimes called an unsaturated polyester resin and is the material commonly used to bond fiberglass fabrics into hard sheets. As such we hear it sometimes referred to as fiberglass resin. Although this resin as mentioned above is available in quite a number of variations, of the three families, polyester is probably the most consistent in terms of the process by which it is polymerized. Generally by the simple addition of a peroxide catalyst, the base resin cures into a hard solid within a matter of minutes or hours depending on the type. Most polyester resins will accept a variety of fillers to achieve varying physical and visual effects as well.

It is polyester's ability to accept a broad variety of fillers that makes it, in my opinion, the most user friendly in this regard. Although polyester has a very noxious odor that can be overwhelming in the artist's studio, it is also something that because of its excellent warning properties, can be easily filtered and/or allowed for via good ventilation in the studio. In other words, if you can still smell it in a big way, you either need more ventilation, or more filter. In addition, just because something smells bad, doesn't necessarily mean that it is particularly toxic. As we will see later in this discussion, sometimes it is what you can't smell that is most toxic.

skylights; from automotive components to jewelry, and of course in sculptural applications. By the addition of fillers, reinforcements, colorants, fire retardants, and so forth, this rather mundane material can be made to perform in a wide variety of environments.

By using various reinforcements such as fiberglass, Kevlar or graphite, polyesters can become thin, strong composites to be used in structural applications such as boat hulls and motorcycle fenders. By adding fillers such as calcium carbonate or hydrated alumina this material can simulate stone or ceramic. Introduce some atomized metals such as bronze or steel and polyester resin can be made to look and act like a foundry cast piece of metal. Add some crushed stone aggregate to polyester and simulate granite or terrazzo by polishing the surface after having cast it into a mold. By casting clear polyester in layers, one can imbed objects into a clear mass and simulate having an item floating in the transparent resin. Add some dye to this same clear resin and simulate amber or glass. The possibilities are endless and only limited by your imagination.

One of the major benefits of polyester resin casting is that once the part is demolded, it can be sanded and finished to achieve an optically clear surface. If the surface becomes scratched, that same surface can be polished once again to optical clarity. Pieces made from polyester can be bonded with more polyester to create larger pieces than the original module. As long as the polyester being bonded is clean and dry, more polyester will adhere to the cured surface. In this way it is possible to assemble various components to create a much larger piece. This is true whether the resin piece is reinforced with fiberglass or whether the individual pieces are cast from solid resin. If the larger part is made from layers of clear resin or the parts are assembled from clear resin, a line between the bonded sections may in fact show where each layer or piece was added. This can sometimes be hidden by the configuration of the piece or if the angle of viewing is not the same as the plane of the bond.

Light weight fillers such as glass or plastic microballoons can be added to polyester resin in order to lower the density of the final casting. Likewise things like wood flour, nut shell flour and cork can be added to lower the density of the resin casting as well as alter the look of the casting to simulate wood. Along with any of the aforementioned fillers, one can also incorporate colorants of various types to achieve a wide variety of color effects. When adding color, and especially when mixing different kinds of colors into a resin it is always a good idea to do a small test to determine that the blended color will be stable and give the effect desired.

In general when casting with polyester resin based materials, most flexible mold materials will work at least on a limited basis. Silicone and polyurethane RTV's are best suited to casting with polyester resin and although latex rubber will work on a limited basis if treated properly, we generally do not recommend using latex rubber molds for production applications. Of course in any casting situation, an appropriate mold release agent will always aid in giving maximum mold life. It is even possible to use simple household containers as basic molds for geometric shapes. Polyethylene yogurt containers and other cups of this type make excellent molds for casting rough shapes that might either be incorporated into a larger casting or perhaps polished to achieve a glassy surface. Sometimes even old light bulbs, glass jars and tin cans can be used to cast rough shapes in polyester resin. There are some limitations however. Styrene plastic based containers such as Styrofoam cups and the hard styrene drinking cups that are commonly used do not work with polyester resin as they will dissolve.

If we look at the next family of polymers, which is epoxy, we will see that epoxy can do most of what polyester can do and in most cases do it better. There will be some exceptions though. In general, epoxies tend to be more resilient and physically durable than polyester, but there will be some sacrifice in terms of clarity. All of the fillers listed above work equally as well in an epoxy resin as they will in a polyester resin. Probably the major drawbacks to using epoxy resin versus polyester will be cost, optical clarity, ease of use and UV stability.

In general, if comparing the cost of polyester with epoxy, the epoxy will tend to be one and one half to two times the cost of a good grade of polyester. In addition there are very few optically clear epoxy resins and they are not only difficult to find, but extremely expensive. The method by which an epoxy must be measured and mixed can also be a stumbling point when comparing epoxy to polyester. Most epoxies will require accurate measuring and mixing of the components to achieve proper cure of the finished product. This can mean that an accurate scale for measuring small quantities of material may become a necessary tool in the studio. Generally speaking epoxies do not perform as well outdoors as they tend to be of limited UV resistance and will not only yellow severely once exposed, they will also form a chalky surface that diminishes the appearance of a finished piece. Simply stated, if epoxy is to be used outdoors, it must be protected with an appropriate top coat.

The simplest epoxy systems will consist of two components that are simply mixed one to one by volume, unfortunately in the real world, most epoxy systems consist of components that must be weighed in ratios other than one to one. Most of the better performing systems might have ratios of three to one, four to one or even something like 67 parts to 33 parts by weight. If one is willing to invest in the necessary equipment to be able to utilize these kinds of systems, then all is well. If on the other hand one attempts to use some of these more complex systems without the benefit of accurate measurement, the epoxy in question might never cure properly and will remain soft and/or sticky indefinitely. Because of the fact that epoxies require this additional adherence to and exact ratio of resin to hardener, we find its use somewhat limited in the sculptural arena. Other than cost and some of the minor factors listed there is no other reason why an epoxy resin system should not be used in the artist's studio; and in fact because of the fact that generally speaking epoxies tend to be less noxious they can actually be more user friendly. The one area that must be addressed from a toxicity stanpoint however is that all epoxies and their individual components are sensitizers, meaning that the more one exposes himself to the chemicals unprotected the more allergic that individual will become. In other words as with any chemical, use with caution and protect the skin especially from exposure.

The last group of thermoplastic polymers we will discuss is the polyurethanes. Of the three groups, polyurethanes tend to be the most diverse as well as the most use specific. In other words there are many products that are designed for a specific end use. We have fast setting products, slow setting products, clear materials, opaque materials, semi flexible urethanes, filled urethanes, and urethanes that are self foaming, both rigid and flexible. If you are looking for a product that is designed for a specific application, chances are that one has been formulated.

Although polyurethanes have in many cases been designed for specific applications with some very specific properties, these materials can be modified much the same as the polyester and epoxies. There are some limitations however. Because of their nature, polyurethanes tend to be moisture sensitive, which can cause problems when adding fillers to a base resin. It can be difficult to overcome this fundamental problem, but not impossible. Coloring polyurethanes can require special colorants, which means that choice of colors can be limited. As long as one is willing to work within the narrower window of parameters, it is possible to create sculptural elements and other creative products using this group of products.

Probably the most common polyurethanes in use today are what we call the rapid setting simple one to one systems. There are quite a number of these products in the market place and they all work in a similar fashion in that they are generally low viscosity materials mixed one to one by volume that cure to a hard durable plastic in a relatively short period of time-typically in five to ten minutes. This is essentially the base line product that most polyurethane manufacturers are producing these days. From there we have an abundance of products that can provide a wide variety of physical and visual characteristics.

As stated earlier adding fillers to polyurethanes can be a problem, but with some rather simple tools it is possible to use fillers much the same as with polyesters and epoxies, although finishing the surface of polyurethanes including painting, can be more difficult because of the nature of these materials. By utilizing a pressurized chamber in which to place a mold with the uncured resin and filler, it is possible to overcome the reaction of a polyurethane resin system with any moisture laden filler. Obviously this will require a bit of financial investment, but if one is looking for a resin system that cures rapidly, is durable and must utilize a specific filler it may be financially feasible to justify an investment in a simple pressure pot and compressor. It is because of some of these rapid setting polyurethane systems that even when including the cost of this type of equipment when looking at the potential rapidity by which a part can be produced, the additional cost per part based on the cost of the equipment can be minimal.

Some of the more specialized resins available are the semi-flexible products. These fall somewhere in the area between a hard resin and a rubber or elastomer. Still within the Shore "D" hardness scale they will tend to be in the 40-60 range and as such are hard yet extremely durable materials that will take a beating, literally. These highly specialized materials find use as bumpers, wheels, abrasive resistant surfaces for industrial equipment medical and other highly developed end uses. Because of their use specific application and their higher performance status these materials can be somewhat difficult to use and may have some unusual mix ratios. But, if you need a product that has extreme physical and thermal characteristics this family probably has a member that will fill your need.

Another group of specialized products developed within the polyurethane group is the urethane foams. Available in both rigid and flexible versions, they are available in densities of anywhere from one half pound per cubic foot to 60 pounds per cubic foot. As with all of the aforementioned resin systems the foams work by the simple addition of an A and a B component and will react at various rates and rise to different volumes, depending on the product. Although these materials can be used as stand alone products, often they are used as a filler within a shell of any one of the three groups of thermoset polymers we have discussed. If one needs something light weight and durable, a foam core may be just the ticket. It is even possible to use a polyurethane foam as a core for some non resin materials like plasters and gypsum cements.

The final group of polyurethanes is probably the most specialized of this family. These are the water clear aliphatic polyurethanes, and they give some of the clearest most durable castings of any of the three polymer families we have discussed. The down side to using these materials is that they tend to be the most toxic materials offered here. Although they are odor-free, these can be highly toxic and as such require industrial grade ventilation and protection. The upside is that if one can protect oneself, these materials will provide a part that is highly stable and will remain clear even in the harshest environments. If one is prepared to work with these products that individual will be rewarded with a very functional product.

In review, if one is to venture into the realm of polymer resins and is prepared to deal with the toxic aspects of some of these materials, then surely the possibilities are endless. Once the end application has been evaluated, it is possible to pinpoint which product will truly be the "best" for the process.