Getting Started in Solid Surface (2002)
The R. J. Marshall Company

The desire for many manufacturers to enter the solid surface market place is a logical one to explain. At a time when the environmental concerns of gel coating are causing current concerns and potential future problems for production the prospect of not gel coating as well as expanding sales into the kitchen counter top market is very inviting. This movement toward solid surface is not matched with exacting scientific facts or a long history of how to make quality parts.

The problems of how to make quality solid surface may not be any more difficult than the problems of cultured marble, but they are different. General areas that must have more attention when making solid surface are:

1. Stain resistance of the filler and matrix resins as well as the integrity of the surface to prevent staining materials from penetrating to levels that cannot be easily cleaned.

2. Hardness of the surface to resist scratching that comes from a harsher environment of kitchen use.

3. Light stability of the matrix resin in relation to color shifts and strength deterioration, since light stable gel coats no longer protect the matrix resin.

4. A complete matrix resin cure to insure the maximum potential of the resin.

5. High heat distortion resins that do not soften when exposed to prolonged temperatures above a dishwasher or near the stove.

6. Significant interactions between Aluminum Trihydrate fillers and MEKP initiated resin systems.

7. The elimination of porosity throughout the total matrix.

8. Significant surface preparation including sanding and buffing.

9. Timely mold release for both flat stock and shapes.

10. Systems that demonstrates low blushing of bowls in dark colors or granites.

11. Color consistency or pattern effect throughout the total matrix.

12. The ability to rout and seam parts together without color variations.

13. Flame retardant parts that meet Class A as Corian does.

14. Garbage disposal vibrations and weight place additional stress on a kitchen sink and may cause crack failure.

There are also the other concerns that both cultured marble products and solid surface products have in common such as thermal shock and impact strength.

Because of the need for a uniform matrix that can be fabricated there are fewer options available to the manufacturer in their attempt to insure a quality product. Solid surface technology is not a complete science, but rather an evolution of the art.

With all this in mind, I will attempt to go over some of the choices a manufacturer of solid surface must make and some guidance on how to make the right decisions along the way.

RESIN SELECTION AND USE

There are many choices of resins to use in this application, but all of them have some common properties you should demand so that you have the best opportunity to make a quality part. Most of the resins that are used today are specifically designed for the solid surface application. Resins made with Neopentyl Glycol and Isophthalic Acid are the most popular because they offer a high heat distortion temperature, better chemical resistance, and lower water permeation.

All these factors are seen as positive, but can quickly be offset by a poor curing resin. These resins are usually higher in color than the water white onyx resins the industry is accustomed to having. Some applications may not need all the improved properties, but certainly some do. Look at your application and discuss it with your resin manufacturer to make sure that the resin can meet the physical properties required by your application. The resin should be light stabilized. Although this will usually add color to your resin it can prevent a significant quick color shift that will cause customer dissatisfaction. Some resins are called acrylic modified. This usually means a small portion of the styrene monomer is replaced with methyl methacrylate. All resins that are called acrylic modified do not have the same amount of acrylic monomer in them. You may want to ask the acrylic content in comparing competitive resin systems.

It has been said that the major benefit of the acrylic is to make the product smell like Corian. In fact, it can make a lighter stable and tougher product if it is cured well. When discussing your resin requirements with a supplier make sure that you are getting a resin designed for solid surface. Do not accept a resin that is just a good casting resin.

Resin systems are complicated chemical reactions that are difficult to fully understand. Do not add promoters, inhibitors, surfactants or plasticizers to your resin unless your resin manufacture is in agreement or you have completely tested the end result. Air release agents are a popular item to add, but if the manufacturer has already added them your addition may hurt the property you are trying to enhance. Catalyze in strict accordance with the advice of your resin manufacturer and catalyst suppliers. Too much catalyst is just as bad as too little. Too little may mean a part that will never cure, while too much introduces extra plasticizers and may actually react with itself rather then the resin. The type of catalyst and resin must be compatible. Some resin systems work well in MEKP; Some in MEKP/2,4 PDPO; and others are designed for BPO systems. All these abbreviations are hard enough to understand, so your best bet is to ask your resin manufacturer for the specific catalyst they would recommend. If after you test it you are not getting the results you want go back to your resin supplier and/or catalyst supplier and ask them to test some other variations to get the results you want. In some cases you will have to make a decision, trading off one property for another. (i.e. High 2,4 PDPO catalyst mixes often increase the color of the resin while giving a better cure). It should be noted that although the current wisdom points in the direction outlined above some very good results have been reported with regular general-purpose marble resins. In our lab one such resin out performed the "Densified Resins" in one of the tests. This is yet another indication that we cannot jump to absolute conclusions without making errors along the way.

Postcure refers to a heat assisted curing system. Most resin manufacturers suggest this. You simply take the part after it is released from the mold and place it in a warming oven for two to four hours. The resin determines the time and temperature. Your resin manufacture should be able to tell you the conditions. The result is usually a part that cures in the 95-98% range versus a room temperature cure part in the 84-87% range. Postcuring increases surface hardness, heat distortion temperatures, and increases stain resistance. Systems such as BPO catalyzed systems often do not recommend postcure as the heat generated by the catalyst breakdown and rapid cure is much higher causing the cure rate to be in the 95-97% range. Postcuring cannot hurt if done as your resin manufacturer suggests. Do not overheat the part during postcure. Increased temperature decreases the time needed only to a point. After that increased temperatures can discolor the part significantly. Some more details of this will be covered in the catalyst section.

FILLER SELECTION AND USE

The most popular filler used in solid surface is Aluminum Trihydrate. It offers a nice off white color, chemical resistance, a workable hardness, and flame retardant. There may be other fillers that can be used in some applications but ATH is the product in Corian and is the most tested of the fillers in this type application. All ATH is not the same. Some of the differences are color, size, and reaction with the resin's cure system. ATH filler systems can be designed for color, stain resistance, particle packing, or thermal shock. A filler system that is designed to give superior stain resistance may give poor thermal shock or retard the cure of the resin system you are using. Because of the newness of the application and the wide variety of resins entering the market every day very little statistically good data is available about fillers and how they work, this is particularly true of thermal shock results. You need to approach setting up your filler requirements as if you were the only one using the resin and the particular filler combination. Stain testing, hardness, and part processing for flat stock are the easiest type of testing to do, so that is where you should start. You should ask your filler supplier about "What properties were designed into the filler system and what properties were compromised?" Let's look at some of the common properties you will want in a solid surface part and how the filler will effect them:

1. Stain resistance is important because the gel coat is not protecting the matrix. If a mineral such as calcium carbonate were used, mild acid would attack the filler and have the potential of damaging the matrix. The resin in general will not stain during the ANSI stain test procedures, unless it is under cured. The ATH and fissures between the ATH particle and cured matrix resin are sources of staining that may be hard to clean. The conventional wisdom would point out that fine ground ATH would give the best stain numbers. The staining areas would be isolated close to the surface, allowing a cleaning with a mild abrasive to refinish the surfaces by sanding of the stained area. Fine ground ATH has the ability to retard a cure of a polyester resin when using an MEKP catalyst. If this happens the poor cure could easily offset the advantage of a fine ground ATH. It is important to note that passing the ANSI standard is not the issue. High quality parts demonstrate ANSI stain numbers in the low to mid 30's, while the standard is passing for anything below 50. You should try to be in the 30 to 40 range to make a high quality part.

2. Surface hardness is a good indication of the degree of cure, ease of fabrication and the parts ability to withstand scratching. You should have a Barcol Meter and try to get a Barcol hardness between 60 and 70. If the Barcol hardness exceeds 70 the part may be hard to route and fabricate; if the Barcol is below 60 the cure may be low and the part will scratch easier. The Barcol hardness will usually increase as the filler loading is increased. If your Barcol hardness is too low and your loading is between 65 - 70 percent ATH your resin must be reviewed. It may not be curing well or it may be the wrong resin for your application.

3. Resin cure can be greatly effected by the ATH filler. This whole area is not well understood. Whether the ATH interferes with the resin, promoters, or catalyst doesn't really matter. The result is what you need to measure. How is your Barcol hardness building with time? Is one catalyst better then another in building the Barcol hardness? Gel times are important for working times, but Barcol hardness and peak exotherm times and temperatures are more important when considering cures. Understand your alternative and exercise the appropriate one. You can change filler type; change resins; change catalyst levels; change catalyst; or postcure your parts to get a better cure. Each solution may have a trade off in another area, always ask your filler and resin suppliers what those trade offs may be.

4. Thermal shock of solid surface bowls has probably the least amount of data on it. I have seen an ATH filler work in one system extremely well but fail in two other systems. The best-tested systems for thermal shock are the onyx systems available today and used by the cultured marble industry. These may give excellent thermal shock, but have demonstrated shortcomings in stain resistance in several resin systems. Pick a filler system designed to make bowls, understand the trade offs of the filler system, and test several parts in your resin system before going into production.

5. Blushing is a significant problem in solid surface bowls. You should realize that Corian bowls are light colors that show blushing the least. We, as an industry, do not

understand the cause and effect of this process. This means that there is no standard answer for the problem. This problem may not be as significant as it first appears. Blushing is a non-repairable situation in a cultured marble bowl, but in a solid surface bowl blushing may be a problem that is cured with regular cleaning with a "soft scrub" type cleanser. If the latter is the case, the consumer in normal cleaning will remove the blushed layer. The best advice I can give is to stick with lighter colors for bowls and test your individual resin systems with several fillers. Your test should record data on when the blushing is first noticed and how easily is it removed. Other factors that should be watched are consistency of mixing and curing.

CATALYST SELECTION AND USE

Just to set the record straight I need to make two statements on catalyst. First I know less about this area than any other, and second peroxide is not a true catalyst but rather an initiator. The difference may not appear to be significant at first but it is when you start to understand how it works. A catalyst helps speed up a reaction while remaining unchanged, while an initiator "gives up its' life" to become chemically involved in the reaction. This is important because if you put in too little peroxide, you not only slow the reaction, but also may not have enough to complete the reaction.

Now, after that technical explanation I will go back to referring to the peroxide you add to the resin as catalyst. (Old habits die hard, even knowing they are wrong.) There are three commonly used options and one not so common option for solid surface curing systems.

1. MEKP - The Methyl Ethyl Ketone Peroxide systems that are being used today rely on the traditional cure technology of cast polymers to promote a complete cure. These systems usually go to about an 84-87% cure within 24 hours. After that time the part will continue to cure as long as some reactive monomer is in the right place at the right time. The monomer, usually styrene or methyl methacrylate, is also escaping to the air as it permeates out of the part. A post curing process that elevates the part's temperature often follows this type of cure system. Proper postcuring temperatures are a function of the resin. When using the postcure technique to complete the cure of your part you should always consult your resin supplier and start the post cure as soon after demold as possible. If you wait to postcure, the reactive monomer will start to permeate through and out of the matrix.

2. 2, 4 PDPO - Many people feel that 2, 4 Pentanedione Peroxide increases the continuation of the cure to a higher level than MEKP does by itself. While this is true in some cases, it does not appear to be universally true. There can be some negative side effects of blending this filler with MEKP. The negatives might include a slower gel time and additional color in the resin. The typical blends range anywhere from 40/60, 50/50, or 60/40. The best thing to do is ask your resin supplier about this type of catalyst and then experiment with different blends to get the working time you want. The part can be tested with a Barcol meter to give you some idea of the cure. One hint

is to make duplicate parts and postcure one for an extended period of time. This latter piece should give you a benchmark of the Barcol hardness of a fully cured part.

3. BPO - There are two BPO systems that are being introduced today. A room temperature BPO system offers a cure system that may not need to be postcured. The system cures fast and how in a relatively few hours. The systems usually are not as clear or colorless as the MEKP systems. The most critical characteristic is the rapid cure. This combination of higher temperature and rapid shrinkage can damage molds. Mold preparation and timely demold become much more important than with the other systems. The room temperature cured BPO systems use amines in the resin promotion system. Amines are know to yellow with age and light and may cause a color shift that is unacceptable in your application.

A second type of BPO system is a heat-activated system that starts at elevated temperatures. These systems do not use amines in the promotion system and do not have a higher potential to yellow. These type systems typically need to be heated above 1500 to 1800 F in order to cure.

MOLDS AND MOLD PREPARATION

Densified resins present a unique set of circumstances for the mold. The most important part to be made is flat stock sheets that are then fabricated into the size counter top desired. I have seen people cast on glass, stainless steel, fiberglass, or Formica. If using Formica it is probably a good idea to have the laminate bonded to the substrate with a high temperature epoxy. This will insure that the mold will hold up even under higher peak exotherms. Shapes are a particular problem as the resin peak exotherm and shrinkage may both be significantly higher then normal casting resin matrices. In most cases the surface is going to be sanded, so that a perfect surface is not necessary.

During the manufacturing process the matrix may sit on the mold surface for 20-30 minutes. If anything can attack the mold it will; conversely if anything on the mold surface can attack the matrix it will. The standard mold wax is probably not a good choice. Natural waxes dissolve in styrene. Once in styrene they can hurt the resin/filler bonding or just stay in the resin. When exposed to oxygen many of these waxes turn white. A permanent silicone resin release would appear to be the better choice. It is designed to stay on the mold and that's exactly where you want it. Several manufacturers do not use a mold release on their Formica flat stock molds. They wait until the matrix is pulling away from the sides then they blow high-pressure air under the part to release it. Some then turn the part over to let it cure the rest of the way; others just leave it to finish curing after it is released. The only preparation for this technique is to wash the mold down with acetone prior to pouring to clean off any polyester left from the previous pour.

Sinks are difficult. You should make sure you have a mold designed for solid surface before attempting to pour. The mold must be able to withstand greater temperatures, increased exposure to styrene and methyl methacrylate, and the increase stress of rapid shrinkage. Since a sink will be difficult to sand, they usually are not. Any stress lines will cause you fits, particularly in the granite fillers. The one item that most people will agree on is that you should release the part as soon as possible. Once release you can leave it on the mold or support it in a rack until it finishes curing.

TROUBLESHOOTING SOLID SURFACE

The most common problems of making solid surface are:

1. Slow Gel Time - This problem is common because the typical filler used in densified systems has fine ground ATH in it to give better stain resistance. The best way to solve this problem is to have your resin, catalyst or filler manufacturer to look at various catalyst changes to speed up the reaction. Do not exceed the recommended maximum catalyst additions, as catalysts have a high percent of unreactive diluents. Extra catalyst introduces additional materials that do not react. A second method of attacking this problem is to heat up the cure area, molds, resin or filler. Increased temperature will increase your reaction rate. Many times temperature is the problem. Since these systems have a more significant need to be cured, care in storing raw materials as well as heating the work area must be taken. A third method of handling this problem is to go to a resin/filler system that has less of an effect on gel times. This requires you to review your problems with both your filler and resin suppliers. This avenue might lead to a resin designed for BPO catalyzation, where the system is designed for rapid and complete cure, with little effect from the ATH.

2. Slow Cure Times - If the part remains like rubber for too long after gel, your production can be slowed down, and demolding may be difficult to judge. The same steps that you go through for slow gel times you also go through for slow curing. The test on cure is usual a Shore D meter versus a Barcol meter. It must be pointed out that fixing the gel time does not always fix the cure. From a technical standpoint the peak exotherm and time to peak are good indications of the curing cycle. Your resin, filler, catalyst manufacturer should be able to relate to a faster peak exotherm after gelling.

3. Warpage and Filler Settling - This problem is common when a manufacturer tries to make product without a vacuum mixer. The extra resin added to get good air release is allowing the filler to fall to the mold, while the resin floats. In most cases increasing the filler loading will solve this problem, and give a harder surfaced product.

4. Thermal Shock Cracking of Sinks - Use a designed filler for solid surface sinks, demold as soon as possible, and use resin designed for solid surface sinks. Even with doing all the above test your product several times before releasing it into the market. Kitchen sinks will have even other problems. The pots and pans will cause more scratches; water could be hotter or colder; staining materials will be dumped down it; and garbage disposals will vibrate away at your matrix. This is not an easy task and there is not many years of data saying what will work and what will not. Be cautious!

5. Blushing - Blushing may not be greater in a highly pigmented dark matrix, but is certainly more noticeable. There appears to be several different things people call blushing. The first is a haze on the surface after demold and during final curing. This blush is surface related and must have to do with shrinkage and mold release. It is not as important if the surface preparation calls for sanding down the surface. In sinks where the surface is not being sanded the problem is much more important. A good mold release and properly designed resin seem to help, but at this point we just do not know the cause or solution for all cases. Resin rich pockets shrinking and stressing during cure cause a second type of blush. This cure may be over days if the part is not cured when made. More filler or lower shrinking resins help this type of blush. Third is a blush that comes from a fully cured part on the surface. After sanding down the surface a new white blush reappears. Since the matrix is changing and the resin is cured there must be something else in the resin that when exposed to air or moisture reacts. This can be mold release compound, air release agents, pigment diluents, or catalyst diluents to name a few. You will have to find the culprit and eliminate it.

The last type of blushing is from water during thermal shock. This may not be as significant as you might think. A thermal cycle machine is an attempt to shorten the time it takes to simulate many years of service. With solid surface materials, during that many years of service, the surface will have been scrubbed with "soft scrub" type cleanser many times. This will have continually abraded the surface and perhaps removing the blush before it is noticed. Some good results and some poor results have been seen without the benefit of knowing why. Test your sinks under normal conditions for several months to get a feel of what your performance level is.

MARKETING SOLID SURFACE

Perhaps the first place to start is our last subject. The evolution of solid surface as a material used in a wide variety of applications means that you have many options. In general there are several levels of solid surface manufacturing that relate to what you will make.

1. The first is the manufacturing of shapes. The casting of shapes reduces the fabrication time and expense greatly, giving you a competitive advantage over the fabricator of sheets. This advantage is both in the reduction of raw materials and the labor of fabrication. The first items that come to mind are the companion products to a bathroom counter, such as tubs, showers basins, and vanities. This is just the beginning of items that can be cast to specific shapes. It should be noted that the finishing of shapes is more difficult and sometimes labor intensive. There are several techniques from hand sanding, to sand blasting, to automatic equipment. All of this is designed to sand off enough of the surface to give a uniform color and texture to the part. In granite effect materials the surface may need to be sanded half way through the largest granule size. This type of manufacturing may only require a vacuum mixer, a small post cure oven and the appropriate molds.

2. The manufacturing of sheets is the most visible product in the industry. By casting to a specific job you can reduce the material that will be scrapped. Several small manufacturers cast the sheets to the size they need and additional 1” x 1” strips that are used to build edges. This eliminates half the edge building time and labor. If this is what you intend to market you will need a vacuum mixer, wide belt sander and a post-curing oven. Sheets are

cast today on a wide variety of surfaces including high-pressure laminate, stainless steel, glass, and FRP molds.

3. Marketing products outside of the box is also a real possibility. One large user of solid surface sheets makes nothing but pen and pencil sets. Any item that can be made from wood can be made from solid surface.

Once you decide what you will make you need to determine how much and what variety. The answer to this question will help to determine what size and type of equipment you will be interested in using. Vacuum batch mixers come in a variety of sizes. They typically do not mix well when less then 30% of the mixing bucket is used. Vacuum continuous casting machines are available if runs are larger and longer of specific colors.

So where is the place to start getting set up for making solid surface, first decide what you want to make, then call your suppliers. Pick a few trusted suppliers and have them all meet together so that resin, equipment, and fillers all perform as a system. The products you make will be functional, creative and beautiful.

Good luck in this new adventure.