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THE COMPLETE RESIN RESEARCH EPOXY GUIDE

*** *This information was gathered from various documents of well known "epoxy guru" Greg Loehr (developer of Resin Research). Therefore, this guide reflects Greg's experience and point of view and not necessarily that of Foam E-Z.*

DIFFERENT RESINS and HARDENERS:

Mixing hardeners for custom applications is one of the reasons we made everything 2 to 1.

With fast, you have a 25 min pot life, slow 50 min and extra slow 200 min. Slow has 4-6 hours flip time; fast has 2-3 hours flip time.
Mixing different hardeners together will give you other results and there isn't any algebra necessary.

In most conditions you'll find our standard 2000 resin on PU to have similar flex characteristics to polyester although your weights will be lighter with the same glass schedule. EPS blanks with heavier glass schedules with 2000 will be a bit stiffer. We also have 2020 resin which is more flexible and 2040 (in development) which will have even more.

ADVANTAGES:

Epoxy is stronger so the board comes out stronger with better resin. Since epoxy is stronger it takes less resin in the laminate to do the same job as polyester. And epoxy has a slightly light specific weight. This makes a lighter board even with the same blank used for the poly. In fact with epoxy on Clark foam you can use a green blank and it will come out the same weight as the same glassed poly lamination using a blue. And MUCH stronger.

You can laminate ANY foam with epoxy. Not just urethane. This gives you the option of making your own blanks.

Our new epoxy system as fast as MEK initiated polyester so production times are

quicker than in the past.

Cosmetically epoxy is clearer making a whiter board. Yellowing is also slower than with poly.

Epoxy can be cleaned up with soap (GoJo type) and water. There is no need for clean up solvents.

Our Epoxy has very little vapor (odor) so work can be done almost anywhere. No masks are necessary with just moderate ventilation.

You use approximately 1/3 the amount of epoxy resin to build a board as you would polyester.

These last three, immediately above, give you an indication of the reasons epoxies are better for the environment and for labor.

Epoxy gives the laminator more work time and there is no real "gel" time to catch you. The resin just gradually thickens as it begins to harden. This allows a higher quality laminate.

All the newer fabrics (Kevlar, carbon, s glass, etc.) were designed for use with epoxy. Not surprisingly, they all perform best in an epoxy matrix.

On the health issues, with our epoxy (Resin Research), I have never seen any sensitization that doesn't involve a co-toxin. *The one in particular in our business is* ***acetone****. It serves as a vehicle for toxins through the skin. We eliminated acetone from our shop long ago and have never had any problems.* We now use soap and water, which work better anyway. Our resins also do not contain phenol or formaldahyde, which many other systems do. These are some other co-toxins I mentioned above. Also our hardeners are based solely on cycloaliphatic diamine technology as opposed to straight chain amines. This also reduces toxicity. We also have safeguards built into our formulations to reduce toxicity. This makes our hardeners much safer to use than most other epoxies.

EPOXY SAFETY ISSUES:

Toxicity. Vapor from most epoxies is much lower than it's polyester counterparts. The resins we produce (Resin Research Epoxies) are all high solids and have 1/50th the vapor of polyester surfboard resins. In our shop (which is well ventilated) we don't even wear masks. Epoxy is also NOT a carcinogen. That has been well proven by OSHA and many others in industry. What epoxy is, is a skin sensitizer. This varies greatly between different epoxy systems depending on different company's formulations. Most older epoxy hardeners are formulated with a chemical known as TETA or another called DETA. These base hardeners are in the aliphatic amine family, are very reactive, somewhat unstable, quite toxic and easily can cause sensitization of the skin (or dermatitis). Most of these hardeners are also modified with phenol and formaldehyde. Phenol is what dermatologist use for chemical skin

peels and increases TETA and DETA's toxicity to the skin dramatically. Many of these older hardeners are up to 50% phenol. Formaldehyde is also no picnic as it also increases risk because of it's ability to act as a vehicle for the phenol and amines through the skin and into the blood system. By the way, the reason these epoxy hardeners are still used today is because they're CHEAP. DETA and TETA cost 1/5 what a modern diamine based hardener costs to produce. Anyone who has worked with many of the West System epoxies are familiar with these low cost systems. Modern epoxy hardeners are nothing like their 60's counterparts. As I mentioned above, they are formulated with modern diamines and have vastly reduced incidences of sensitization. They also have lower vapor, better color, better finish, and lower exotherm. They contain NO phenol and NO formaldehyde. Our company was one of the first in the US to formulate and market diamine based epoxy hardeners 20 years ago, which gives us an edge in experience with these chemicals. As superior as they are they still must be respected as skin sensitizers. The simple way to eliminate problems related to dermatitis in the workplace is to reduce or preferably eliminate contact with the skin. This means gloves. That's it. We wear disposable vinyl gloves. Vinyl is preferable to rubber because rubber gloves are also skin sensitizers. The other, even more harmful, ingredient is contaminated acetone. Like formaldehyde above it is a vehicle for toxins into the bloodstream. Fortunately epoxy can be cleaned up with soap and water. Not standard bar soap but with products like Go-Jo and Fast Orange. These products are water based and don't act as a vehicle the way VOC solvents do. In 20 years of producing epoxy surfboards we have NEVER had one incidence of dermatitis in our shop. I have also NEVER seen a case of dermatitis that didn't have something to do with the co-toxin acetone. Given the aforementioned resin parameters and if shop practice adheres to the above suggestions, epoxy resins are MUCH safer to use for producing surfboards than their polyester counterparts.
Additive F:

ADDITIVE F:

Additive F is a miracle breakthrough in the production of epoxy surfboards. It does so many things it's unbelievable.

In laminating, it helps wet the cloth eliminates most air bubbles, especially around wings and boxes, reduces the amount of resin needed, and most of all eliminates blush. Blush is what causes the banana peel effect you were referring to. In hot coats it eliminates blush, fish eyes, other surface blemishes and increases Barcol hardness. This increase in Barcol makes the board sand easy and improves the bond and strength between layers.

It also doesn't interfere with recoating as wax solution in polyester does. That means no sanding between layers. One of the things I've tried to relay on this site is that epoxy boards have become easier to make (and safer as well) than polyester boards. Somehow I don't think that has gotten through.

Additive F reduces resin use by about 20% in laminates.

How much Additive F to use:

1cc per ounce of hardener = Laminations
2cc per ounce or hardener = Hot/Gloss Coats

EPS vs. XPS:

XPS (extruded polystyrene) generally does not wick water. That's not the problem with it. The building material industry got nailed for using EPS (expanded polystyrene) because it DID wick water. It (EPS) is now available with new technology that doesn't (EDRO technology) He was right that XPS does delaminate because of trapped blowing agent gasses and this is XPS' great failing in surfboard construction. Meanwhile the advances in EPS have answered the issues involved with it and it now presents a very fine material for both surfboard and house construction. EPS boards never bubbled. But XPS does, big time. Always has.

Polystyrene (EPS) is my personal first choice. About two years ago a new technology sprung up from Europe called EDRO. EDRO machines are a new computerized version of the old EPS (expanded polystyrene) press technology. It makes an EPS foam with significantly enhanced strength and fusion that doesn't leak when dinged. The first EDRO machines installed in the US were done here in Florida. They are now across the US with two in Fl. and at least two in California. This technology takes polystyrenes strength to weight advantage and combines it with a foam that doesn't leak or delaminate.

Shulers foam was being used by Patagonia and others, this is an extruded polystyrene (XPS). I was the Dow distributor for a similar product about 12 years ago. The problem we had then, and the problem that continues to plague it today, is delamination. This is caused by the fact that a significant amount of blowing agent is trapped in the cells during production. Blowing agent expands under heat. That's what makes it work. 95% of the blowing agent in EPS foam is lost during the pre-expansion process. 95% of what's left is lost in the molding or press cycle. With urethane the chemicals are being changed during the polymerization process and you end up with only CO2 left in the cells. But with XPS the cells are left filled with blowing agent gases. When these cells are damaged, and the gas released is then heated, a delamination or bubble forms under the glass. Also these foams are copolymerized with polyethylene which NOTHING sticks to. This makes the problem even worse. This problem has existed with XPS since Bob Simmons first used it in the 50's. Also the new Solomon blank is based on an XPS foam so don't go holding your breath on that one either. While it's true that these foams are superior as far as being water tight, today I'll go with EDRO EPS

I prefer EPS over XPS. XPS has a lower melting point and is basically unstable at 165¼f. EPS becomes unstable at 185¼f and that 20 degrees makes a big difference. On the other hand XPS is watertight and doesn't suffer from water intrusion the way EPS and urethane do although this issue is no longer a large one on either of these. All foams today have issues because of the low densities we use. In my experience EPS has the best balance of features.
Epoxy Laminating

MIX RATIOS and QUANTITIES

Below I'm writing some tips on making our stuff easier to use. If you take your time epoxy is actually easier to laminate than polyester, uses much less material and eliminates harmful chemicals in the factory. *Always be sure to THOROUGHLY mix epoxy*.

1. Mix ratio must be adhered to. Deviation from the mix ratio will keep the resin from attaining a full cure. Also the material must be THOROUGHLY mixed. If not there can be soft spots. We use metered buckets (I'm sending you one which we get at the local hardware store) to assure proper mix. We use large paint stir sticks (like the ones hardware stores give you to stir paint). All our resins are 2 to 1 mix ratio by volume. The metered buckets work unreal, actually better than pumps and we laminate right out of those buckets.

2. Additive F. We use it in every batch we shoot, including laminates. It eliminates blush which is the biggest problem in building epoxy boards. It only takes 1cc per ounce of hardener in the mix. We put it in after pouring the resin and hardener into the bucket and then mix them all at once. It makes the resin a bit cloudy but clears out when the resin cures.

3. When laminating, the first thing to do is to pour all the resin out and spread it over the glass. You then wet the rails and tuck them. This gives the resin time to soak into the cloth on the flats. Polyester must be pushed through the cloth. Epoxy just soaks in and it does that in its own good time. It can't and shouldn't be forced. Additive F actually helps with this quite a bit. After it soaks in, squeegee out any air and remove any excess. We use plastic, "spreader," type squeegees. We've found that they move epoxy better than rubber squeegees do. They take a couple boards to get wired but after the initial learning curve laminating is much easier.

4. We use VERY little resin. Below is an example of our use levels for different size boards. As there is no "gel" time, any resin left over can be used on the next board. If you run short you can easily mix up additional resin to finish with. Usually we just work out of one bucket and simply keep mixing more material as needed. It isn't the same, "this bucket for this board," as polyester. These are estimates for total mixed material.

6' and under - 9 -12 oz. bottom 12-15oz. deck

7' and under - 12 -15oz bottom 15-18 oz. deck
(Epoxy beginners should add a couple ounces to these numbers).
8' and under - 18 - 21 oz bottom 21- 24 oz. deck

9' and under - 24 - 27 oz bottom 27- 33 oz deck

Hot coats run just a bit more than an ounce per foot. For instance a 6' board would take about 7 oz. per side. Longboards, 9', take about 12-15 oz. per side. If you're glossing use a bit less than a hot coat. We use 3" disposable white bristle brushes for hot coating. We don't clean them. We use them for one batch and pitch em. Not only do we feel that their not worth cleaning but we've also had problems in the past with

contamination from cleaned brushes which manifested itself in bad hot coats. New brushes always make for clean hot coats.

5. Do not use acetone for clean up and never let contaminated acetone touch the skin. Any toxicity problems we've seen in the past always included contaminated acetone. Not only that but acetone doesn't work that well with epoxy anyway. Leaves everything sticky. For your hands use disposable vinyl gloves. Clean gloves between boards with scrap fiberglass. I usually cut scrap and pile it neatly on the table so I have plenty ready. Clean your squeegee with scrap glass. Anytime the squeegee gets slick I just wipe it and my gloves down. When the gloves get funky, peel em off and put on a new pair. 10 cents a pair is cheaper than acetone. With so little resin being used very little goes anywhere except on the board so things tend to stay much cleaner. We don't ever get more than a drop or two on us. If you do get some on you, use Go-Jo or Fast Orange or some other waterless cleaner with water to get it off. These clean epoxy more effectively and are much safer to use than acetone.

LAMINATING TIPS:

IF you're having problems with the Epoxy wet out, the reason most likely is you're still thinking of the polyester technique. Epoxy doesn't need to be pushed into the fabric. If you do this it will get frothy. [GO SLOW].

The first thing to do after mixing is to pour all the resin on the board and spread it around so the entire surface is covered. Then wet your laps by pulling resin off the flats onto the lap. This gives the resin time to soak into the flats. Also, use a stiff squeegee that moves the resin more effectively. I use one of those plastic spreaders, the yellow ones. After you wet and tuck the laps, the resin should have sufficiently soaked into the flats with no elbow grease. Now simply remove the excess while flattening the fabric and clean your laps. It's that simple. Also by pouring all the resin out immediately you reduce exotherm and lengthen work time. Using the above technique I laminated a 12 foot board with a 3 layer 6 oz deck the other day with our new fast hardener in 85º with time to spare.

First pass is merely spreading the resin out over the cloth leaving it very wet. Then let it soak. Move the resin from the middle towards the ends. Don't push towards the middle. That way you won't rake the glass. This is the really hard part to explain to people that are used to polyester. Letting the resin soak in instead of pushing.

Laps:

We use a variable speed Hitachi sander with an 8" hard soft pad and 80 grit production paper. Seems to work well, we turn the speed down low when sanding laps.

Cutlaps:

Have done a lot of opaque pigments and a few tints. I've begun doing all cutlaps even with clears. Sanding properly and taping your cutlap work with colors is critical to

avoid bleeding under along the tape line and sanding scratches. I've gone back and cut single layer cutlaps the next day but too soon and you have a gooey mess. Average for me would be 3-6 hours to flip. No more difficult to trim than polyester.
Trim laps should be done with an exacto knife instead of a razor blade. And a double dose of additive F in the laminate seems to make the trimming easier as well....

HOT COAT and GLOSS TIPS:

With RR epoxy you double the amount of additive F when hot coating or glossing, they are the same mix. For glossing/hot coating you add 2cc of F for every ounce of hardener used. When you laminate you just use 1cc per oz. So , yes....just another layer....with double the F...

There are some simple rules to glossing:
1. Everything must be clean. That's the board, the room, the brush, the bucket and everything else that might come in contact with the resin. Contamination will surely ruin your gloss coat.
2. I usually sand to 100 for glossing. I've seen others go to as far as 220 but I've never seen the advantage to the extra work. 100 is just fine.
3. You'll never get a good gloss using a sqeegee, you have to use a brush. It takes a certain amount of resin for it to be able to "flow out". Using too little and the resin can't move and self level. This does add a bit more weight than getting it really thin but it's the only way to get that show room finish. If you don't want the extra weight then go for a sanded finish.
4. With Additive F you can polish RR epoxy. In fact it polishes just about like polyester. Without Additive F epoxy doesn't polish well at all.
5. When glossing with epoxy double the amount of Additive F. This will give you better flow and your gloss will come out flatter.

As for urethane finishing, this takes really good equipment and a VERY clean spray booth with a constant flow of fresh air. Most of us aren't set up to do this reasonably. I've done a good bit of this and it's a real professional type of effort to even attempt it. As much as I did, I never had the equipment to get the consistent results I wanted. This is also VERY toxic.

The dry spots on the rails are probably from oil in your hands. All hands have a certain amount of oil. Wiping the board down with denatured alcohol will help remove this. By the way, denatured alcohol is ethanol with 5% wood alcohol which makes it poison. They put a small amount in so people can't drink it since ethanol (grain alcohol) is what is in alcoholic beverages.

I've been playing around with getting the weave to disappear in a Resin Research epoxy lamination. I have discovered that if you shoot a hot coat with additive "F" in it over the glass lamination while the cloth layup is still a little gummy -- depending on the temperature -- an hour or two after the glass layup what happens is that you can sand the hot coat without touching the weave at all with very positive results. If you're good enough with the brush and want a light board with sanded finish you're ready to go. If you want to polish things out to perfection or want to do some pin-

lining just sand the surface down with 80 or 100 grit (220 for the pin-lines) and shoot another coat on with additive "F" and 'WALA' you have a real sweet finish coat with very little work. Shooting the hot coat when the lam is still tacky allows it to flow much better. but

Epoxy hot coat disaster
I've made a major blunder whilst hot coating the deck of my first timber hollow board. I'm using epoxy. I brushed it on to the deck and it looked ok, but an hour later it had gone all pitted and wavy. It hasn't delaminated, but there are areas which are still sticky (toffee like) even after 4 days.
I did the bottom of the board and its perfectly smooth. Any suggestions as to how I rectify the problem? I want to sand it back and start again but the sticky patches are the problem. Silly question, but could I put some hardener onto these area? Any thoughts on this?

Always be sure to THOROUGHLY mix epoxy. It is not a catalytic reaction like polyester so each part (resin and hardener) has molecules that must react with the other part. It's called an addition reaction. If they don't get together they won't kick. Thorough mixing is the solution and an easy one at that. We use big paint stir sticks, they do a better job than tongue depressors. One good thing about having this problem..... you won't ever do it again.

Glassing Schedules:

2.5lb EPS - Use one layer 6 or 2 layers of 4 bottom..... Use 2 layers 6 or 3 layer 4 deck.

2lb EPS - Use one layer 6 or 2 layers of 4 bottom..... Use 2 layers 6 or 3 layer 4 deck.

1.5lb EPS - Use one 4 and one 6 oz for bottoms..... Use two 4 and a 6 for the deck.

These are minimums. For strength, go up from there.

Temperature:
Keeping a small room between 60° and 85° isn't that difficult and gives consistent quality results.

The new fast hardener is fine above 50°. Additive F will solve many climate problems as well.

At less than 70° time is usually not an issue. Fast hardener has plenty of work time and you can still flip it in less than 5 hours. Slower curing agents like our slow or the surf source resin doesn't allow you to flip in less than 12 hours, or even more, in cooler temps. Also when the resin doesn't kick in a reasonable amount of time, bad things happen. Again Additive F eliminates these problems and a faster curing agent always gets better results in cool temps.

Keep Additive F warm to keep the solids in solution.

There are mixing buckets available that you can pour both sides into and not have to have a bunch of mixing cups around that are inaccurate. We work straight out of those cups. They usually last about two or three batches of boards before we throw them out. They cost about 50 cents a piece. Heating resin can cause problems and does make for inconsistent results. Hot resin will cool rather rapidly when poured onto a cold blank. It will also bring the temperature of the blank up which can cause out-gassing. Heat curing done on an uncured lamination can also cause outgassing from the foam. My best suggestion is to work in an area that is between 60 and 85 degrees. The cure speed of epoxy today, at least our, is much improved with the addition of our new faster curing hardener. This is available now and at 75° you can flip it in 3 hours. Softening is a problem with epoxies that have low heat deflection temperatures. I use a microwave for about 20-30 seconds.

Fin Boxes:

I mix Cab-o-sil into the resin until I get a peanut butter thickness. This way nothing moves after it's you set all your angles and resin doesn't absorb into the foam. You can do the box before or after the laminate with Lokbox. I use Add F just like always (lam amount) so I don't have bonding issues in successive coats. With slow [hardener] you'll set within a few hours. Be sure to get the resin out of the bucket, or cup, immediately after mixing to keep exotherm down. This way you won't burn the blank.

The epoxy resin is so strong that any mil fiber, cabo isn't necessary. The lokboxes, Future get glassed over and the same should go for FU also, the only problem I have come across is gassing around the boxes from the heat that the resin produces. But as with all specialty projects, take the time to back fill and make sure it is ready to go to the next phase. Jim Phillips
EPS Flotation:

On floatation, I usually make my boards about 1/8 inch thinner than a poly. The density is less because the board is lighter and the 1/8 seems to work fine. If you don't want to make the entire board thinner just thin the rails.

EPS Shaping & Sanding:

Regular planers work fine. I usually use sandpaper with a bit more grit than with Clark foam. Usually fine sand with 50 and finish with 80. 100 screen after the spackle. I've done finer but the glass can move if you get too fine, like 220. The spackle is so light that I never saw a need to fine sand the blank past that point. With the scales I was using I couldn't even measure the weight when the spackle had dried.

Sealing the EPS Blank:

Spackling compound: works excellent. Best base for air brush and cosmetically the best. Drawbacks: Spackling does tend to yellow a bit if you use tap water. Use purified water for better results. Also adhesion to the blank is not as good as microballoons of as no seal. These are not serious issues but as long as we're being thorough here. To seal with spackling paste, water down the paste so it has the consistency of mayonnaise. Then squeegee it onto the blank like a foam stain. The stuff will thicken up as you work so you may have to add more water at some point. You can do both sides at once as the spackling paste doesn't tend to stick to the rack. After the paste has dried lightly fine sand with a softpad and screen and your ready to laminate. [TAPE OFF STRINGER BEFORE SPACKLE]. [SPACKLE HAS TO DRY OVERNIGHT].

White Glue: Cosmetically not as good spackling. White glue softens with water intrusion causing delamination. This was an early method that has been discontinued by nearly everyone.

Micro and epoxy: Excellent method. Good adhesion to the blank. Fair cosmetics. Fair for airbrush. Do NOT use additive F if your going to airbrush with water based paints during this step. The paint will bead on the microballoon surface. Blush can occasionally be a problem in bad weather which can create adhesion problems between the seal and the laminate. This was an early method that is still used by many today.

No seal: This is now possible with the advent of better EPS foams. Adhesion to foam is VERY good In fact we have never broken a board built this way. Sometimes a small cheater coat is required after the lamination has set. This method requires excellent fine sanding of the blank and even with this the cosmetics are not as good as the other two acceptable methods. This method seems to lend itself to real high performance construction where performance and break strength are preferable over cosmetics. Big waves, Hawaii, Mexico, etc.

Another opinion:
I don't use any micro balloons added to my epoxy, I don't blow off the blank before I start, just keep it free of hand prints. It takes about 3 ounces of Resin Research epoxy to seal the bead foam and the styro dust mixes into an excellent putty that chemically bonds to the foam.(I feel that using spackle, fills, but may not get that chemical bond, the board I snapped at Sunset had the glass locked onto it) A sanding and it's ready, but I put on a second sealer that lays as smooth as linoleum and give that another light sanding.
I tried to lam without sealing and had blow problems, but since taking the time to seal the blank has more than benefited my efforts. Ultra tight/dry lams with no draining or pin air. Spend minutes, save hours
I can get an 8 footer from 3 ounces. I keep collecting small tubs, one of the better is an apple sauce tub. Two resin...one hardener, a longboard lam, at first I was blowing

it on my resin amounts, poured lots in the drain bucket. Can't do that at $55.00 a gal

COLOR WORK:

Colors can be done generally using the same color dispersions that are used for polyesters. While I have not done a lot of color work in epoxy, swirls and the like should work similarly to polyester. And by saying I've not done a lot, I have done some and found things to work fine. Trim laps should be done with an exacto knife instead of a razor blade. And a double dose of additive F in the laminate seems to make the trimming easier as well.

Tinting

For tints we usually seal the blank twice to get a real nice surface. Very light pastels and yellow don't require this but medium tints usually do. Personally I'd go with the yellow on the first one. Pretty much the easiest color.

Airbrushing

Just make sure you use acrylic paint. Any other paint's solvents will melt the foam. You can use acrylic at pretty much any step in the process and it'll be fine: right on the foam & then seal with epoxy or just laminate with extra resin; after sealing with epoxy or with spackle, after laminating but before hotcoating, even after hotcoating and then go over the paint with another thin coat of resin (epoxy or poly) or with Future (tm) acrylic floor polish.

Epoxy and Clark Blanks (Polyurethane)

I have done many Clark blanks with epoxy. Good way to go. Easy to laminate, no harder than poly. With the right mix of Additive F it is easy to sand, no harder than polyester. Makes a finished board with much better strength to weight than polyester laminate.