Apogee Components

PEAK OF FLIGHT

NEWSLETTER

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Styling Your Fins With Carbon Fiber

Cover Photo: The "My other car is a Rocket Ship" vinyl decal. Get yours at: https://www.apogeerockets.com/Rocket_Novelties_and_Gifts/My_other_car_is_a_Rocket_Ship

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Carbon Fiber construction

By Braden M Carlson

As long as I have been flying High Power Rockets (which is about 6 years now), I have found myself, along with many others, staring awkwardly at rockets with carbon fiber components. Something about the look, the black weave with an almost silver checkered pattern is absolutely mind-blowing and attention gathering. It is almost as if a High Power Rocket is not a serious High Power Rocket until it has some naked, high-gloss carbon fiber on it somewhere. While I know that isn't true, the makeup of a rocket being what determines it's a rocket, it never stopped me from wanting to try to build rockets with carbon fiber.

While carbon fiber can look absolutely amazing, the true benefit to composite layups is the ability to add strength to your rocket projects, whether it is the airframe or the fins. It opens up a world of bigger motors and faster, higher flights. Both fiberglass and carbon fiber allow you to truly make a rocket project your own, as laying up your own composite truly brings you the feeling of building a rocket, not just assembling it.

The first place to start in learning composite layups is fiberglass; it is much cheaper, and you don't usually have to worry about how it looks, since most people just paint over it. After getting a good grasp on fiberglass, though, I decided it was time to try some Carbon Fiber. Having made that decision, I decided it would be an awesome idea to try to replicate the legendary Jim Jarvis' 54mm all carbon fiber Estes Big Daddy. Let's just say, it didn't turn out well, and it never actually ended up leaving the ground.

I started looking more and more into carbon fiber construction and discovered the process of using a vacuum pump to suck all of the air out of a bag and constrict carbon fiber or fiberglass cloth. Using a vacuum and release fabric creates near perfect composite layups without having to worry about weighing it down, letting it sit out in the air for something to land on it (a pretty common occurrence at my household), or having excess and uneven epoxy to leave you with hours and hours of my absolute least favorite part of our beloved hobby - sanding. The process is called vacuum bagging, and it can get very expensive. A good vacuum bagging setup can cost hundreds in materials. However, with a little Internet research, I was turned on to an alternative method of vacuum bagging composite layups for smaller components - The Foodsaver.

That's right! That thing that could very well be sitting on your counter right now that is designed for sucking the air out of a bag of food to keep it from going bad works fantastically for laying up composites. In this article, I will cover my experience with it, and demonstrate how it can be used for High Power Rocketry applications. I do need to re-iterate, though, that this is not my idea, nor is it new. However, as far as rocketry applications go, I can only find a really good write-up for using this method to do composite layups around airframe tubes. While the Foodsaver is GREAT for

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Photo 1: Starting with a Foodsaver, Foodsaver bags, Carbon Fiber roll, Rocket Kit.

doing airframe tubes, it can also be used for composites on many other components. The component I see the Foodsaver as most useful for is fins.

My test subject for this article is the very cool Estes Leviathan. Even if you don't want to do a ridiculous composite layup on the fins, I highly recommend picking one up, as it is a great looking kit and it's pretty exciting that Estes is making big kits again!

As with any project, we start with the essentials. So let's take a look at the materials needed for this project. The two obvious ones are the composite cloth of your choice (I chose Carbon Fiber), and the Foodsaver. Equally as important are rubber gloves, chip brushes, Foodsaver bags, a mixing cup or bowl, Release Fabric, Breather Fabric (I use paper towels, they work great), a scale (in the event that you are using epoxy that requires it to be mixed by weight, as I am), and of course, your epoxy. My epoxy of choice is Aeropoxy. (I used West Systems for the decoration layers, more on that later.) I bought Aeropoxy when I was building a high performance minimum diameter rocket because of its high Tg (Glass Transfer Temperature). While it's not relevant in this build as this rocket likely won't even see Mach 1 and heat will not be an issue, I decided that since I like the work-ability and drying time, there's no reason not to use it. It is my highest recommendation that before you even consider mixing up your epoxy, you are 100% sure that you have everything you will need within your reach. With that, we move forward.

We begin by rolling out our composite cloth. Mine is 2x2 twill 5.9oz. 3k Carbon Fiber cloth, purchased from Soller Composites. I also got my release fabric from Soller, and they are a great place to do business with when looking for composites. I laid out a fin onto the carbon fiber cloth and cut a box around it that would allow adequate overhang to ensure that I would have enough room to worth with around the edges of the fin. Some like to cut out the shape of the fins and leave a slight overhang, you can do that. These are people who have more patience than I do. As long as you are laying things out and cutting them, go ahead and cut your release fabric as well.

After cutting out our carbon fiber, I put it in a cup to weigh it. A good friend of mine with a lot of experience with carbon fiber told me a good ratio of epoxy to mix is 1:1.25 Carbon Fiber to Epoxy by weight. This way you are not left with a ton of wasted epoxy, and you will not run out while doing your layup. We had 51.4 grams of carbon fiber cloth (that includes the weight of our excess cloth). After a little math and rounding, I came to the conclusion that I should mix 65 grams of Aeropoxy to do the fins.

Just one more time I'd like to reiterate that you should always make sure that you have absolutely everything you are going to need within arms reach before you start mixing epoxy. I enlisted my dad to help me with getting this all setup, as I had been taking pictures. If you have someone who can help you with your layup, then by all means, ask them to help you out. Two sets of hands in situations like these are FAR superior to one, not to mention the many benefits in having an extra set of watchful eyes to keep a lookout for things that you may not notice. For example, the cheap chip brushes I got from my local hardware store kept leaving bristles in my epoxy. Luckily, my dad was more attentive than I was, and managed to pull them out before we vacuum bagged them.

We started by laying out quaint little beds for each fin to lie on. We first put down our release fabric, then our carbon fiber cloth. This gave us a simple solution for getting the epoxy spread evenly on both sides of the fin. After laying out our little piles, we put on our rubber gloves and weighed out each portion of the epoxy and mixed it up. We officially got the ball rolling by taking one fin at a time, and painting on a generous layer of epoxy. The goal here is not to soak the fin in epoxy, but to apply an adequate layer that will soak into the carbon fiber cloth and completely wet it. If you are not completely sure how much epoxy you should be using, you can always place the fin on the cloth, and flip it over, then use the chip brush to dab the cloth onto the fin

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Painting on the epoxy

Photo 2: Applying epoxy to the other side of the fins.

and pull the epoxy out from underneath. Again, it should absorb into the cloth and leave it adequately wet, but not be so wet that the excess is running and dripping.

After you have done so, place the fin carbon side down on your release fabric. Once you have done all of your fins this way, it's time to start applying epoxy to the other side of the fins. This part is easier, as the fins are already seated and they aren't going anywhere. All you have to do is paint the epoxy on while they sit there, then carefully place your cloth on top, ensuring once again that your cloth is going to be properly wetted. A pro tip here is to use your brush to drag epoxy over the edges of the fins, allowing it to soak into the excess cloth as well. This will make your life a whole lot easier down the road. After doing so, simply place the release fabric on top. Congratulations, your sandwiches are nearly ready and you've completed step one.

Step two begins with adding our breather fabric to the "sandwiches" that were made is step one. The breather fabric I use is simple paper towels. I take two or three half sheets, fold them over each other, and put one on each side. When doing this, be careful not to slide your carbon fiber cloth around on your fins, otherwise you are going to be frustrated with the result. Now it's time to get down to the meat and potatoes. When actually bagging them, it is up to you how many fins you want in one bag. I did two fins in each bag, as smaller bags allow the Foodsaver to vacuum out all the air faster. When sliding your fin sandwiches into the bag, be very careful not to get the fins too close and accidentally overlap pieces of carbon fiber. The end result can be two fins stuck together by the excess carbon fiber. While it's very unlikely, it's still not a fun thing to deal with, so as always, pay close attention to what you're doing.

Once your sandwiches are inside the bag, line up the edge of the bag with the vacuum channel inside the Foodsaver (you can do so by lifting the lid), press the lid down, and press the "Vacuum and Seal" button. This will remove all the air from the bag, creating the desired constriction, and will melt the two side of the bag together, ensuring that air will not get in until you are ready for it. After you have sealed all your fins in bags, clean up your mess and pat yourself on the back, because you've just completed your first vacuum-bagging project with a Foodsaver!

Photo 3: Completing the vacuum seal.

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The "green stage"...

Or so you thought. You should let your epoxy get to its "green" stage. I've yet to see a laminating epoxy that actually visibly turns green, but essentially, it means the epoxy is mostly cured, but still flexible. With Aeropoxy, it's pretty safe to just wait about 24 hours. After that, you're safe to pull out your fin sandwiches and remove your breather and release fabrics. What you'll be looking at is your cloth with all the excess epoxy forced through the release fabric and into breather fabric. Your composite cloth will be impregnated perfectly with resin, and if it's carbon fiber, you'll likely be disappointed by the fact that is looks like a matte finish and it's not shiny whatsoever. That's not something to worry about, as it takes a lot of effort to get your carbon fiber looking shiny.

Photo 4: Opening your "sandwiches".

However, the thing you should be worrying about is cutting off the excess cloth around the edges of the fins. When the epoxy is in it's "green stage", I simply use a fresh #11 X-ACTO blade and go around the edges. You usually do not run into any issues, so long as you heeded my above warning about wetting the excess cloth well. When the excess cloth is thoroughly wet, you will be able to get that X-ACTO blade through it like butter, and it will leave nice clean, easily sandable edges. However, if you do not wet the excess cloth, you'll get the lovely frayed hairy edges of

Photo 5: Cutting out your fins.

doom. When you try sanding those, you'll be itchy for days. A million little carbon fiber or fiberglass fibers flying around and landing on your arms is the last thing you want. Trust me on that one. Once you have cut down the excess cloth, simply sand down to the fins and voila, you've got yourself some nice bagged composite fins.

These fins are not for added strength; they're going on this rocket for looks and nothing else. That is why I decided I was going to make them as high sheen as I could, while also continuing to live my lifestyle as a lazy person who absolutely hates sanding. I started by adding another coat of epoxy to my fins after letting the Aeropoxy dry for 48 hours. This time, I used West Systems epoxy, because it was readily available, and because of the pump system that automatically gives you the perfect amount of harder and resin to mix, making it easier. On top of all that, I may just be crazy, but West Systems epoxy seems to be clearer than Aeropoxy, which in my mind meant it was better for decoration. It also dries a bit quicker. I applied one coat, let it dry completely, and then wet sanded it with 320 grit sandpaper.

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Learn from my mistakes

However, I made a grave mistake. Something prompted me to put the fins on wax paper while the second coat of epoxy was drying. Once it was dry, I removed the wax paper and revealed to myself a lovely array of mountain ranges in the epoxy from the crinkled wax paper. I had created for myself my very own enemy. Sanding, and lots of it. I went ahead and sucked it up, sanding and sanding with my 320 grit sandpaper, until I finally reached the point where I went “Meh, that’s good enough”. My advice to you: If you are going to add more epoxy to make your carbon fiber beautiful, learn from my mistake - brush on the epoxy, and hang those fins up somewhere. Do not set them down on anything. The idea with these layers is just to add enough to “shellac” the actual carbon fiber cloth. You’re basically putting a thin layer of viewing glass over the top of your vacuum bagged work, so it’s best not to go too crazy and put too much epoxy on. Just brush enough on to get it looking wet, allow it to dry, and sand it smooth. I ended up doing four coats of epoxy. You likely wouldn’t need this much, but since I had a lot of fun little pinholes and bumps to try to correct, I needed quite a few. I wet sanded between coats with 320, 400, and 600. Finally, I finished off with 800 and 2000 grit sandpaper, then applied three coats of Krylon clear coat over top of them. The end result is nowhere near as professional looking as some of the amazing carbon fiber work I’ve seen in my high power career, but it is satisfactory to me.

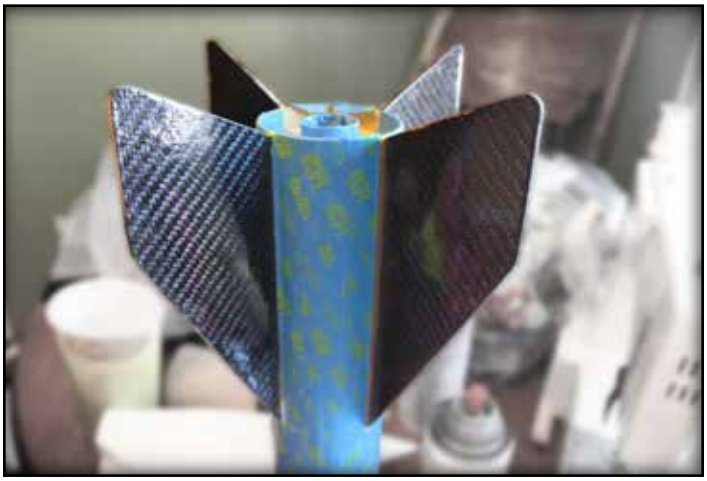

Photo 6: Getting closer.

This is an ideal time to add a disclaimer. If you are planning on using this, it’s imperative to pay attention to your center of gravity location. Five coats of epoxy, carbon fiber cloth, and three coats of clear paint added quite a bit of weight to the tail end of this rocket. To compensate, I have added weight to the nose, and did away with the old school Estes tri-fold shock cord mount method. Instead, I added a one-eighth inch tubular Kevlar harness to the top of my motor mount to anchor the shock cord to. It may not have added a ton of weight, however it did add enough for me to be concerned about ripping the shock cord out in the event of a late parachute deployment. I honestly just

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The finished product

wouldn't advise using the paper and glue shock cord mount on these bigger Estes rockets anyway. Now, back to the composites.

This method of cheap vacuum bagging also works quite well for tip-to-tip layups on smaller rockets. Depending on the size of the fins, you could potentially fit up to a three-inch minimum diameter rocket in one of these Foodsaver bags. That was actually my original intended purpose for purchasing this carbon fiber and the Foodsaver. However, it did not take me long to realize that I'm not an extreme altitude kind of guy. While I do love seeing high altitude flights, I decided that I do not have a strong enough heart to send all of my electronics, my rocket, and my motor case ten times higher than I can see from the ground. Nonetheless, it can be done with a Foodsaver. It would simply require a bag large enough to fit the whole fin can inside of, and from there, you'd be on your merry way.

All said and done, this rocket turned out good enough for me, and it looks quite nice in pictures and from about ten feet away. Again, that's nothing to do with this layup method, and everything to do with my mistakes. I hope this helps some people looking into the world of composites and vacuum-bagging get into it, as it is a very neat hobby to have, and it is a very beneficial skill to have in the world of high power rocket construction. I'd like to give a small shout out to Alex Laraway for letting me pick his brain through the process of learning composite layups. He was a big help! I truly hope this article inspires those who have yet to give composites a shot. This method is an extremely cost effective way to get into it. If you don't want to spend the money on expensive epoxies and carbon fiber cloth, fiberglass cloth is a great place to start, as well as smaller, more affordable bottles of hobby grade laminating epoxies. In the end, if you're satisfied with the result, then you have done something correctly!

Photo 7: The finished product.

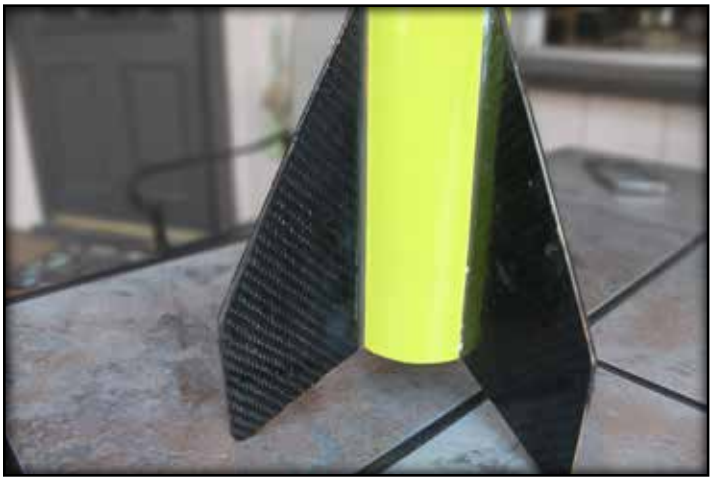

Photo 8: Close up of the fins.

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