Carbon Fiber Composites Starter Kit

This Gozilla Carbonworks CF Composites Starter Kit has been put together by carbon fiber professionals with years of experience in carbon fiber composites. The materials used are the best available and as such this kit is designed for amateur and professional, including use by those new to composites altogether. The following pages should give you the essential, practical advice you need to produce your own carbon fiber parts or improve your skills with proven workshop techniques.

Kit Contents

- Real carbon fiber fabric
- Laminating epoxy resin
- Epoxy hardener
- PVA mold release agent
- 1” laminating brush
- Latex gloves, Mixing pot and Sticks

Uses for This Kit

- Experiment with making carbon fiber products
- Reinforce an existing product
- Repair a carbon fiber product such as a fishing rod, yacht mast/ boom, vehicle bonnet etc.
- Satisfy an urgent or small requirement for carbon fiber and resin in a professional composites workshop.

Principles of Wet-Lay Carbon Fiber Lamination

Using this carbon fiber laminating kit you will be producing carbon fiber parts using a process described as ‘wet-lay’ lamination. This is because you will be using liquid epoxy resin to ‘wet-out’ the dry carbon fiber fabric, allowing the resin to flow in and around the carbon fibers. The carbon fibers are described as the ‘reinforcement’ and the resin is the ‘matrix’. Once the resin cures, it is the combined properties of the carbon fibers and the epoxy matrix (together, a composite) that make the material so strong.

When you laminate a product you will be putting carbon fiber down onto the inside of a mold. When the product is removed from the mold it is the material that was in contact with the mold that becomes your ‘finished’ side meaning that the important part (to create the best looking product) is how the first layer of carbon fiber is laid down into the mold. Subsequent layers of carbon fiber or other reinforcement will not be visible on the surface of the part.

Choosing or Making a Suitable Mold

Before you can make your first carbon fiber part you will need to find or make a suitable mold. This could be as simple as a sheet of plastic if you were making a flat sheet or a complex molding made from fiberglass in the case of a more detailed part. Whatever you use as a mold for your part you will need to be sure that its surface finish is as good as you want the finish on your part to be and that you prevent the carbon fiber part from sticking to it.

Molds for Experimentation or Simple Shapes

A good place to start for experimentation or relatively simple parts with pieces of plastic (such as polypropylene) jointed together to make your basic shape. Joint lines can be improved by 'beading' plasticine in a radius along the joint line, ensuring that when the part is removed from the mold it will have smoother corners.

Alternatively, if you can find a plastic or metal part that is already the right shape (or a part of it is) then that too will make a great mold for your part. In our workshop we have used conveniently sized Tupperware containers and even curry bowls to make one-off parts like covers and even speaker- pods.

Molds for Production Parts or Sophisticated Shapes

Commercial laminators generally use fiberglass molds when producing wet-lay carbon fiber parts. Fiberglass molds can be made into any shape and can be extensively polished inside so that the carbon fiber parts come out of the mold with a high-gloss surface finish.

Information on how to make a standard fiberglass mold is readily available on www.godzillacarbon.com to point you in the right direction. When making a fiberglass mold for use with the Carbon Fiber Laminating Starter Kit you should always use good quality epoxy resin to ensure maximum compatibility with the carbon fiber part and release agent and is free from dust and protected.

Step By Step Practical Guide

Before starting to make your first part we suggest you:
- Ensure you have enough space to work, that the work area is free from dust and protected with newspaper or similar if necessary.
- Have to hand a set of scales, a hair-dryer, a set of sharp scissors and some lint-free cloth.
- Have something suitable to use as a mold.

Stage 1 – Apply Release Agent to the Mold

The first step is to prepare the surface of your mold to prevent the carbon fiber part from sticking to it. Included in the kit is a small container of PVA Release Agent. Alternatives to this include mold release wax or nothing at all in the case of a mold surface that epoxy resin will not stick to (like polypropylene plastic). To make sure, we suggest using the PVA included in the kit no matter what your mold is made from.

Start by pouring about a capful of the release agent onto a lint-free cloth. By using a lint-free cloth (available from most supermarkets, hardware stores etc.) you will avoid any small flecks of the cloth from contaminating the coating of release agent.

Start wiping the release agent over the surface of your mold gently using the cloth. The green coloring in the release agent is there to help you see where you've been and how thick the coat of release agent is. Ideally, you're looking to have a thin but consistent cover of the release agent all over the surface of the mold. You will need to top-up the release agent on your cloth as you go.

Under no circumstances allow any of the mold's surfaces to be uncoated otherwise you will experience the dreaded 'sticker' where your part will be stuck fast to the mold.

Once you have coated the part thoroughly (ensuring you have worked the agent into any awkward corners) set the mold to one side and leave it for about 20 minutes until dry to the touch.

Apply a small amount of release agent to a part of the mold that will not be used in the finished part. That way you can do your touch-test for dryness without risking marking the PVA on the mold's working surface.

Stage 2 – Mix Epoxy Resin and Hardener for the Surface Coat

Put on a pair of the Latex gloves. Use the scaled mixing pot to measure 2 parts of the epoxy resin with 1 part of the epoxy hardener into the same pot. For example, 10ml of hardener should be mixed with 20ml of resin. Try to gauge enough total resin to give the inside of your mold one thin coat of resin.

Using one of the mixing sticks stir the resin and hardener together thoroughly. In this process, spend a good few minutes mixing the two parts, particularly as at colder roomtemperatures they may be very thick. Ensure you mix all the resin and hardener from the edges of the pot as unmixed parts will not cure and will ruin your finished part.

Specification:
Work life : 30 minutes at 70°F
Cure time : 24 hrs at 70°F reduce cure time – heat to 100°F

Stage 3 – Apply the Surface Coat of Epoxy Resin

EXPLAINATION: In this next step we mix some epoxy resin with epoxy hardener to make a surface coat for our part. The surface coat will provide a thin-layer of clear resin on the surface of our part without any carbon fiber reinforcement in it. The reason we do this is to create a part with a smooth, glossy finish free from any fibers touching the surface meaning that any polishing or repair work we do to the surface of the part will not break through to the fibers and detract from the glossiness of the part.

The second reason for this step is to create a tacky surface which we can press the carbon fabric onto, holding it in-place whilst we wet it out with resin, hopefully preventing it from lifting away(or bridging) from the surface of the mold and creating what we is known as voiding.

Next, still wearing the Latex gloves and using the 1” laminating brush, apply a thin and even coat of the mixed resin to the surface of the mold. Ensure that you get the resin into any awkward corners of the mold but be very careful that you don’t end up with thick pools of resin in these areas otherwise the finished part will have visibly ‘milky’ corners where there is a thick layer of resin obscuring the carbon fiber beneath.

Once you have applied this coat, set the mold on one side and leave for between 1 1⁄2 and 4 hours depending on the temperature of the room you’re working in. The resin will cure quicker in a warmer room and slower in a colder room. Keep checking until the resin in the mold is slightly firm and tacky. If your glove sticks slightly to the resin without any of it coming off on the glove then the level of tack is about right.

Tips

In a workshop, resin is cleaned from brushes and other laminating equipment before it cures using acetone. As a hobby laminator, your best access to something similar would be a large container of nail polish remover which is essentially the same thing. We would include it in the kit but its volatility makes it dangerous to ship. Use liberal qualities of the nail polish remover in a pot to rinse the brush and any other equipment clean so it can be used again. Alternatively, wrap your brush in some plastic film and keep it in the freezer. The low temperature will prevent the resin from curing so that you can simply defrost it and use it next time you’re laminating!

Stage 4 – Cut the Carbon Fabric

We are now ready to start working with the carbon fabric itself. If you haven’t already done so, carefully remove it from the tube and lay it out on a clean flat work surface. Never lay fabric onto a work surface with any dust, uneven or rough surface or contaminants on as this is the easiest way to ruin a product. Dust or dirt will cling to the fabric and be visible on the surface of your part and a rough surface (such as one with resin spatter or splinters on) can snag the fabric and distort it.

Work out how much fabric you will need to cover the surface of the mold. You can do this beforehand using a paper template for complicated shapes or for simpler shapes we can make a guess, always aiming to be slightly oversize as a margin for error.

Stage 5 – Lay Carbon Fabric into the Mold

It’s now time for the all-important laying of the carbon fabric into the mold. This is only critical the first time you do it as subsequent layers will not be visible in the finished part, they will only provide additional thickness and stiffness.

Drape the fabric very loosely over the tacky mold surface, allowing it to contact as little as possible. Once in position start to apply a very light pressure to the fabric in the center of your mold and then work your way out ensuring that there is enough fabric available as you do so as to avoid ‘bridging’ any contours in the surface of the mold. This is one of the important techniques to master and when you first make parts this is likely to be where your imperfections will occur. Once the fabric has been pressed to the tacky epoxy resin on the surface of the mold any subsequent attempt to move it will disturb the fibers and detract from the cosmetic finish of the part.

Keep working your way out gently until the fabric has been laid flat down onto the whole surface of the mold. If the fabric is starting to grip at the edges before you get there, use your spare hand to keep the fabric from touching the edges of the mold as you work your way from the center to the edges, effectively 'feeding in' the fabric with your spare hand.

The 2/2 twill fabric included in the laminating kit is especially good at draping round contours and can be manipulated to follow most shapes without the requirement for cut lines. If you can't get the fabric round without cutting and jointing it then it is acceptable to cut and overlap the fabric as required but avoid this where possible for the sake of the cosmetic appearance of the part.

Stage 6 – Wet-Out Fabric

You are now ready to 'wet-out' the dry fabric using the some more mixed epoxy hardener and resin. Use the same ratios of hardener to resin and mixing technique described in Step 2. You will need at least twice as much resin for this next step as you used for the surface coat.

Again, using your 1" laminating brush (either cleaned with acetone/nail polish remover or stored in the freezer) start to apply the mixed resin to the dry carbon fabric. Aim to apply just enough to thoroughly wet out the fabric without flooding it. The ultimate finished part (from a strength perspective) will use as little resin as possible whilst still fully surrounding all fibers with resin.

Use the brush to press the resin into the fabric, don't use it like a paint brush as this might drag the carbon fiber with it and distort the weave on the surface. Continue this stippling action to work the resin well into the fabric, ensuring that you get it well into any difficult corners or contours. Don't be afraid to use your finger to press the fabric into any corners or contours as seems necessary.

At this stage you can use a hair-dryer or heat-gun to gently warm the resin, reducing its viscosity and allowing it to flow freely around the carbon fibers. Be careful not to overheat the part, this will accelerate the curing process unnecessarily and could damage the mold. You will often see tiny bubbles on the surface of the resin when you do this showing that any air trapped in and around the fibers has made its way out which is good news for the strength and finish of the part.

Stage 7 – Apply the Surface Coat of Epoxy Resin

EXPLAINATION: In this next step we add additional layers of carbon fiber reinforcement to the part. This is to build up its strength and could be anywhere from one to ten or more layers depending on the strength the finished part is required to have. It would be possible to make a part using no additional layers of carbon fiber but this would mean a very thin and flexible part. Additionally, adding additional layers of reinforcement will prevent light from being seen through the gaps between the carbon fibers on the surface.

Using the remaining resin you mixed for Stage 6, add the required number of additional layers of carbon fiber reinforcement using a similar method to that described in the previous section, although keeping the weave as neat as possible is no longer necessary since these layers of carbon fiber will not be visible on the surface of the finished part.

Stage 8 – Tidy Up and Leave to Cure

Once you have added all the additional layers of carbon fiber or woven glass reinforcement you want to your part, use your scissors to cut away any excess fabric from around the edge of the mold. You want to leave enough overhang to ensure that you have somewhere to grip the part when you come to release it, but remove any excess that could drape and possibly cause fabric to cure held away from the surface of the mold.

Tips

Use acetone or nail polish remover on your scissors after you have cut wet fabric with them to remove any traces of resin before it has a chance to cure.

Once you have trimmed the excess away, check over the part again to make sure that all the fabric is consolidated down and still sitting properly in all the awkward corners and contours. Take as long as you like to do this, as you will still have plenty of 'pot-life' left in the resin.

Once you're happy, set your part on one side somewhere safe to cure fully. Typical curing times will be around 8hrs at an ambient room temperature of 70°F. For colder conditions allow anything up to a full day or until the part feels fully hardened to the touch.

Stage 9 – Release Part

Don't ever attempt to release a part until it is fully cured, doing so will almost certainly damage the part. Once you're confident that the part is fully cured and ready to release (have a good tap at it with your nails) then begin by flexing the overhang away from the mold surface all the way around the edge of the mold. Be very careful to avoid the sharp splinters of reinforced carbon surrounding the part. Once you have done that, try gripping some of the overhang with your fingers and pulling the part free of the mold.

If it won't come away, repeat the whole process being more forceful until it does. As a last resort, plastic wedges driven into gaps between the mold and the part can be used, as can taps from a rubber mallet. It is worth noting that the part should come away from the mold quite easily and if anything more than light force is required then the PVA coat was probably not applied properly.

Cutting and Trimming the Part

Once released, the part can now be trimmed and finished.

Polishing and Care

Because the part was made by using a clear layer of resin as the surface coat before any carbon was put down, there is a thin layer on the part that can be polished without breaking through to the carbon fibers. This means that degree of rubbing back and polishing can be performed on the part to bring it to a high gloss (if the mold's surface was not high gloss already). This is useful for polishing up the ever so slightly matte finish that the PVA release agent can leave on finished parts or for polishing out scratches should the part become damaged in the future.

Fine polishing paste and rubbing compounds can also be used to polish the finished part and automotive car polishes and waxes are all perfectly safe to use on your part for the ultimate shine. UV resistant clear coat is also recommended for double protection of your shiny project.