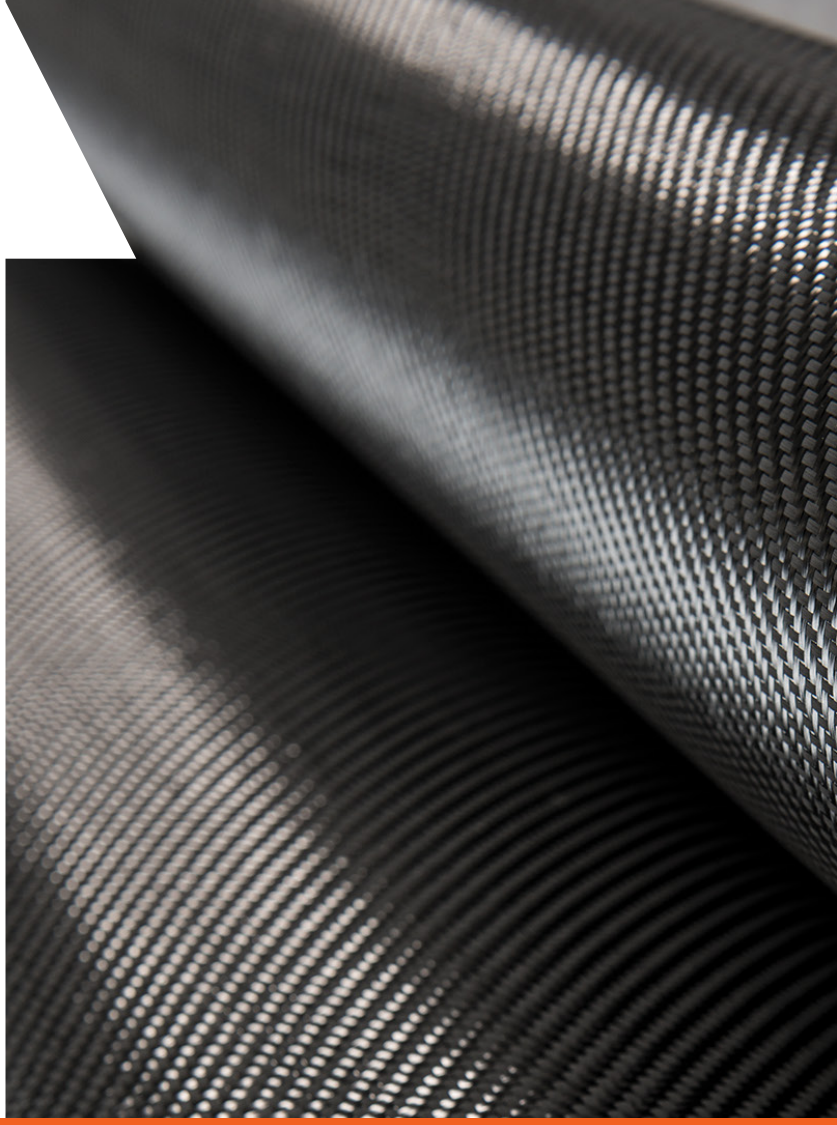
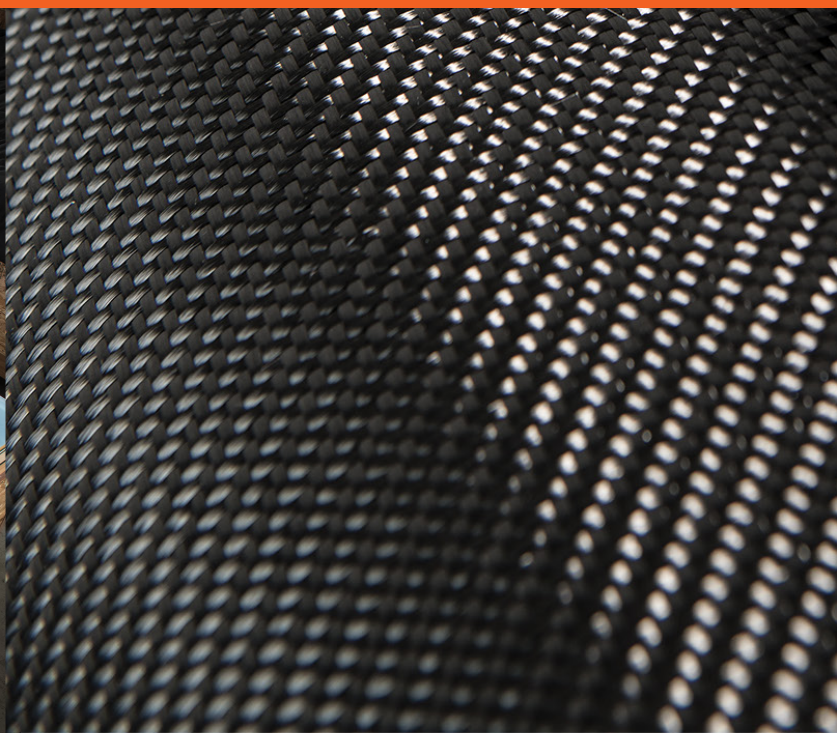
PROTECH
COMPOSITES



CARBON FIBER 101



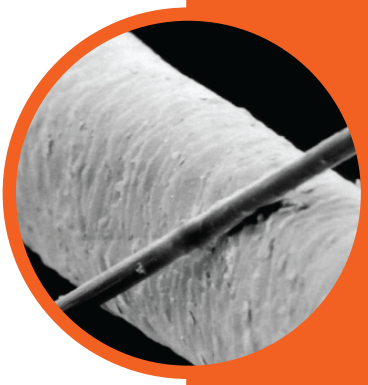
What is this stuff anyway?

Carbon fiber is a high strength, high stiffness, low weight synthetic fiber that can be used in a wide variety of aesthetic and structural applications. Carbon fiber composites are about 10 times stronger and 5 times lighter than steel, and 1.5 time lighter than aluminum. Together with the right resin systems, carbon fiber composites are extremely corrosion resistant.

Where does it come from?

Carbon fiber starts with a precursor polymer material called PAN (Polyacrylonitrile). It's a specialized plastic that is spun into extremely fine fibers. These fibers are washed and stretched to obtain the desired fiber diameter. This helps align the molecules within the fiber and aids in forming tightly bonded carbon crystals.

The fibers are heated to 400-600F in a process that adds oxygen molecules and rearranges the atomic bonding pattern in order to convert their linear pattern to a more thermally stable ladder bonding. After stabilization, the fibers are heated to 2,000-5,500F in an oxygen free environment to expel non-carbon atoms from the material. As non-carbon atoms are removed, the remaining pure carbon atoms form long chain tightly bonded crystals that are parallel to the long axis of the fiber. This is where the fibers get their great strength properties.



HERE IS A TYPICAL CARBON FIBER SHOWN AGAINST A HUMAN HAIR.

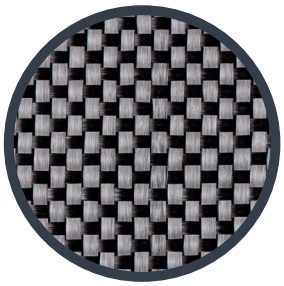
What happens next?

The fibers are collected into bundles of specific diameter called Tows and wound onto bobbins. Standard tow sizes are 1k, 3k, 6k, and 12k, but specialty products use tows that are 48k and higher. The K designation means “thousands of filaments per tow”, so the 3k for example has 3,000 carbon fiber filaments per tow and the 6k has 6,000 filaments per tow. This is the key to the strength of the material. All of those tiny filaments gathered together in a strand create a tow with amazing strength.

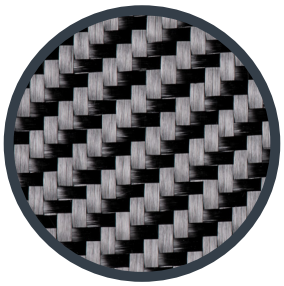
Yeah, but how does that become a carbon fiber sheet?

The tows are loaded onto a loom where they are made into a fabric. There are several types of fabrics. The most common are Woven (plain weave, twill, satin, etc.), Unidirectional, Multidirectional (biaxial, triaxial, quasi-isotropic, etc.), and Nonwoven (chopped or continuous strand mats).

Most of our products are made with woven fabric in either a plain weave or 2x2 twill configuration.



PLAIN WEAVE

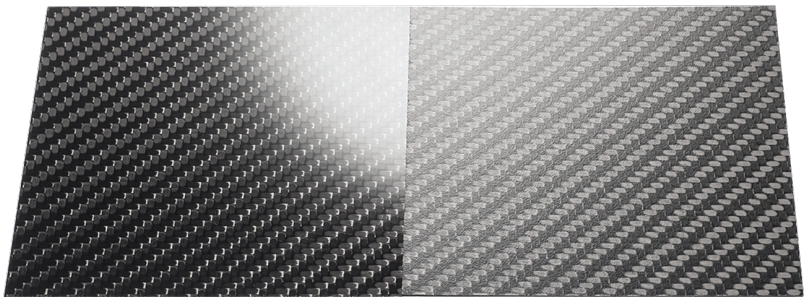


2X2 TWILL

At Protech Composites, we purchase carbon fiber fabric from weavers right here in the USA. Our primary production method is a vacuum infusion process which injects epoxy resin (matrix) throughout every tow and filament in the carbon fiber fabric (reinforcement). We use a UV stabilized epoxy as our matrix because of its low density and high compression strength as well as the clear crystal clarity it adds to our gloss panels. After curing, the epoxy adds rigidity to the strength of 3 the carbon fiber giving the end product incredible material properties. Carbon fiber sheets, panels and parts have immense strength, light weight, low coefficient of thermal expansion, are easily machined, and appropriate for an endless variety of applications.

How is the gloss finish applied?

It isn't really. The deep, crystal clear, gloss finish on our products is a result of the manufacturing process and not a secondarily applied coating. Protech Composites uses very flat, very smooth mold surfaces when making a gloss product. As the resin permeates the carbon fiber fabric, a thin layer contacts the mold surface and transfers that perfectly smooth surface characteristic to the carbon fiber surface. The result is a mirror-like gloss finish.

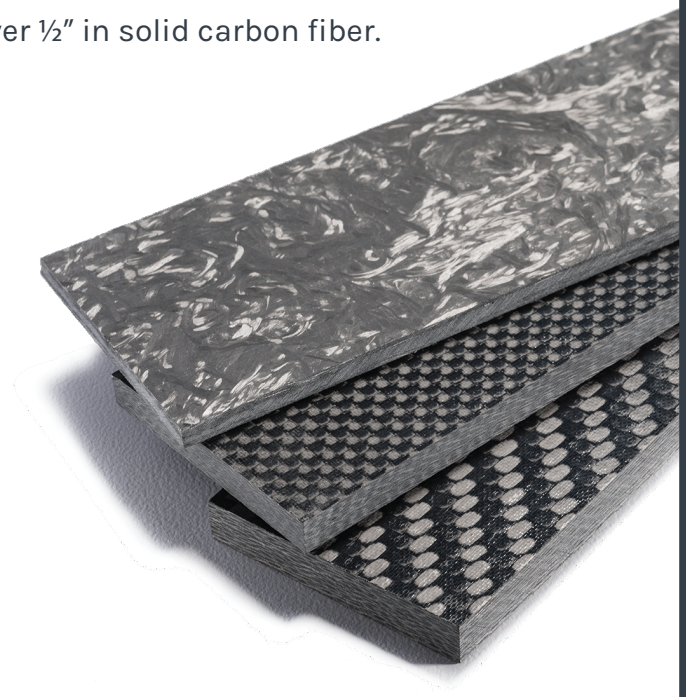


What's Pre-Preg?

Pre-Preg is a term used to describe a reinforcement, such as carbon fiber fabric, that has been pre-impregnated with a matrix, such as epoxy resin. The fabric is coated on one or both sides with an epoxy matrix that cures when subjected to heat. Pre-pregs are typically shipped and stored frozen to prolong the shelf life, and thawed to ambient temperature for production.

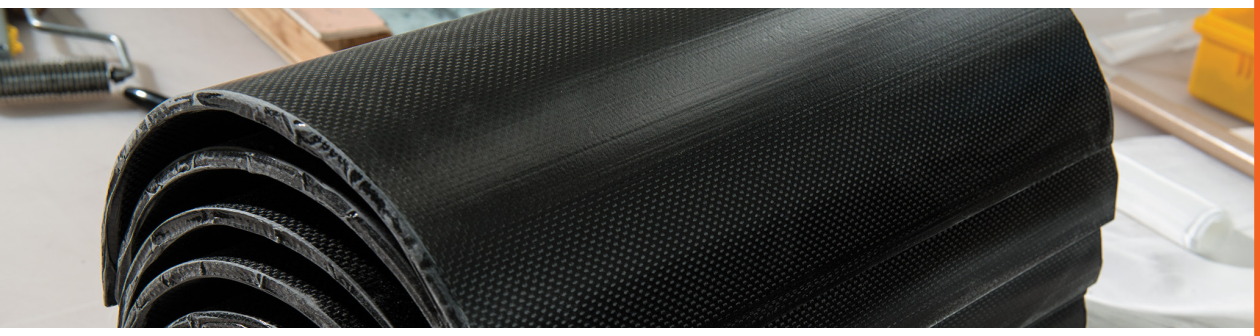
How thick are the carbon fiber sheets?

We make our 100% carbon fiber sheets and panels to specific thicknesses by layering the fabric. For example, one layer of 3k fabric produces a very thin veneer about .25mm (.01") thick, while one layer of 6k fabric makes a sheet about .5mm (.02") thick. The layers compress as the thickness increases, so it takes 8 plys of 6k to create a 3.1mm (.125") panel. Most of the panels we make are ¼" or under, however we can go well over ½" in solid carbon fiber.

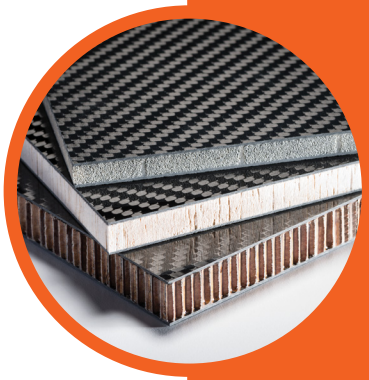


Are they flexible?

Yes and no. The thicker the panel the more rigid it becomes. Also remember that a thin carbon fiber sheet will only bend in one direction at a time, much like a sheet of construction paper. You can roll it into a tube, but it won't stretch around a ball. The sheets are not thermoplastic, meaning it is not a material that becomes pliable or moldable above a specific temperature, and returns to a solid state upon cooling. In terms of flexibility our thinnest veneer which is .25mm (.01") thick, will wrap around a 1" pipe. The .5mm has a flex radius of approximately 4", and the 1mm (.04") about 12". Above that thickness the flexibility reduces significantly.



For a product with extremely low flexibility a sandwich panel made with a Nomex Honeycomb, foam, or balsa core might be the answer. They are extremely rigid and amazingly light weight.



Ready to discuss your next Carbon Fiber project?

Learn more about our process and our products at:

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