

MANUFACTURING OF E-PROPS PROPELLERS

The E-PROPS propellers are fully made in France (South-East, Provence, near the city of Sisteron).

E-PROPS parts are designed and manufactured to be very light and very strong at the same time.

Materials and manufacturing process are validated by many tests and are following a strict quality system.

1- E-PROPS MANUFACTURING PROCESS : RTM

All E-PROPS parts, blades, hubs and spinners, are made with manufacturing process called RTM (Resin Transfer Molding).

This process is used by major companies as AIRBUS and BOEING for some critical ultra-light carbon parts on liner aircraft.

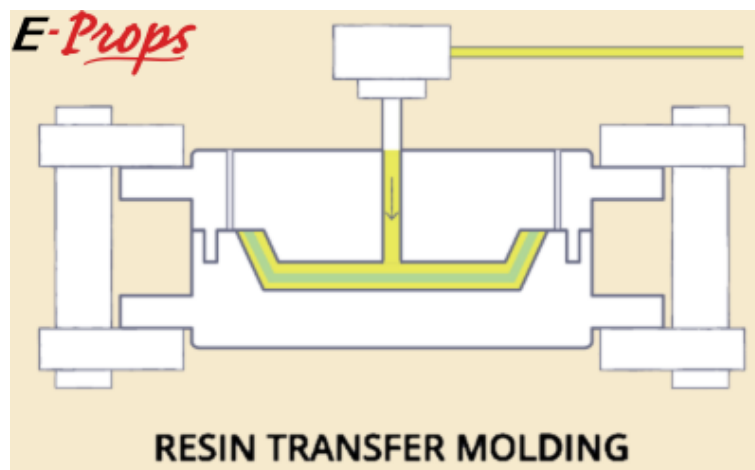
RTM is one of the best methods for mass production of composite parts.

It is primarily used to mold components with large surface areas, complex shapes and smooth finishes.

There are several benefits to using the Resin Transfer Molding process over the alternative processes available. Some key benefits include :

- Very good surface quality
- Very high fibers ratio
- Wide range of reinforcements
- Large or long and complex shapes
- Low environmental impact
- Labor savings
- No direct contact with the materials, far better for the operators' health

RTM process is realized by following a strict cycle of temperatures. The cooking of carbon parts allows to improve certain properties, in particular mechanical and of resistance under very hot conditions.



To assure a strict quality control and the reproducibility of the production, the components are exactly weighed very throughout the manufacturing. For example, 7 weighings are necessary for a propeller range Ultralights / Aircraft.

E-PROPS ensures the production monitoring by RFID and KANBAN method. These methods and tools optimize the manufacturing quality, reassure and fluidify the supplies, allow the real-time follow-up of the production process, the traceability of all the manufacturing steps, and offer a set of successful and reliable indicators.



E-PROPS : production monitoring by RFID and KANBAN

Two 8-axis machining centre have been built by the E-PROPS team to allow the dimensional analysis, the rectification and the finish of the carbon parts automatically, without dismantling of the part. They are equipped with a directional spindle programmed according to the digital definition of the part, with a wide tool store. The precision of measure by the scanner laser is of 5/100th of millimeter. The scanner sweeps the carbon part, the program recognizes it according to its database, then the different tools come to make all the finishing work: deburring, cut, drilling, sanding and polishing. All the stages between the molds and the stock are automatic.

Carbon parts built with the RTM process then finished with a precise CNC centre, as E-PROPS propellers, are far superior to conventional "half-shell" fiberglass parts in terms of structural properties, quality, lightness and aesthetics.

2- CARBON BLADES

All E-PROPS blades are made in CARBON BRAID + EPOXY RESIN.

- CARBON BRAID, HCF process.

Carbon has an excellent compromise of rigidity/weight.

The use of a single material (carbon) is far better than the use of two materials, such as a mixture of fibreglass and carbon (often used to save carbon which is much more expensive than fibreglass). Propellers with a single base anisotropic material have an illimited potential (manufacturer recommended duration of use), as wooden propellers.

The HCF process (Helical Continuous Fibers), specifically designed by E-PROPS, ensures an exceptional strength of the 100% carbon + epoxy resin blade, from leading edge to trailing edge, from blade's foot to tip. To the contrary of the usual process called "half-shell", used by most of the manufacturers of composite propellers, the carbon fibers are continuous between the top and bottom surfaces. The braid is made like a sock. The mechanical strength is increased and becomes very high : no risk of rupture by delamination of the leading edge, no craks on the blades or on the hub.

To make very strong carbon parts, the most important is to have the maximum of fibers and the minimum of resin; it means a high fibers ratio.

Fibers is 50 times more resistant than resin.

Examples of tensile strengths :

- carbon : 4.000 MPa
- epoxy resin : 80 MPa

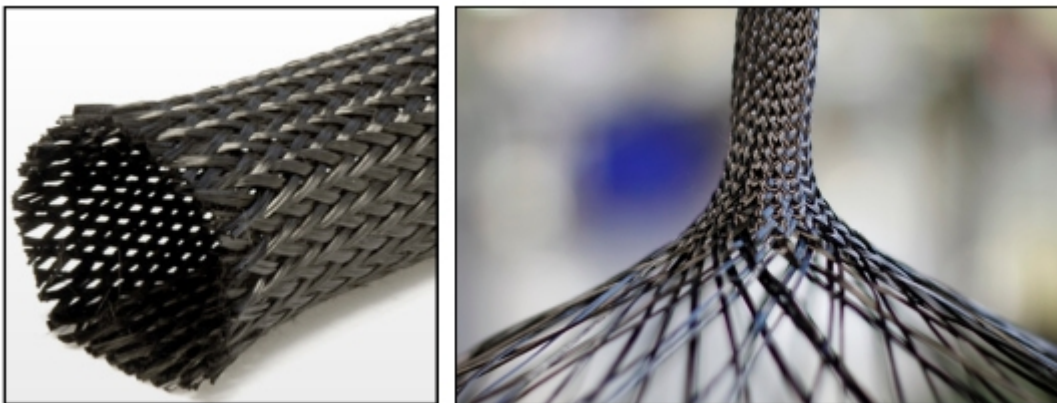
Parts made by E-PROPS have a very high carbon fiber ratio : **63%** (which is exceptional).

For example, a 2 glued half-shell blade has a fiberglass fiber ratio of about 30%.

The gap is very important, because of the ratio, and because the carbon fibers are more resistant than glass fibers :

Values of tensile strengths :

- fiberglass : 2.600 MPa
- carbon : 4.000 MPa

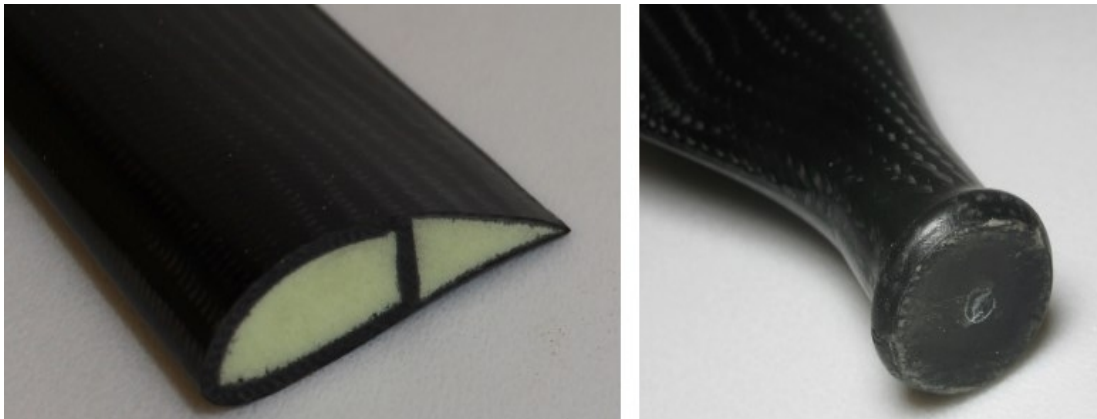


- The EPOXY RESIN is the resin preferred in aeronautics because it has :
 - * a very good mechanical and thermal properties
 - * a very big resistance to fatigue
 - * a good dimensional stability
 - * a chemical good performance
 - * and above all, an excellent adhesion on carbon fibers

The epoxy resin used by E-PROPS is including a high resistance to UV additive (UVA and UVB).

Details of the blades manufacturing :

- Foam core with internal spar (D-Box)
- On ultralights/LSA range : blade's foot with titanium ring inside
- 100% carbon, no metallic part = no galvanic corrosion
- Internal protection of the leading edge : injection of a special resin with Nanostrength®
- External protection of the leading edge : Titanium of 5/10th thickness and length 40 cm (on propellers diameter 170 cm)
- Unique ref number on each blade for a perfect traceability (RFID chip inside)
- Set of blades are balanced together, with a strict tolerance of static moment



D-Box (spar) in the blade / blade foot



Titanium leading edge protection

The material of our propellers, carbon braid according to HCF process (Helical Continuous Fibers) + epoxy resin, without parts in other materials, is anisotropic. Also, like wooden propellers, E-PROPS propellers have an unlimited potential.

3 – CARBON HUBS and SPACERS

The E-PROPS hubs are made in CARBON FABRIC + EPOXY RESIN.

Carbon fiber fabric has several advantages including high stiffness, high tensile strength, low weight, high chemical resistance, high temperature tolerance and low thermal expansion.

E-PROPS is only using carbon fabric produced by major companies working for aerospace industry : their materials are more expensive, but the quality is far better, with a good traceability.

The RTM manufacturing process is also used for the hubs.

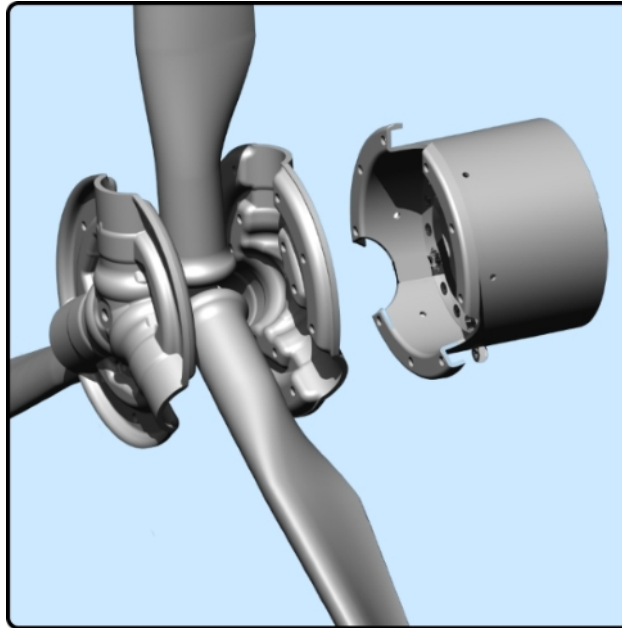
Those parts are extremely strong and very light.

Details of the hubs manufacturing :

- 100% carbon fabric, without metallic part = no galvanic corrosion
- Unique ref number on each part of the hub, for a perfect traceability (RFID chip inside)
- Hub is balanced together with the set of blades, to avoid vibration of the whole propeller
- Hubs are polished for a perfect finition.



the 3 parts of the hub + spacer



hub and spacer / 3-blade propeller

4 – SPINNERS

The E-PROPS spinners are made in CARBON FABRIC + EPOXY RESIN. The RTM manufacturing process is used for the spinners. Those spinners are very light and very robust.

Details of the spinners manufacturing :

- 100% carbon fabric
- Unique ref number on the spinner and on the flange, for a perfect traceability (RFID chip inside)
- Spinners + flanges are balanced together. If necessary, a screw is fixed on the flange to make a perfect balancing (this screw must not be removed)
- Spinners are polished for a very good finition. No paint, no varnish.

Finish :

You can paint the spinner if you want. All you have to do is to sand the surface, very lightly (600 grain sandpaper). The recommended paint is a bi-component polyurethane. A well sanded primer is necessary for a beautiful finish. Be careful to the balancing.



