"Out-of-autoclave" CF monocoque sports car cockpit chassis

The Australian designed and built FR-1 has become a reality after nine years and over Aus$ 1 million invested to produce this one-off high-performance concept car. This unique, hand-built two-seater roadster sports car has many innovative engineering and design features. These include a new lightweight carbon fibre composite monocoque cockpit chassis.

By

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The new carbon fibre composite monocoque cockpit chassis, the first ever built in Australia, was designed and moulded "out of autoclave" at only 70°C from GMS EP270, an epoxy prepreg with a 200gsm 3k twill carbon fibre base fabric. This unique epoxy/carbon cockpit chassis, with approximate dimensions of 2 metres by 1.5 metres, weighs only 80 kg but still provides the high torsional rigidity needed. This has been achieved by design optimization in the number and orientation of the carbon fibre plies used. The high mechanical performance of the fabricated chassis laminate has been independently tested, correlated and analysed using finite element analysis (FEA) by the Australia Future Fibres Research & Innovation Centre (AFFRIC) at the Deakin University of Melbourne.

Over 90 sponsors

Unusually, the entire FR-1 concept car project is run by a charitable foundation called Autohorizon, whose aims are to demonstrate the engineering, design and manufacturing expertise available in Australia today and to inspire Australian school and college students to become the engineers and designers of the future. The FR-1 project has over 90 sponsors, including the Victorian Centre for Advanced Materials Manufacturing (VCAMM), Holden, Boeing Aerostructures Australia, the Automotive Centre of Excellence (ACE) in Melbourne where the concept car was built, and GMS Composites, who manufactured and supplied the GMS EP270 carbon fibre prepreg system for the project. FR-1 has been a fantastic engineering project, bringing together leading automotive designers and material technologies in Australia. It gave GMS Composites the opportunity to demonstrate the application performance that can be achieved with their low-temperature, out-of-autoclave advanced carbon prepreg system.

Different epoxy prepreg options

The VCAMM/Autohorizon/Boeing engineering team which has worked on the FR-1 project designed and built the FRP cockpit chassis and the glass fibre mould tooling. They looked at a number of different epoxy prepreg options; GMS EP270 was selected from the onset due to a combination of several critical factors. Firstly, as the vehicle is a one-off,

More Information

GMS Composites is located in Melbourne, Victoria, Australia, where they have their main offices, production plant, R&D, and warehousing and distribution operations. The company has been manufacturing epoxy prepregs for over 12 years and now has an established range of over 10 different prepregs resins systems covering a wide range of industries including aerospace, motorsport, marine, sporting and leisure goods, ballistics and tooling. GMS Composites is part of GMS Industrial Pty. Ltd., whose origins in insulation materials date back more than 70 years, but today is a modern epoxy prepreg composites producer focused on supplying the rapidly expanding high-performance fibre-reinforced composites markets in Australia and Asia Pacific. GMS Composites also offers CNC machining services, plus distributes a number of insulation products and composite-related consumables, reinforcement materials, resins, cores and mould releases from leading global suppliers.

Fig. 1: The carbon fibre epoxy composite monocoque cockpit chassis was moulded out-of-autoclave under vacuum from GMS EP270 epoxy prepreg at only 70°C

they were looking for a cost-efficient low-temperature tooling and production process, and for a material which they could obtain in small volumes. Secondly, they needed a material which, once post-cured, would provide the dynamic strength and stiffness properties required in the monocoque cockpit chassis for a sports car powered by a Holden 6.0 litre V8 with a Ferrari 355 transmission. GMS EP270 with a carbon fibre fabric fitted the bill perfectly, being a high-performance out-of-autoclave epoxy resin prepreg designed for low-temperature moulding under a vacuum at as low as only 70°C, using glass fibre tooling. GMS Composites has the manufacturing flexibility to supply even small volumes of the prepreg system in a choice of carbon fibre, aramid or glass fibre reinforcements. In addition to moulded FRP parts, GMS EP270 can also be used in the construction of composite sandwich structures as well as for tooling applications.

Fig. 2: Demoulding the epoxy/carbon composite monocoque cockpit chassis

Production expertise

Having completed the design and material specification phase and built the mould tooling, the FR-1 project team then used the production expertise of Boeing Aerostructures in Port Melbourne to assist with layup, moulding and to fully cure the carbon fibre prepreg, as well as bondingthe chassis using an aerospace-grade high-performance Araldite® structural adhesive. Jason Bonar, who has been with Boeing for over 18 years, worked with the Autohorizon team on the moulding and layup of the chassis, which included eight 16-hour cure phases and a final post-cure, all done out of autoclave under vacuum at 70°C. During production, the GMS EP270 prepreg offered the benefit of being very easy to work with, conforming accurately to the tight and detailed tool. The finish and integrity of the final product was outstanding. For some years now, in order to drive down capital and operating costs, as well as to gain greater production efficiency and flexibility, many leading OEM and tier 1 manufacturing companies in the aerospace industry have now approved and specified a number of primary and secondary structural composite parts manufactured from out-of-autoclave composite prepreg materials.

Out-of-autoclave prepregs have the added benefit of simpler and significantly lower tooling costs. While exact figures are not given out by Boeing Aerostructures, out-of-autoclave composite part manufacturing costs are estimated to be a factor of four times lower, with tooling costs typically reduced by over 50%. ■

More information:
www.gmsindustrial.com.au
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Fig. 3: FR-1 sports car finished cockpit with a carbon fibre composite monocoque chassis

Fig. 4: Race track testing the finished FR-1 roadster sports car