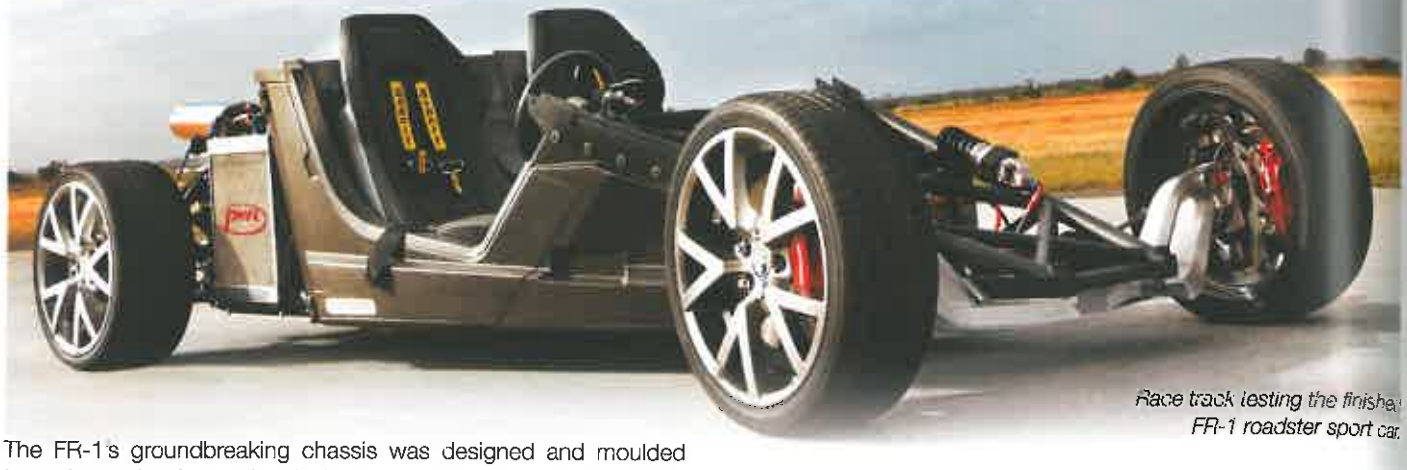
FR-1 – composite concepts

After nine years and over $1m of investment, the Australian-designed and -built FR-1 concept car has become a reality. The unique, hand-built high-performance two-seat sports roadster boasts many innovative engineering and design features, including a new lightweight carbon-fibre composite monocoque cockpit chassis, the first ever built in Australia.



Race track testing the finished FR-1 roadster sport car.

The FR-1's groundbreaking chassis was designed and moulded 'out-of-autoclave' at only 70 degrees Celsius from GMS EP270, an epoxy prepreg with a 200gsm 3k twill carbon-fibre base fabric. This cockpit chassis, with approximate dimensions of 2m by 1.5m, weighs only 80kg but still provides the high torsional rigidity that the car design demands. This has been achieved by design optimisation 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 FEA analysis, by the Australia Future Fibres Research & Innovation Centre (AFFRIC) at Deakin University, Melbourne.

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 FR-1 project.

"FR-1 has been a fantastic engineering project, bringing together leading automotive designers and material technologies in Australia," says Sam Weller, Managing Director of GMS Composites. "We are thrilled to have been involved and to demonstrate the application performance that can be achieved with our low temperature, 'out-of-autoclave' advanced carbon prepreg system."

The VCAMM/AutoHorizon/Boeing engineering team, which worked on the FR-1 project, designed and built the FRP cockpit chassis and the fibreglass 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, they were looking for a cost-efficient, low-temperature tooling and production process, in a material that they could obtain in small volumes. Secondly, they needed a material which, post cured, would provide the required dynamic strength and stiffness properties in the cockpit chassis needed for a sports car powered by a Holden 6.0-litre V8 with a Ferrari 355 transmission. With a carbon-fibre fabric, GMS EP270 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 degrees Celsius, using fibreglass tooling.

GMS Composites had the flexibility to supply the small volumes of the GMS EP270 prepreg system in a choice of carbon fibre, aramid or glassfibre reinforcements. In addition to being used for moulded FRP parts, GMS EP270 can also be used in the construction of composite sandwich structures as well as for tooling applications.

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 and moulding, and to fully cure the GMS EP270 carbon fibre prepreg, as well as bonding the 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 lay-up of the chassis, which included eight 16-hour cure phases and a final post cure, all done out-of-autoclave under vacuum at 70 degrees Celsius. During production, GMS EP270 prepreg offered the benefits of being easy to work with, conforming accurately to the tight and detailed tool. According to Bonar, the finish and integrity of the final product was outstanding.

"With respect to workability and surface finish, I found GMS EP270 prepreg to be on par, if not better, than any other prepregs I have used," said Bonar.

The first epoxy carbon-fibre composite monocoque cockpit chassis ever built in Australia is approximately 2m by 1.5m, with the torsional rigidity needed despite weighing only 80 kg.


The cockpit chassis was 'out-of-autoclave' moulded under vacuum from GMS EP270 epoxy pregreg at only 70 degrees Celsius.


Demoulding the cockpit chassis.

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 an 'out-of-autoclave' composite prepreg material. 'Out-of-autoclave' prepregs have the added benefit of simpler and significantly lower tooling costs. While exact figures are not available, '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%.

With their main offices, production plant, R&D and their warehousing and distribution operations located in Melbourne, GMS Composites has been manufacturing epoxy prepregs for over 12 years. They now have 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 also offers customers CNC machining services, and distributes a number of insulation products and composites-related consumables, reinforcement materials, resins, cores and mould releases from leading global suppliers. AMT

www.gmsindustrial.com.au www.conceptfr1.com