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Vehicles

Lamborghini explores the sixth element

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The result of advanced carbon-fiber reinforced plastic material application to the Sesto Elemento technology demonstrator is an overall vehicle curb mass of just 999 kg (2200 lb), even though the car has a V10 engine and all-wheel drive.

The Sesto Elemento (Italian for Sixth Element) shown by Lamborghini at the 2010 Paris Motor Show is primarily a technology demonstrator aimed at furthering the use of carbon fiber construction methods at the Audi-owned brand. The result of the advanced material application is an overall vehicle curb mass of just 999 kg (2200 lb), even though the car has a V10 engine and all-wheel drive. For comparison, the current Gallardo LP 570-4 Superleggera has a segment-best dry mass of 1340 kg (2950 lb).

The vehicle's light weight combined with the engine's 570-hp (425 kW) output results in an overall 1.75 kg/hp for 0 to 100 km/h (0-62 mph) acceleration of only 2.5 s—and with lower fuel consumption.

With the Sesto Elemento, Lamborghini says it is the first vehicle manufacturer to master the complete carbon-fiber reinforced plastic (CFRP) process across a range of technologies, from 3D design through simulation, validation, production, and testing.

"We put all of our technological competence into one stunning form to create the Sesto Elemento," commented Stephan Winkelmann, President and CEO of Automobili Lamborghini. "It is our abilities in carbon-fiber technology that have facilitated such a forward-thinking concept, and we of course also benefit from the undisputed light-weight expertise of Audi AG. We will apply this technological advantage right across our model range."

For the concept car, Lamborghini's R&D engineers relied primarily on three CFRP technologies and related manufacturing techniques.

Forged composites, materials with short carbon fibers that are hot pressed in a mold, are used for complex structures such as the underside of the monocoque and the suspension arms. The use of forged composite technology for the car's monocoque represents a claimed first time application in an automobile by way of a "one-shot" process. Control arms made using the forged composite method result in components that are around 30% lighter than comparable aluminum parts.

Carbon-fiber-mat prepreg components, which involve soaking in a thermoset liquid resin, pressing in molds, and curing in an oven under heat and pressure, have a very good surface finish so they are the preferred choices for use in visible areas.

A braiding method to manufacture composite filament derived from the textile industry. Each thread is diagonally intertwined on different levels.

The driveshaft is made by a CFRP wrapping technology, allowing engineers to get rid of the central joint and its weight.

The front frame, exterior panels, and crash boxes are also made from the CFRP, as are major suspension components and wheels. The rear subframe, with the engine mount and rear axle suspension points, is made from aluminum. The tailpipes are made of Pyrosic, an advanced glass-ceramic matrix composite able to withstand temperatures up to 900°C (1650°F). The material is similar to the carbon-ceramic composite material used for the brake discs.

Lamborghini designers took advantage of CFRP processes to reduce and integrate a number of components. The front and rear body shells are both manufactured in a single piece attached by easily removable fasteners. Engineers call this integration "cofango," combining the Italian word "cofano" (hood) with "parafango" (fender). The approach is similar to that used for the 1966 Lamborghini Miura's one-piece rear.

The entire car is finished in a matt-shimmer clear coat so the CFRP can be seen, with the shimmer by fine nanotechnology red crystals. The exterior's two vertical ribs in front improve stiffness and guide cooling air directly to the radiator and brakes behind them. Cooling air flows through two red triangular openings in the hood beneath the windshield and then large outlets in the side panels behind the front wheels. Extremely wide sills, forming a connection between the air outlets behind the front wheels and the large air inlets in front of the rear wheels, house components such as the radiators for cooling the engine and transmission oil.

For the minimalist interior, the fixed seats get their structure from the car's forged composite tub, with seat cushions upholstered in hi-tech fabric attached directly to the tub. Steering wheel and pedals are adjustable for height and reach to enable the fixed seats. Much of the interior trim—floor, roof, doors, center console—is made of CFRP. Most controls are concentrated in front of the driver, but three piezoelectric buttons on the center console control engine starting, reverse shifting, and light switching.

Lamborghini's carbon-fiber materials experience dates to 1983, when it produced the first prototype CFRP chassis for the Countach, with the first series production parts appearing in 1985. The current Lamborghini Murciélago is made largely from CFRP, its body-in-white contains 93 kg (205 lb) of the material. The engine cover panel of the Gallardo Spyder is one of the largest CFRP components with Class A surface quality for cars.

Lamborghini is continuing development of its materials technologies, some of which are patented, at its two research centers, the new ACRC (Advanced Composite Research Center) and the University of Washington's ACSL (Advanced Composite Structures Laboratory) in collaboration with others such as Boeing.

ACRC engineers at company headquarters in Sant'Agata Bolognese focus on leading-edge research on innovative materials and production methods for carbon fiber elements at low production volumes. Over 30 experts develop vehicle components, build prototypes and associated production tools, and develop optimized production technologies. Systems largely developed in-house are said to allow extremely high precision levels thanks to manufacturing simulation processes. One of those is the extensively patented RTM Lambo process, which makes use of minimal pressure and relatively low temperatures to manufacture carbon-fiber components and structures to high levels of quality, precision, and surface finish.

The ACSL uses experimental tests to define the mechanical behavior of the different materials and technologies using methodologies from the aviation industry. In 2009, Lamborghini upped its investment in the ACSL with the goal of furthering the university's long-time research in aeronautics and astronautics with partners such as The Boeing Co. and the U.S. Federal Aviation Administration for application in sports car development.

The ACSL has already contributed significantly to Lamborghini's certification methodology for carbon-fiber composite materials, and Lamborghini has collaborated with ACSL Head Professor Paolo Feraboli on research projects since 2001. In 2007, the automaker increased activities with projects focused on crash behavior of composite automotive primary structures, and in 2008, contracted a research project with the Advanced Structures Technology Group of Boeing Research & Technology supported by the ACSL.

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