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JEC EUROPE 2012
Paris (France) | March 27-29

TECHTEXTIL NORTH AMERICA
Atlanta (USA) | April 24-26

PERFORMANCE DAYS
Munich (Germany) | May 9-10

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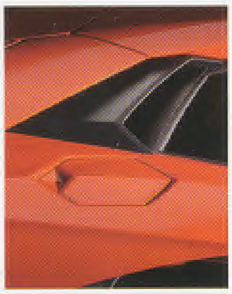
GO CARBON WAS THE 14th IN A SERIES ON CARBON FIBER MARKETS AND TECHNOLOGY SPONSORED BY INTERTECH-PIRA (UK). THIS YEAR'S CONFERENCE WAS CHAIRED BY PROF. KHALID LAFDI OF THE UNIVERSITY OF DAYTON (USA), AND HAD OVER 100 ATTENDEES.



COMPOSITES

GO CARBON FIBER 2011 - AUTOMOTIVE

After opening remarks from the conference organizers, Mauizio Reggiani, VP of R&D and Chief Technical Officer of Automobili Lamborghini (Italy), and Professor Paolo Feraboli, Director of Automobili Lamborghini Advanced Composite Structures Laboratory (ACSL) at the University of Washington (USA), showed the many uses of composites at Lamborghini. Prof. Feraboli explained that ACSL is a center of engineering Lamborghini, Maserati, and Audi, specializing in out of autoclave (OoA) composites, crash worthiness, and lightning strike protection. The Lamborghini 700 HP Aventador (~$400,000) features a 100% carbon fiber "forged" composite monocoque. The technology involves compression molding of a randomly oriented short fiber and has the ability to achieve highly consistent thicknesses on very thin components.

Andreas Wuellner, Managing Director of SGL Automotive Carbon Fibers LLC (USA), gave an update of the Moses Lake (Washington State, USA) Carbon Fiber Plant. SGL Carbon Fiber and BMW have entered into a joint partnership to produce the carbon fiber that will be used in the construction of the BWM i5 electric vehicle. The Moses Lake plant is responsible for converting PAN precursor, Mitsubishi Rayon (Japan), to carbon fiber. The woven fabric, done at Bavarian Wackersdorf Innovation Park (Germany), is sent to the BMW assembly plant in Landshut, Bavaria. Currently one carbon fiber production line is installed and operating and two more are planned to meet the anticipated demand.

FORD'S LONG-TERM VISION

Patrick Blanchard, Technical Leader - Lightweight Materials R&D, Ford Motor Company (USA) presented Ford's long-term vision for the application of lightweight materials, including carbon fiber composites, primarily for improved fuel economy. Hybrids appear to be their answer, since the internal combustion engine will not go away in the near future. Ford has extensive experience using carbon fiber composites including many prototype parts on the 1979 LTD, and non-structural parts for specialty vehicles such as the Aston Martin and Ford Mustang. While Aluminum is an attractive lightweight material, readily available and fits into the existing automotive fabrication infrastructure, carbon fiber composites would be more attractive if they can overcome certain barriers, including high price, limited availability, slow fabrication times, and non-compatibility with the existing automotive infrastructure. Price and availability of carbon fiber may be resolvable as realistic automotive demand increases. The issue of fabrication time continues to be a concern. He compared different methods of composite fabrication. Ford is leaning towards resin transfer methods with fabric preforms in order to meet the structural requirements. While hang-on parts (fenders and hoods) may be the first for carbon fiber composites, parts integration of more structural components is the ultimate goal.

LIGHTWEIGHT VEHICLES

Dr. Hamid Kia, Lab Group Manager, Polymer Composites, General Motors R&D Center (USA) has developed a formula for predicting the economic viability of lightweight alternative materials for high-volume production of automotive components, specifically carbon fiber composites. Dr. Kia identifies a wide range of structural and non-structural parts which are candidates for carbon fiber composites, some of which are already being produced in small volume on GM's model Z Corvettes. He applies his formula to a range of other GM vehicles of different gross weights, and he found that the formula is not sensitive to vehicle gross weight. If the weight reduction is "compounded" (lighter weight on parts higher up on the vehicle lead to lower weights on the underlying structures), then one pound of weight saving would be equivalent to a $4/pound premium when fuel is $4/gallon. Unfortunately, the current material cost of a 15 pound carbon fiber hood will not meet this criterion.

George Peterson, Senior Technology Specialist, Lotus Engineering (USA) presented an analysis of a white Light Weight Vehicle (LWV) designed by Lotus. The design options included steel, aluminum, and magnesium, as well as carbon fiber composite. The analysis also included the assembly cost and the cost of a manufacturing plant dedicated to composites ($53 million). Several vehicles, including those with internal combustion engines (ICE), electric vehicles (EV), and hybrids, were used in the analysis. The major objectives of the project were to match the performance (crash resistance) of a base-line vehicle, the Toyota Venza, and to achieve the most weight reduction. A 40 %

Lamborghini 700 HP Aventador.

mass reduction was achieved in the Lotus design. He stated *"A lightweight, low drag vehicle, with a properly-sized and optimized ICE power train has the potential to provide operating efficiencies approaching or bettering those of hybrid and EV platforms without their cost and mass disadvantages."*

MONOCOQUE BODY STRUCTURES

Karl Wagner, CEO of Mubea Carbo Tech Gmbh (Germany) described designing and manufacturing of carbon fiber composite monocoque body structures for high performance racing vehicles. Their composite structures were used in vehicles that won Formula 1 races, and are in serial production of structures for McLaren Automotive Ltd. Mubea Carbo Tech utilizes both prepreg/autoclave methods, as well advanced resin transfer molding (RTM) techniques. Secondary assembly includes bonding and precision machining. Mr Wagner acknowledged that reduced cycle time (minutes rather than hours) and reduced material cost (less than 50 euros/kg) are needed.

ECOLOGICAL ASPECTS

"The Life Cycle Analysis of the Entire Life Cycle of Carbon Fiber Reinforced Plastic (CFRP)", presented by Dr. Karel Van Acker, K.U. Leuven (Belgium) analyzed the life cycle, environmental footprint, recycling, and reuse of carbon fiber composites. Van Acker discussed the environmental impact of the production of carbon fiber manufacturing and CFRP parts, and End-of-Life options, as well as reviewing a case study for a CFRP car versus a steel or aluminum car. The environmental impact of carbon fiber was shown by evaluating its total energy use. To make thermoset CFRP parts the energy required is about 230 MJ/kg with ~85 % of that energy dedicated to the production of the carbon fiber and the balance split between matrix resin production and assembly/molding. The production of steel parts uses ~50 MJ/kg. Considering only the difference in fuel consumption of a CFRP car versus a steel car, the breakeven point for environmental impact is 132,000 km. A comparison of the CO_2 emission reduction for cars versus airplanes revealed during the lifetime of one vehicle the CO_2 emissions reduction is greater for an airplane; but when considering the lifetime of all vehicles produced per year, the cars offer the greater.

OIL AND GAS APPLICATIONS

Per Arne Edvardsen, Managing Director, of Vello AS (Norway) gave an overview of applications of carbon fiber composites in the offshore oil and gas industry. Carbon fiber composite "risers" (large diameter tubes for exploration and oil production at great depths in the ocean) have been under development for nearly 30 years. Lincoln Composites (USA) has manufactured a number of prototype riser segments, several of which have been tested in the North Sea. Lincoln Composites also manufactures "accumulator" bottles (cylindrical pressure vessels) which are currently in service on the decks of offshore platforms and which stabilization the platforms against wave action. Several international companies manufacture multi-wall, composite flexible pipe which is used to transport liquids and gases in offshore installations. Tethers and "well intervention" cables made from carbon fiber composites are currently used on several offshore deep-water Tension Leg Platforms (TLP). Technical issues include end termination of the tethers, joining of segments, and compression strength of the carbon fiber composites. This industry segment depends upon the predictability of carbon fiber supply and the stability of fiber price.

Carbon woven fabric, done at Bavarian Wackersdorf Innovation Park (Germany), is sent to the BMW assembly plant in Landshut, Bavaria.

WIND ENERGY APPLICATIONS

Daniel Shreve, Director, MAKE Consulting (USA) gave a somewhat negative report of the wind energy industry, worldwide; although his forecast for carbon fiber during the period 2012-2016 was more positive. His growth rate for installed power (worldwide) for this period, at 10% per year, is down slightly from previous forecast of 11%. He sees China maintaining a robust growth, while growth in North America and Europe will decline due to economic factors. Manufacturers are reducing wind generator prices and margins, and some consolidation is expected in the industry. Offshore wind farms will increase in number, which implies longer blades, more near-shore blade manufacturing, and more carbon fiber. Mr Shreve predicts an increase in the ratio of carbon fiber to glass fiber for blades to grow from 25/75 to 33/67 from 2012 to 2016 as blade length increases, slightly higher than other reports on blade construction.