Low Cost Carbon Fiber Production

Lightweight Materials

U.S. Department of Energy

Energy Efficiency and Renewable Energy Program

Oak Ridge National Laboratory

UT-BATTELLE

Transportation

FOR THE 21ST CENTURY

Background

One way to reduce automotive fuel consumption is to reduce vehicle weight. Replacement of steel and aluminum body panels and chassis components with structurally equivalent carbon fiber composites offers up to 68% weight reduction, resulting in savings of up to 40% in gasoline consumption. Carbon fibers have been incorporated in high-performance applications for several decades, but relatively high cost has constrained their use in automotive applications. The availability of carbon fibers at a cost of between $3 to $5 per pound would result in increased use in automobiles. Oak Ridge National Laboratory is working with Hexcel Carbon Fibers to define low-cost carbon fiber (LCCF) technologies.

The Technology

Hexcel Carbon Fibers' LCCF project evaluated PAN (polyacrylonitrile)-based precursors: large tow benchmark, commodity textile acrylic tow, chemical modifications, acrylic fibers spun without solvents, radiation and nitrogen pretreatments; and other precursors such as polyolefins - polypropylene (PP), linear low density polyethylene (LLDPE), high density polyethylene (HDPE), polystyrene, and polyvinyl chloride (PVC pitch).

The results of the lab-scale evaluation led to selection of the most promising technologies: commodity textile acrylic tow with chemical modifications and/or radiation pretreatments, and LLDPE. In the course of down-selecting the technologies, Hexcel Carbon Fibers developed a continuous in-line chemical modification process and demonstrated a reduction in stabilization times by approximately 50%. E-beam radiation technology was evaluated and selected for the prestabilization. A continuous two-stage sulfonation process for LLDPE and PP fibers was developed. Cost models for large tow benchmark, commodity textile acrylic fibers with chemical modification and radiation pretreatments, and LLDPE sulfonation were also developed by Hexcel.

Commercialization

The goal of Hexcel's project is the definition of the technologies for the commercial production of low-cost carbon fiber. This includes materials and facilities, and will be supported by detailed manufacturing cost analyses and processing cost models. Laboratory trials and pilot-scale demonstrations support the defined technologies.

Hexcel's project is directed toward developing technologies that can be implemented into commercialization plans using available industrial facilities and infrastructures with the least capital investments. Such an approach would speed commercialization of the technologies.

Benefits

- A significant cost benefit would be realized by moving from large tow precursor to commodity acrylic fiber, with cost savings of about $1.50 per pound of carbon fiber

	Chemical process	Radiation process
Precursor	$1.90	$1.90
Pretreatment	$0.12	$0.35
Stabilization and oxidation	$1.51	$1.51
Carbonization	$1.19	$1.19
Sizing, surface treatment, packaging, and quality control	$1.11	$1.11
Total cost per pound	$5.83	$6.06

Predicted manufacturing costs for selected technologies (mill cost plus 20% ROI)

For more information on how DOE is helping America remain competitive in the 21st century, please contact:

C. Dave Warren
Composite Materials Program Manager
Metals and Ceramics Division
Oak Ridge National Laboratory
(865) 574-9693
warrencd@ornl.gov

Success Story

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