

# Microwave Assisted Plasma (MAP) Manufacturing of Carbon Fibers

*Lightweight Materials*

## Transportation

FOR THE 21ST CENTURY

U.S. DEPARTMENT OF ENERGY

ENERGY EFFICIENCY AND  
RENEWABLE ENERGY PROGRAM

OAK RIDGE NATIONAL LABORATORY



### Background

With the assistance and direction of the U.S. Department of Energy (DOE) FreedomCAR and Vehicle Technologies Program, the Oak Ridge National Laboratory (ORNL) is conducting research and development into lightweight materials for transportation.

Significant automobile weight reduction and corresponding increases in fuel economy can be achieved by replacing dense materials (such as metals) with strong, lightweight materials. Carbon fiber reinforced composites are an excellent candidate for this lightweight material. Carbon fibers, as the load-bearing components in these composites, offer significant weight saving potential because of their remarkably high strength, high modulus, and low density. The use of carbon fibers is currently prohibitive because of their high cost. Carbon fibers with the properties needed for automotive applications currently sell for \$6 to \$16 per pound.

### The Technology

ORNL researchers are developing microwave assisted plasma (MAP) technologies to carbonize and graphitize polyacrylonitrile (PAN) precursors. The project has proven that carbon fiber with very uniform properties, suitable for use by the automotive industry, can be continuously produced using MAP processing. The MAP process can also produce fibers with specific tailorable properties. Most importantly, this project has demonstrated the economic feasibility for producing approximately 30 Msi modulus fibers at a significant cost reduction compared to those produced conventionally. Two patents

have been awarded and others are pending on this ORNL technology, which has enjoyed the support and cooperation of U.S. carbon fiber manufacturers.

The initial continuous pilot unit was designed to achieve a line speed of 6 inches/minute to demonstrate technical feasibility. At the time of this summary, a carbon fiber production line speed of about 120 inches/minute has been achieved. This slightly exceeds most conventional production line speeds.

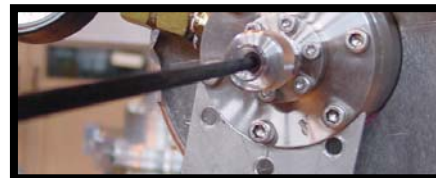
Mechanical data indicate that MAP carbon fiber surpasses the values targeted for the FreedomCAR program. ORNL's MAP carbon fibers have achieved modulus between 29-32 Msi and ultimate tensile strength of 342-424 Ksi. Comparable, conventionally manufactured carbon fibers feature 31Msi modulus and 485 Ksi ultimate strength. In general, electrical and morphological properties of these fibers compare favorably to those in commercial 50K tows presently in the market.

### Commercialization

Although this technology is still under development, there has been interest and inquiries concerning technical and economic data from carbon fiber manufacturers and also from carbon fiber processing equipment manufacturers.

### Benefits

- Cost estimates indicate a likely cost savings of 40% in the direct production costs and a reduction in the final carbon fiber cost of about 18%
- Faster processing speed
- Reduced processing energy demand
- Reduced footprint and capital outlay for compact equipment and plant layout
- A higher degree of product quality control



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

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### Success Story

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