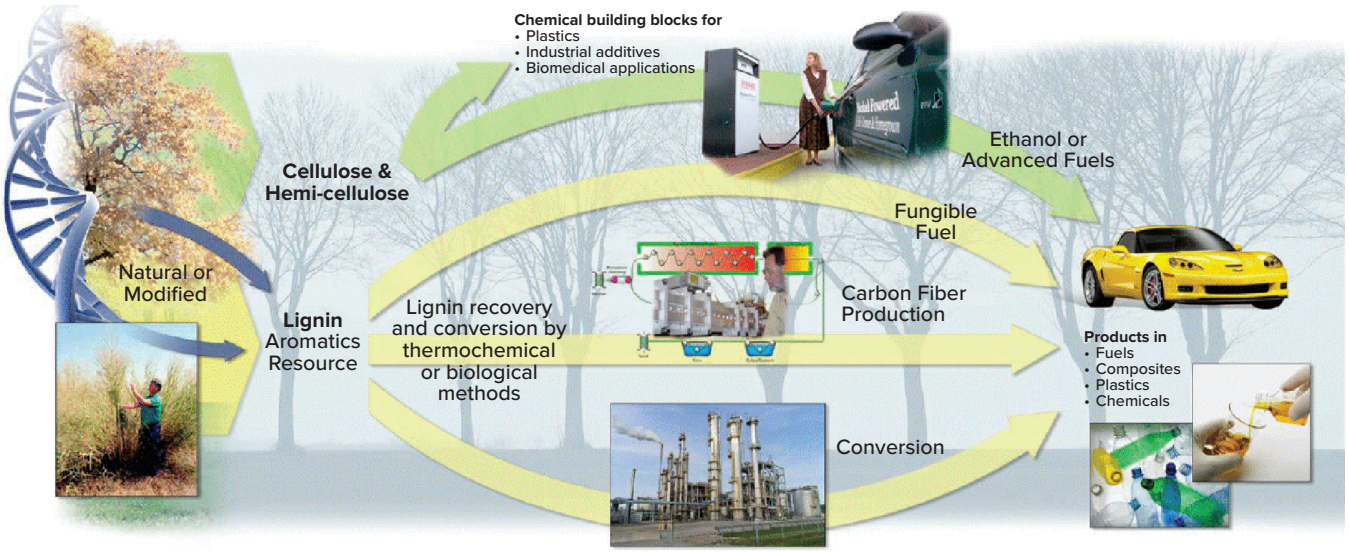
CARBON FIBERS FROM RENEWABLE SOURCES

This patent bundle combines NREL's expertise in the biological utilization of lignin and metabolic funneling to carbon fiber, with that of ORNL's expertise in chemical approaches to lignin separation and downstream processing to Carbon Fibers (CFs). The emphasis is on blends of lignin with appropriate polymers, including PAN, PET, PEO, and polyolefins.

TECHNICAL ADVANCES

- Novel process that allows nitrile synthesis in a controlled and selective reaction of esters derived from fermentation that results in bio-derived acrylonitrile (a key building block for the production of ~90% of the CF production), which is used in the production of polyacryloni-trile (PAN) polymers. This process also eliminates the release of the poisonous, flammable hydrogen cyanide.
- Carbon Fibers (CFs) with covalently bound epoxy groups engage with crosslinking molecules, which posses reactive groups that crosslink between the epoxy groups in the sizing agent and a polymer matrix. A lightweight, high-strength material is obtained.
- CFs derived from polyacrylonitrile (PAN) precursor fibers have a tensile modulus of 242 GPa, and a tensile strength of 4137 MPa. Interlaminar shear strength (ILSS) was in-creased from 67 MPa to 97 MPa (+45%), and the 90° flexural strength was increase from 32 MPa to 56 MPa (+75%).
- Activated carbon fibers from renewable resources have porous, high surface areas for adsorptive applications. The carbonaceous precursor material is both carbonized and activated in a single step.



In planta genetic engineering, enhanced extraction methods, and a deeper understanding of the structure of lignin are yielding promising opportunities for efficient conversion of this renewable resource to carbon fibers, polymers, commod-ity chemicals, and fuels [Credit: Oak Ridge National Laboratory, U.S. Department of Energy]. A. J. Ragauskas et al., Science 344, 1246843 (2014). DOI: 10.1126/Science.1246843

CONTACT
Oak Ridge National Laboratory
Eugene R. Cochran, PhD, MBA
Technology Transfer Division
Phone: 865-576-2830
Email: cochraner@ornl.gov

U.S. DEPARTMENT OF ENERGY
Argonne National Laboratory is a U.S. Department of Energy laboratory managed by UChicago Argonne, LLC.

January 2018

MOTIVATION, CHALLENGE, AND OPPORTUNITY

Demand for Carbon Fiber (CF) reinforced polymers continues to grow in different applications. Lignin-derived Carbon Fibers (CFs) could reduce costs by using a renewable source that is independent of oil price fluctuations. In addition, these fibers can be used to reinforce polymer materials and carbon-carbon composites avoiding the release of harmful by-products. Lignin has a significant potential cost advantage over even textile-grade PAN as a precursor material for low-cost carbon fiber production. Whereas the cost of PAN is almost directly proportional to the cost of oil, the cost of lignin is largely independent of oil prices. This IP bundle includes valuable strategies to include CFs in materials for diverse applications and improved properties. In addition, industry leaders will have the opportunity to leverage the expertise from both National Labs through one standard and convenient agreement.

TECHNOLOGIES IN THIS BUNDLE

TECHNOLOGY	NUMBER
Multifunctional Curing Agents and their use in Improving Strength of Composites Containing Carbon Fibers Embedded in a Polymeric Matrix	US 2016 0102180, ORNL
Activated Carbon Fibers and Engineered Forms from Renewable Resources	US7727932, US8377843, ORNL
Methods for Producing Acrylonitrile	US62/297,187, NREL
Renewable Unsaturated Polyesters and Resins	US62/327,518, NREL
Method of Improving Adhesion of Carbon Fibers with a Polymeric Matrix	US9365685, ORNL