

Apparatus and Method for Oxidation and Stabilization of Polymeric Materials

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Technology Summary

Researchers at ORNL have developed a faster and more cost-effective method of oxidizing and stabilizing thermoplastic materials than is currently used in conventional carbon fiber production. This invention increases the rate of oxygen diffusion and chemical cross-linking of the polyacrylonitrile (PAN) precursor or other polymeric materials.

The production of carbon fibers from polymeric materials is a multi-step manufacturing process. Conventional oxidation or stabilization is the most time-consuming and rate-limiting step of this process, and has been the subject of much research for the purpose of reducing processing time and determining the final properties of the manufactured carbon fibers.

The invention is based on the use of reactive oxidative species (ROS), such as monatomic oxygen, and atmospheric plasma to increase the rate of oxygen diffusion to nonoxidized polymeric material prior to carbonization. The chemically reactive species, ROS, are produced by non-thermal atmospheric plasma and are better able to diffuse through the converted material, allowing oxidative stabilization to occur faster with plasma processing. The polymer is stabilized and cross-linked as a result of exposure to this plasma-derived gas containing ROS at a selected temperature. With different configurations, both batch-type and continuous processing can be supported with this method.

Advantages

- Creates a more uniformly stabilized fiber that can yield a more uniform product after carbonization at less cost
- Diffuse plasma avoids the deleterious effects of filamentary plasma
- Capable of starting with PAN precursors and advancing the oxidation process to fully oxidized fibers, or to a desired level of oxidation
- May allow processing of fibers or other thermoplastic materials of greater thickness than what is considered commercially feasible

Potential Applications

- Useful to the carbon fiber industry in preparing polymer fibers, particularly PAN fibers, for later carbonization treatments

Patent

Felix L. Paulauskas, Terry L. White, and Daniel M. Sherman. *Apparatus and Method for Oxidation and Stabilization of Polymeric Materials*, U.S. Patent US 7,786,253 B2, issued August 31, 2010.

Felix L. Paulauskas and Daniel M. Sherman. *Apparatus and Method for Oxidation and Stabilization of Polymeric Materials*, U.S. Patent U.S. 7,649,078 B1, issued January 19, 2010.

Felix L. Paulauskas, Terry L. White, and Daniel M. Sherman. *Apparatus and Method for Oxidation and Stabilization of Polymeric Materials*, U.S. Patent US 7,534,854 B1, issued May 19, 2009.

Inventor Point of Contact

Felix L. Paulauskas
Materials Science and Technology Division
Oak Ridge National Laboratory

Licensing Contact

Alexander G. DeTrana
Senior Technology Commercialization Manager,
Materials Science
UT-Battelle, LLC
Oak Ridge National Laboratory
Office Phone: 865.576.9682
E-mail: detranaag@ornl.gov