System to Continuously Produce Carbon Fiber via Microwave-Assisted Plasma Processing

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Technology Summary

Using a microwave-assisted plasma (MAP) system developed at ORNL, carbon fibers with specific mechanical properties can be produced on a continuous or semi-continuous basis more efficiently and less expensively than conventional methods. This invention can contribute towards widespread use of carbon fiber-based composites by the consumer industry as an alternative to lower-strength, heavier conventional structure materials such as steel.

Current carbon fiber production methods are challenged by the high-cost of carbon pre-cursors, the expensive energy and equipment, and the cost associated with a limited production rate. Carbon and graphite fibers are conventionally produced through the controlled pyrolysis of fibrous organic carbon precursors such as polyacrylonitrile (PAN), mesophase pitch (petroleum or coal tar), rayon, or other polymeric-based precursors in a lengthy process. The three process stages of carbonization, graphitization, and surface treatment represent much of the cost associated the overall carbon fiber manufacturing process due to their time, power, and maintenance requirements.

The MAP system simplifies carbon fiber production by replacing the carbonization, graphitization, and surface treatment process steps with a signal MAP processing step. The combined use of microwave and plasma energy allows the system to operate at a low thermal inertia (low mass) in less time and with less energy than conventional processes. Another major benefit is that the off-gases produced during the carbonization process supplement the plasma reaction and drive carbonization, thus reducing the amount of volatile gases in the effluent gas stream and the amount of incineration required.

Advantages

- Lower production cost for carbon fibers with acceptable automotive-quality mechanical properties
- Less incineration of effluents is required, including greenhouse gases produced during the process
- Complete processing of fibers from a fully oxidized precursor all the way to surface-treated carbon fiber

Potential Applications

- Industries requiring lightweight, high-strength carbon fiber material
- Automotive industry
- Construction
- Aircraft
- Energy producing companies

Patent

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