

Carbon Felts Derived from Pitch for Use in Enhanced Energy Storage (2024-015)

High yield and low cost petroleum-based carbon fiber mat that increases efficiency of redox flow batteries.

Market Overview

Energy based on renewable resources is often not continuous and relies heavily on Long Duration Energy Storage (LDES). One option for commercial LDES is the use of redox flow batteries (RFBs). Current RFBs rely on polyacrylonitrile (PAN)-based carbon fiber mats, that suffer from high cost and low carbon yield. The RFB market in North America was valued at \$82.2 M in 2023 and is expected to reach \$274.8 M in 2029, with a CAGR of 22.4%. Clemson University researchers have developed a process for making non-woven carbon fiber mats based on a low-cost precursor of petroleum pitch. Their pitch-based mat maintains high power efficiency of PAN fibers at $\sim 140 \text{ mW cm}^{-2}$ while decreasing the overall cost from \$15/lb for PAN fibers to less than \$3/lb for the pitch-based fibers.

Technical Summary

The invention is a non-woven, conductive carbon fiber felt electrode derived from mesophase petroleum pitch for electrochemical applications. Power is retained by flowing redox metal species over the carbon fiber mat that acts as the electrode. The low-cost precursor and simple, scalable process, based on a melt-blowing process, allows for tunable dimensions and surface areas to increase conductivity and electrochemical activity. Additionally, the process for pitch-based carbon mats has a high carbon yield of $\sim 80\%$ while the current PAN-based fibers only achieve a carbon yield of 40%. This high carbon yield also increases the overall thermal and electrical conductivity.

Application

Alternative carbon fiber mats can be used for long time energy storage

Development Stage

Proof of concept/Prototype

Advantages

- **Cost Benefit:** Replaces high-cost precursors (\$15/lb) with low-cost pitch (<\$3/lb)
- **Scalability:** Supports a melt-blowing production process that is capable of simple scaling
- **Customizability:** Further surface treatment of the non-woven carbon fibers with redox active species can lead to additional conductivity enhancements

About the Inventors



Dr. Mark Roberts

Associate Professor of Chemical and Biomolecular Engineering at Clemson University

Dr. Mark Roberts earned his Ph.D. in Chemistry Engineering from Stanford University. Here at Clemson University Professor Roberts' research is focused on developing functional polymers with unique electronic and electrochemical properties for an array of electronic systems, from electrical energy storage devices to chemical sensors.



Dr. Amod Ogale

Dow Professor of Chemical Engineering and Director of the Center for Advanced Engineering Fibers and Films (CAEFF) at Clemson University

Dr. Amod Ogale earned his Ph.D. in Chemical Engineering from the University of Delaware. Professor Amod Ogale is conducting research on high-performance carbon fibers, polymeric films, and composites. The Ogale group focuses on processing-microstructure-property relationships during fiber spinning, film extrusion, and composite formation.



Dr. Abena Williams

Doctoral Student at Clemson University

Dr. Abena Williams earned her Ph.D. in Chemical Engineering from Clemson University studying under Dr. Mark Roberts. Her dissertation was on "Electrode Engineering for Enhanced Performance and Low-Cost Redox Flow Batteries". Dr. Williams now works at Advanced Thermal Batteries Inc. as a battery design engineer.

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