International Advanced Research Centre for Powder Metallurgy & New Materials (ARCI)

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Development of Porous carbon for high performing Supercapacitors

Overview

Super capacitors have been recognized as promising energy storage devices due to their fast charge-discharge time, very high power density and long life cycle period. It is commercially available but widespread usage is restricted by their high cost and low energy density. These drawbacks can be mitigated by developing a new class of high performance carbon electrodes which consist of a combination of materials produced from abundant, cheap and environmentally friendly resources with low processing costs. ARCI focuses mainly on the development of large scale process to convert various bio-wastes into a high surface area porous carbon material with graphitic structure suitable for super capacitor application. ARCI successfully synthesized high performance porous carbon materials using bio-waste like jute stick and cotton fabric by a simple chemical activation process. The resulting carbon material delivers excellent super capacitor performance in terms of capacitance, rate capability and cyclic stability in comparison to commercial activated carbon material.

Key Features

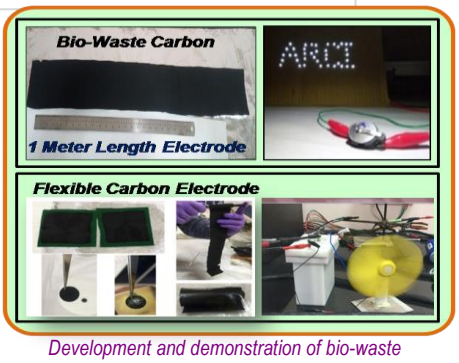
- Facile synthesis of porous carbon by a simple chemical activation process
- Graphene like structured carbon, high surface area, large pore volume
- Conversion of abundant solid waste into useful carbon material
- Specific capacitance, rate capability and cyclic stability higher than commercial carbon
- High energy density based supercapacitor
- Scalable manufacturing process

Potential Applications

- Automotive transport (electric bus, electric bicycles, electric cars)
- Consumer electronics (voltage stabiliser, grid power buffer, street lamps)
- Energy recovery (trams, cranes, tractors)
- Memory backup for static random-access memory (SRAM)

Technology Readiness Level (TRL): 5

- Synthesis and electrochemical performance of porous carbon at laboratory scale
- Scale-up of porous carbon from bio-waste is underway



Development and demonstration of bio-waste derived carbon and flexible carbon electrode

	Aqueous-1V			Non-aqueous-2.7V		
	Bio-waste carbon	Flexible carbon	Maxwell	Bio-waste carbon	Flexible carbon	Maxwell
Capacitance (F/g) @ 1 A/g	162	148	93	116	83	76
Energy density (Wh/Kg)	5.4	5.1	3.2	29	21	19
Power density (W/Kg)	249	249	235	675	674	670

Benchmark study of indigenous Carbon Materials

IPDI*	1	2	3	4	5	6	7	8	9	10
Activities	*Basic concepts and understanding of underlying scientific principles*	*Short listing possible applications*	*Research to prove technical feasibility for targeted application*	*Coupon level testing in stimulated conditions*	*Check repeatability/ consistency at coupon level*	*Prototype testing in real-life conditions*	*Check repeatability/ consistency at prototype level*	*Reassessing feasibility (IP, competition technology, commercial)*	*Initiate technology transfer*	*Support in stabilizing production*
Status	20 %									

Major Patents / Publications

1. Method for producing graphene like structure nanoporous carbon material from jute stick based bio waste for energy storage applications and the product thereof, **Indian Application No. *201711006697*** *dated 24th Feb 2017.*
2. Robust, Environmentally Benign Synthesis of Nanoporous Graphene Sheets from Bio-waste for Ultrafast Supercapacitor Application", ***ACS Sustainable Chemistry and Engineering***, 7, 2516-2529, **2019**.
3. Activated carbon fibres as high performance supercapacitor electrodes with commercial level mass loading, **Carbon, Vol. 140, pp. 465-476, 2018.**
4. Facile Synthesis of Corn Silk Derived Nanoporous Carbon for an Improved Supercapacitor Performance", ***Journal of The Electrochemical Society***, 165 (14) A1-A11, **2018**.

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