IIT MADRAS
Indian Institute of Technology Madras

Technology Transfer Office
TTO – IPM Cell

Industrial Consultancy & Sponsored Research (IC&SR)

Binary Reaction Embedded Anode for High Current Density and Long Cycle Life Lithium Ion Battery

IITM Technology Available for Licensing

Problem Statement

- **Lightweight, high-power rechargeable batteries** are crucial for compact devices.
- Lithium-ion batteries are ideal for **portability**.
- **Electrode material integrity** is key for high current density and long battery life.
- Graphite is used in commercial lithium ion batteries due to its **cycle stability and long cycle life**, but has **limited storage capacity**.
- Silicon nanostructures offer **higher ion storage but may lead to SEI formation**.
- There is a pressing need **for improved battery materials** with **higher capacity & durability**.
- The instant patent disclosure addresses above mentioned issues, and provides an innovative, high-capacity, long-lasting anode.

Technology Category/ Market

Categories: Electronics & Circuits | Chemistry & Chemical Analysis

Industry: Energy Storage Technology

Applications: Portable Electronics, e-vehicles, Renewable Energy Storage, Consumer Electronics, Automotive, Energy Storage Systems

Market: The global lithium-ion battery anode market was worth **USD 7.1 B in 2020** and is further projected to reach **USD 24.8 B by 2027,** growing at a **CAGR** of **19.6%** in forecast period.

Technology

The present patent disclosure provides a **Binary Reaction Embedded Anode for High Current Density and Long Cycle Life Lithium Ion Battery,** comprises:

- a carbon nanotube material having partially exfoliated carbon nanotubes; and sulphur, wherein the sulphur is bonded to the carbon in the carbon nanotube matrix.
- conducting carbon, and polyvinylidene fluoride (PVDF) binder.

The carbon nanotubes are any of single walled carbon nanotubes, multi-walled carbon nanotubes or other metal oxide based structures modified with sulphur.

Method

Purifying carbon nanotube material to remove amorphous carbon or any catalyst particle

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Partially oxidising the purified carbon nanotube material

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Obtaining partially exfoliated carbon nanotube (PCNT) by unzipping and exfoliating partially oxidised carbon nanotube

↓

Preparing a PCNT dispersion and homogenizing the PCNT dispersion by ultrasonication

↓

Adding sulphur dissolved CS_2 to the homogenized PCNT dispersion

↓

Evaporating CS_2 from the dispersion

↓

Subjecting the dispersion to hydrothermal reaction at 180° for 10 hours to obtain sulphur incorporated partially exfoliated carbon nanotube

Key Features / Value Proposition

- The cell is capable of forming a **stable solid-electrolyte interphase** at a **current density of 150 mA g-1 or greater.**
- The cell retains a capacity of **200 mA h g-1** at a current density of **10 A g-1** for **7370 cycles** or more and the discharge capacity of the cell after **10,000 cycles** is **150 mA h g-1** or more.
- The anode is **substantially free** of **elemental Sulphur.** The carbon to Sulphur ratio is **9:1.**

TRL (Technology Readiness Level)

TRL- 3, Validated in Lab

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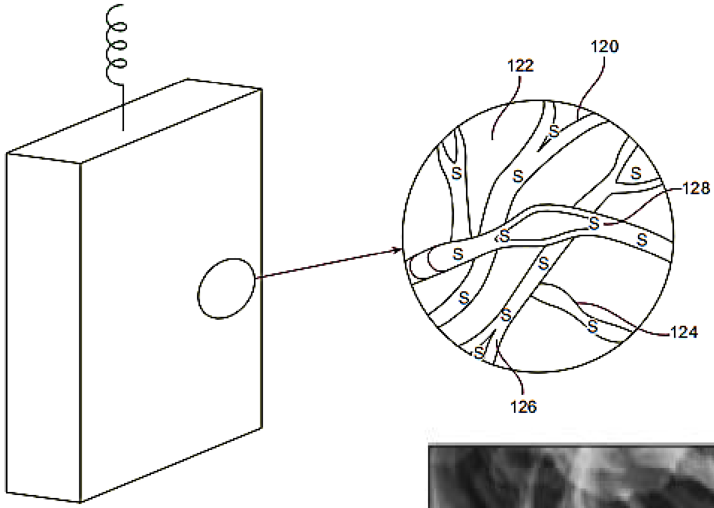
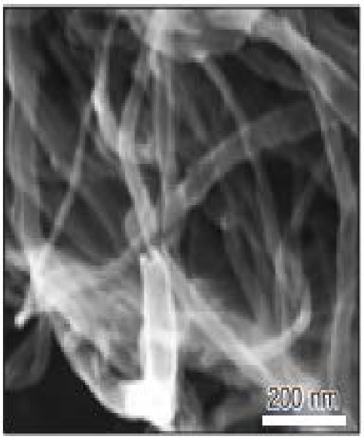


FIG. 1A shows the electrode with S@PCNT as anode material.

FIG. 1B shows the magnified view of anode material comprising sulphur incorporated partially exfoliated carbon nanotube



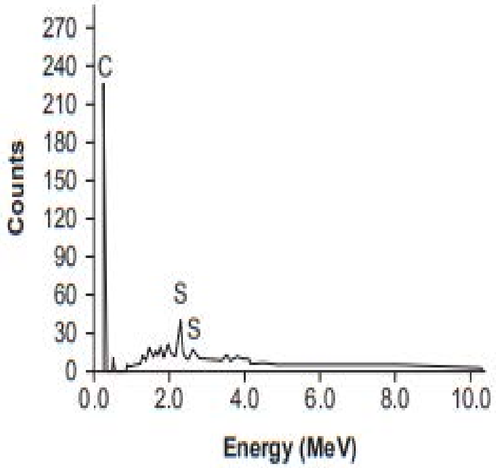


FIG. 2A illustrates the SEM image of S@PCNT wrinkled surface morphology of outer layers of carbon nanotube.

FIG. 2B shows the EDX image of S@PCNT that confirms the incorporation of sulphur in the unzipped randomly oriented carbon nanotubes

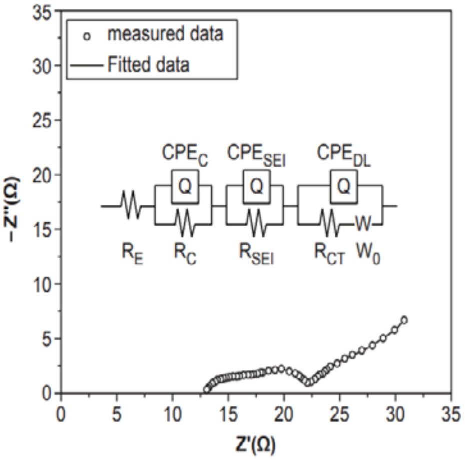


FIG. 3 shows electrochemical impedance profile in the discharged state after cycling in the frequency range of 0.01 Hz to 1 MHz.

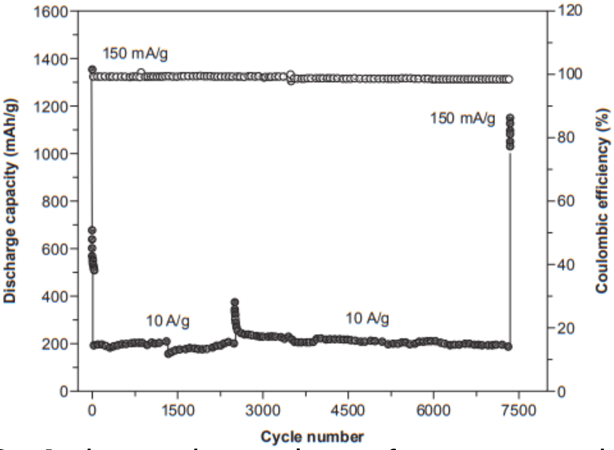


FIG. 4 shows the cycle performance and columbic efficiency of the cell at 10 A/g

Research Lab

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Intellectual Property

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