IIT MADRAS
Indian Institute of Technology Madras

Technology Transfer Office
TTO – IPM Cell

Industrial Consultancy & Sponsored Research (IC&SR)

LITHIUM ION BATTERY WITH MAGNETIC ANODE MATERIAL

IITM Technology Available for Licensing

Problem Statement

- Conventionally used lithium-ion battery technology **employs anode materials such as graphite**, which suffers from drawbacks such as slow kinetics of lithium insertion/extraction, irreversible conversion in metal oxides at high current densities, and recycling that involves multiple processes.
- Transition metal oxides, which follow a conversion mechanism rather than intercalation are used as an alternative, but their **large volume expansion** during cycling affects cyclic stability where there is long felt need to develop high-performance anode materials that overcome graphite's limitations and **enhance overall battery performance.**

Technology Category/ Market

Category – Energy, Energy Storage & Renewable Energy
Applications -Semiconductors, Automobiles, Energy storage, rechargeable batteries
Industry –Energy Infrastructure
Market -**Lithium-Ion Battery Market** exceeded USD **52.5 billion revenue in 2022** and is projected to expand at over **16.5% CAGR from 2023 to 2032.**

Key Features / Value Proposition

❖ ***Technical Perspective***

- ❑ A high performance lithium ion battery device and
- ❑ a method of preparation **with ferromagnetic material as anode**
- ❑ The anode is configured to be magnetized and **control lithium ion intercalation by reducing diffusion path of lithium ions**
- ❑ Involves applying an external magnetic field~1500 Gauss, on the anode side during charging or discharging cycles after a predetermined number of cycles to enhance battery capacity.

❖ ***User Perspective***

- ❑ The battery capacity is **enhanced by 50%** or more
- ❑ **Improving capacity, life cycle, and recycling** of lithium ion batteries using magnetic hematite.

Technology

The present invention discloses a ***lithium ion battery device and a method of preparation*** for the same.
The said lithium ion battery device includes:

- **Lithium based material** — A cathode
- **Ferromagnetic α-Fe2O3/C material** — An Anode

- ❑ The lithium ion battery device also comprises a reference electrode and counter electrode of lithium metal.
- ❑ **Ferromagnetic α-Fe_2O_3/C** is in the form of nanoparticles of 100nm size.
- ❑ The device includes an electrolyte comprising $LiPF_6$ dissolved in ethylene carbonate/ diethyl carbonate (EC/DEC 1:1 v/v).
- ❑ The battery is assembled by loading the prepared anode, lithium cathode, and electrolyte in an areal density range of 0.5-0.75 mg cm–2 to form the lithium-ion battery.

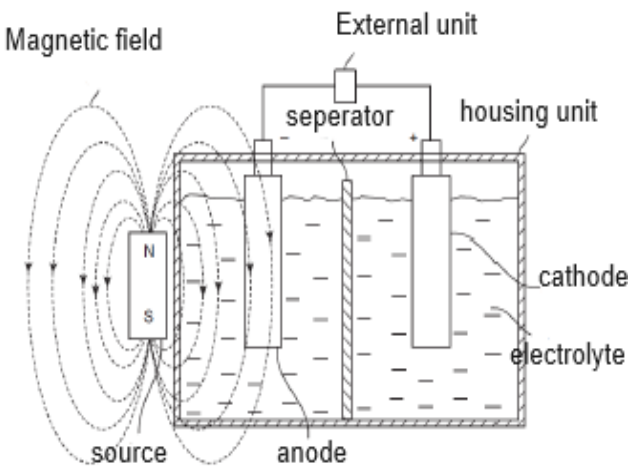

FIG. 1 illustrates a lithium ion battery device with external magnetic field applied to the anode

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Images

Method:

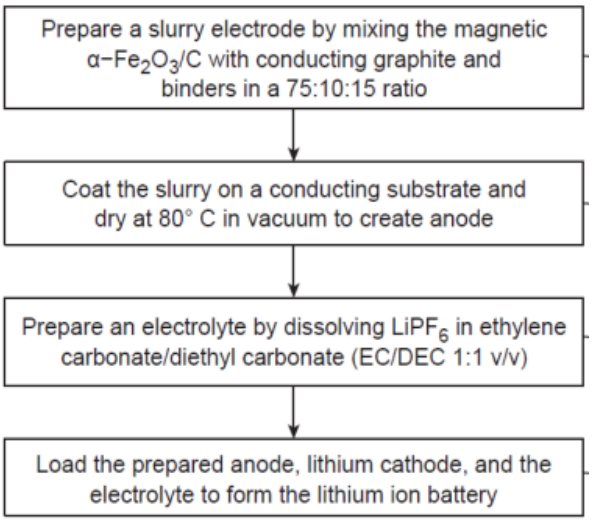

FIG. 2 illustrates a flow diagram of method of preparing a lithium ion battery

The invention further discloses a method of enhancing battery capacity in a lithium ion battery

The said method includes:

- **By providing an anode comprising ferromagnetic α-Fe2O3/C material to the battery**
- **Providing a cathode formed of lithium based material**
- **Applying an external magnetic field during a single charging or discharging at predetermined cycles on the anode**

Applying the magnetic field during **charging** at 501st, 1001st or 1501st cycles recovers **68%, 59%, or 45%** or more of the capacity, respectively

Applying the magnetic field during **discharging** at 501st, 1001st or 1501st cycles recovers **45%, 72%, or 82%** of the capacity, respectively

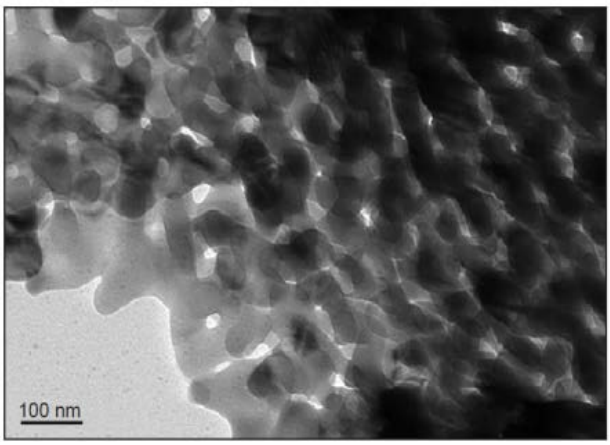

FIG. 3 illustrates a TEM image of ferromagnetic **α-Fe_2O_3/C**

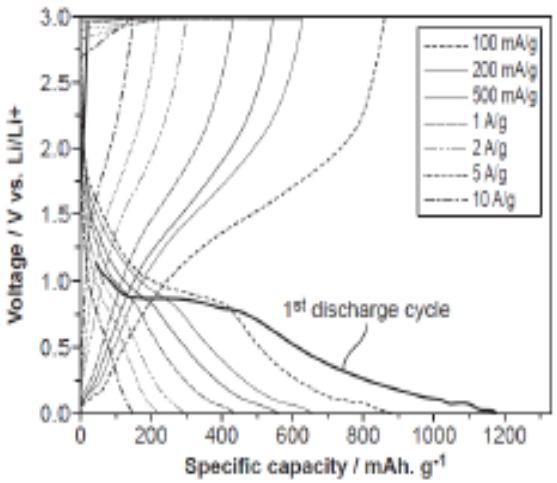

FIG. 4 illustrates charge-discharge profile of the battery at various current densities

Intellectual Property

- **IITM IDF Ref. 1873**
- **IN470163-Granted**

TRL (Technology Readiness Level)

TRL-4, Technology Validated in the Lab

Research Lab

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