Silicon And Carbon Nanocomposite Spheres With Enhanced Electrochemical Performance For Full Cell Lithium Ion Batteries

Tech ID: 32709 / UC Case 2017-495-0

PATENT STATUS

Country	Type	Number	Dated	Case
United States Of America	Issued Patent	11,349,120	05/31/2022	2017-495

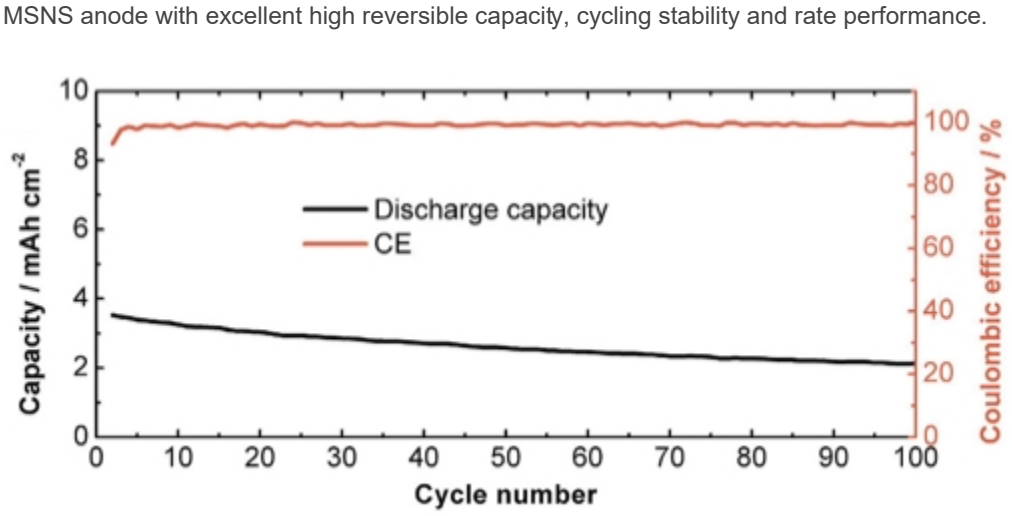
FULL DESCRIPTION

Background

Silicon has proven to be a promising anode material for lithium-ion batteries (LIBs) due to its high theoretical capacity of 3572 mAh/g. However, silicon anodes suffer huge volume expansions during the lithiation process which induces uneven stress-strain distribution causing pulverization and loss of active material. Several academic and industrial efforts have been made on the synthesis of nano silicon, novel binder systems and novel nanostructured silicon anode materials. These methods require very expensive raw materials, high processing cost and result in high surface area which limit the application in full cell LIBs. The large surface area results in a larger solid electrolyte interface which in turn causes high, irreversible capacity loss.

Invention

Researchers led by Prof. Cengiz Ozkan at UCR have developed a patented, innovative and facile synthesis of monodisperse silicon and carbon nanocomposite spheres (MSNS) via a surface-protected magnesiothermic reduction process with subsequent chemical vapor deposition. The team has prototyped both a 2032 type half coin cell with an MSNS anode as well as a full cell LIB with an LCO cathode and an MSNS anode with excellent high reversible capacity, cycling stability and rate performance.



Cycling response of the MSNS/LCO full cell at C/2 rate

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OTHER INFORMATION

KEYWORDS

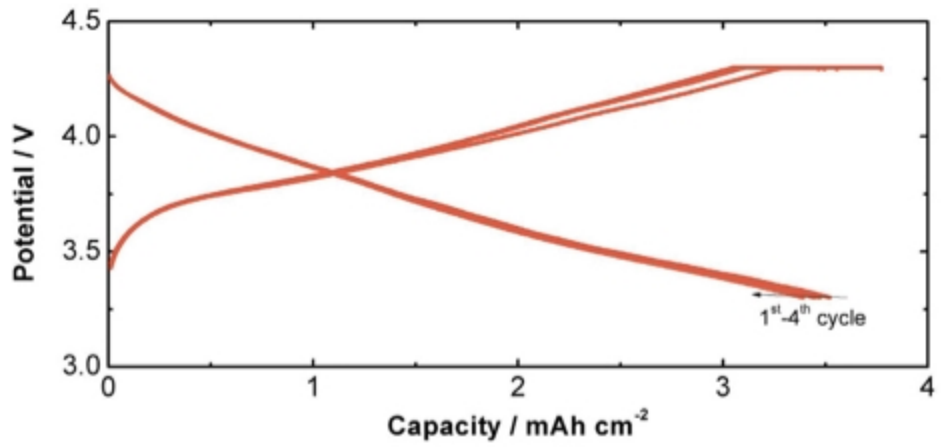
Lithium-ion batteries, Nanocomposite, Silicon anode, Energy storage, Electric vehicles, Drone batteries, Silicon-Carbon composite, Consumer Electronics Battery

CATEGORIZED AS

- **Energy**
  - Storage/Battery
- **Materials & Chemicals**
  - Nanomaterials
- **Nanotechnology**
  - Materials
- **Transportation**
  - Aerospace
  - Alternative Propulsion
  - Automotive

RELATED CASES

2017-495-0



Galvanostatic voltage profile of the MSNS/LCO full cell at C/2 rate

STATE OF DEVELOPMENT

The team has prototyped 2032 type coin half cells with the MSNS as anode material and pure Lithium metal chip as cathode which demonstrated a high reversible capacity of 3207 mAh/g with enhanced cycling stability and rate performance. A full cell LIB was built with MSNS as anode and Lithium Cobalt cathode (LCO). The full cell displayed high volumetric energy density of 850 WH/L and excellent cycling stability.

ADVANTAGES

The benefits and significance of their innovation are:

- Simple and scalable
- Provides for homogeneous stress-strain distribution during lithiation and de-lithiation
- Demonstrated high initial coulombic efficiency of 71.3%
- High reversible capacity, superior rate performance and enhanced cycling stability
- Potential to improve capabilities with optimization of the electrode structure and cell balancing.

SUGGESTED USES

Lithium-ion batteries – specifically anode material, in rechargeable energy storage applications such as:

- Electric vehicles
- Stationary storage
- Consumer electronics
- Drone batteries where battery weight is of importance

OTHER INVENTIONS BY PROF. CENGIZ OZKAN

Please see other inventions by Prof. Cengiz Ozkan

RELATED MATERIALS

- Silicon and Carbon Nanocomposite Spheres with Enhanced Electrochemical Performance for Full Cell Lithium Ion Batteries

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