Scalable, Binerless And Carbonless Hierarchical Ni Nanodendrite Foam Decorated For Supercapacitors

Tech ID: 32656 / UC Case 2016-351-0

PATENT STATUS

Country	Type	Number	Dated	Case
United States Of America	Issued Patent	11,056,288	07/06/2021	2016-351

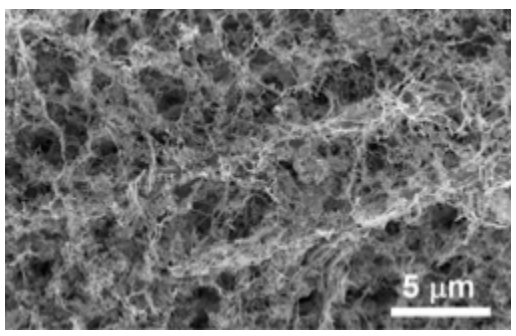
FULL DESCRIPTION

Background

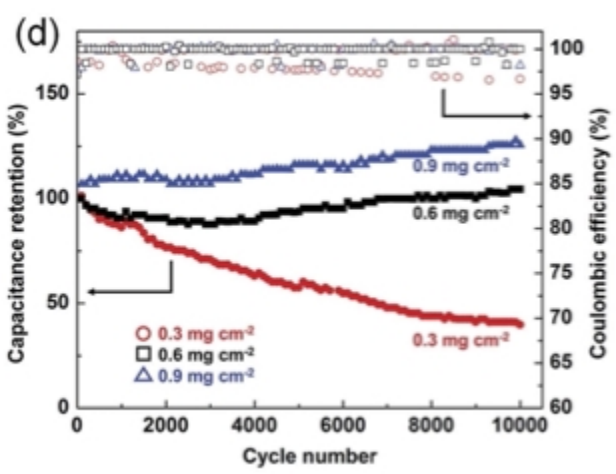
Supercapacitors with higher power density and higher energy density will play an important role in applications that depend on intermittent energy sources (such as wind) and in regenerative recharging in automobiles. Pseudo-capacitors take advantage of fast and reversible surface redox reactions to provide 10-100 times higher energy density than electric double layer capacitors. Among metal oxides used for pseudo-capacitors, Ruthenium Dioxide (RuO_2) – especially the hydrous and amorphous RuO_2 exhibits superior performance – though scarcity and high price prevent its large-scale production.

Current Invention

Inventors led by Profs. Cengiz and Mihrimah Ozkan have developed a patented, Nickel (Ni) Nanodendrite attached on Ni nanowire backbone which is synthesized directly on Ni foam as a novel support for hydrous RuO_2 nanoparticles and its application to symmetric supercapacitors. In their synthesis, hydrous RuO_2 nanoparticles are dip-coated onto Nickel Nanodendrite Foam (NDF) and annealed at 150 deg. C under vacuum.



Scanning electron microscopy image of RuO_2 coated NDF.



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OTHER INFORMATION

KEYWORDS

Ruthenium Oxide, Nickel nanodendrite foam, Supercapacitor, Ultracapacitor, Regenerative recharge, Electric vehicle, Intermittent power source, Energy storage, Electrochemical energy storage

CATEGORIZED AS

- **Energy**
  - Storage/Battery
  - Wind
- **Materials & Chemicals**
  - Nanomaterials
- **Transportation**
  - Automotive

RELATED CASES

2016-351-0, 2011-520-0, 2013-406-0, 2013-407-0

Capacitance retention and coulombic efficiency at various RuO_2 loading.

ADVANTAGES

The novel aspects of their innovation are:

- Easily adapted to large scale production.
- No binders or conductive additives which delivers low equivalent series resistance of 0.5 ohms.
- Very low processing temperature and the use of environmentally benign chemicals.
- High energy density and high-power density with superior cycling stability at over 10,000 cycles.

STATE OF DEVELOPMENT

Lab level prototype.

The team fabricated lab level prototypes for performance characterization. Operated at 1.6V the supercapacitors displayed impressive specific capacitance of 678.57 Farads/gram with a high energy density of 60.32 WH/kg. Even at large current density of 100 A/gram, the prototype maintained a high energy density at 19.73 Wh/kg and a high power density of 40 kW/kg. Coulombic efficiencies were greater than 99.5% even after 10,000 cycles.

SUGGESTED USES

- Super- and Ultra-capacitors
- Rechargeable energy storage
- Applications that depend on intermittent renewable energy source such as wind.
- Regenerative recharge during braking for automotive applications.

RELATED MATERIALS

- Scalable, Binderless, and Carbonless Hierarchical Ni Nanodendrite Foam Decorated with Hydrous Ruthenium Dioxide for 1.6 V Symmetric Supercapacitors

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