# Nanoporous Tin Powder For Energy Applications

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**CONTACT**

UCLA Technology Development Group
ncd@tdg.ucla.edu
tel: 310.794.0558.



## INVENTORS

- Tolbert, Sarah H.

## OTHER INFORMATION

### KEYWORDS

Energy storage, battery, nanobattery, nanoporous tin, selective alloy corrosion, dealloying, demetalification

### CATEGORIZED AS

- **Energy**
  - Storage/Battery
- **Materials & Chemicals**
  - Nanomaterials
  - Storage
- **Nanotechnology**
  - Materials

### RELATED CASES

2016-095-0

## SUMMARY

UCLA researchers in the Department of Chemistry and Biochemistry have developed a method of synthesizing micrometer tin particles with nanosporous architecture and have successfully demonstrated the use of these particles as a high energy density anode for Na-ion and Li-ion batteries.

## BACKGROUND

Among various state-of-the-art batteries, Li-ion battery currently predominates the market of energy storage devices. However, the total capacity of Li-ion batteries is limited by the theoretical capacities of their cathode materials, and can no longer satisfy the increasing demand in new energy storage applications, such as hybrid electric vehicle (HEV)/electrical vehicle (EV) and smart grid. The demand for higher energy, higher power density, and low overall production cost calls for R&D efforts on improvement of traditional Li-ion batteries.

Advanced batteries require anode materials capable of incorporating large amount of ions, which can be quantified by their gravimetric ion storage capacity. Tin has an excellent gravimetric ion storage capacity, but micrometer dense tin cannot be used as an anode material because of significant structural failure (i.e. crack, fracture) under repeated cycling due to volume changes. Therefore, there is a need for high energy density anode materials for Li-ion, Na-ion batteries.

## INNOVATION

Researchers at UCLA have developed a method synthesizing nanoporous tin (Sn) particles by free-corrosion dealloying. The Sn particle size and the porosity can be tuned to match specific application requirements, and composite electrode with nanoporous Sn particles endows long cycle life and fast kinetic performance.

## APPLICATIONS

- The technology can be used for high energy density or high power density battery applications in:
- Mobile electronics (cellphone, laptops)
- Hybrid electric vehicles (HEV), electrical vehicle (EV)
- Stationary energy storage for wind and solar systems
- Battery-powered military products

- High surface area catalyst (i.e. Sn electrode for electrocatalytic reduction of CO2 to CO)

## ADVANTAGES

- The nanoporous architecture of Sn particles allows reversible macroscale volume expansion concomitant with charge/discharge process, thereby improves the cycle stability while maintaining a high energy density (80% capacity retention after 350 cycles).
- The nanoporous structure minimizes the ion diffusion distance within the particles, resulting in improved rate capacity and electrode kinetics.
- The nanoporous architecture offers high surface area facilitating the permeation of electrolyte into the electrode, which is beneficial to the formation of well-defined electrode electrolyte interface.
- Appropriate electrochemical conditioning steps mitigate deleterious catalytic surface reactions that occur on the surface of tin in non-aqueous electrolyte.
- The particle size and porosity of the nanoporous Sn particles can be tuned to match specific application requirements.
- The technology incorporates an economical and scalable fabrication method by utilizing free-corrosion dealloying.

## STATE OF DEVELOPMENT

Prototype has been successfully tested in a laboratory setting.

## PATENT STATUS

| Country | Type | Number | Dated | Case |
|---|---|---|---|---|
| United States Of America | Issued Patent | 10,147,936 | 12/04/2018 | 2016-095 |

## RELATED MATERIALS

▶ Detsi, E., Tolbert, S. H., Punzhin, S., & De Hosson, J. T. M. (2016). Metallic muscles and beyond: nanofoams at work. Journal of Materials Science, 51(1), 615-634.

## ADDITIONAL TECHNOLOGIES BY THESE INVENTORS

- Space Confined Polymer-Based Field Effect Transistors
- Novel Metal Chalcogenides For Pseudocapacitive Applications
- Robust Mesoporous Nife-Based Catalysts For Energy Applications



**UCLA Technology Development Group**
10889 Wilshire Blvd., Suite 920,Los Angeles,CA 90095
https://tdg.ucla.edu
Tel: 310.794.0558 | Fax: 310.794.0638 | ncd@tdg.ucla.edu