TECHNOLOGY

# Si-Carbon Nano-Tube (Si-CNT) Composites for Improved Lithium-ion Battery Electrodes

## OVERVIEW

Background
Silicon has been known as the highest capacity anode material to date for Li-ion batteries. However, during repeated lithiation and delithiation processes (charge-discharge cycles), significant swelling leads to anode fragmentation or pulverization, resulting in the loss of electrical connection. As a result, performance degradation occurs and Li-ion batteries lose their capacity. Various techniques to overcome these problems have been reported. For example, composites of silicon and graphite have been attempted, but the small amount of nano-sized Si used in the composites resulted in low specific capacity. Alternatively, neither carbon coated Si nano-composites or Si film deposited on a nickel substrate exhibit stable and high reversible capacity simultaneously with economical and commercial feasibility. Carbon nano-tubes (CNTs) have excellent mechanical strength and electrical conductivity; however, when CNTs and Si particles are physically blended to form a composite structure, homogeneous distribution of Si particles within the CNTs is practically difficult to fabricate, and separation of Si and CNTs occurs as charge-discharge cycles are repeated.

Researchers at the University of Maryland have developed an improved anode materials system based on Si nano-particles, CNTs, and a nano-structured copper (Cu) foil current collector. The invention has three novel components. The Cu foil surface is treated to have a nano-structured porous structure. The porous surface of the Cu-foil is filled with Si nano-particles on which catalysts for CNT growth is deposited without any extra binder. Finally, CNTs are grown catalytically and directly from the external surface of the Si nano-particles. The CNTs on the Si surface provide electronically conducting pathways from the Si particles to the Cu current collector. No additional electrical conducting materials (eg. carbon black) are required and the Si/CNT-anode system on nano-structured copper foil shows both high capacity and excellent cycle stability. Eliminating the requirement for additional binder and carbon black greatly simplifies the entire Si-anode fabrication process and makes continuous production of the anode material a low-cost commercial reality.

Advantages
High stability
Long charge-discharge cycle life, reduced degradation
High battery capacity
Low cost material
Simplified fabrication

Applications
Battery for mobile devices (i.e. phones, tablets, players, computers, cameras)
Battery for hybrid electrical vehicles (HEVs), and electrical vehicle (EVs)
Remote controlled/autonomous robotics

Field electronics

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## Additional Information

### INSTITUTION

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### CATEGORIES

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- Chemical

### EXTERNAL RESOURCES

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