Clemson University Research Foundation

Electrode and Electrolyte Materials for Li-ion Batteries (09-009)

Improved Materials for Li-Ion Batteries that Enable Higher Power and Higher Charge Capacity

Market Overview

These solid state Li-ion battery materials utilize large electropositive cations in the formation of transition metal phosphate frameworks, resulting in electrode materials with the ability to store more charge and deliver higher power outputs. The demand for high-power batteries for mobile devices and automotive applications is continually growing, with a shift towards cleaner and more efficient fuels and power options. Reflective of this demand, the Li-ion battery market has an estimated worth of $29.98 billion and is expected to more than double in the next 10 years. Clemson University researchers have engineered a method of creating new Li-ion battery materials, developing new cathode materials with improved charge and discharge characteristics. Another component is the open-framework solids that possess superior ion transport properties pertinent to the electrochemical performance of next-generation electrode materials for battery devices.

Application

Automotive batteries for hybrid/electric vehicles, portable electronics, medical devices

Stage of Development

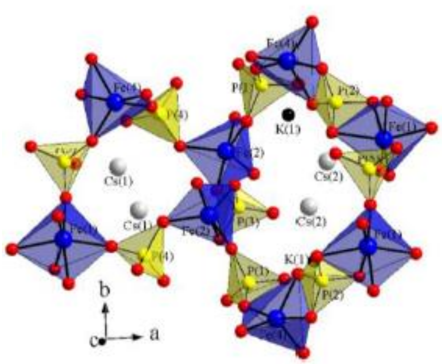
Functional Prototype

Advantages

- Novel synthesis of materials allows for more targeted development, creating batteries to meet specific applications.
- The cathode materials have superior properties compared to current Li-ion phosphate materials, delivering higher power and storing more charge.

Technical Summary

This technology consists of new strategies for the synthesis of a novel family of electrode and electrolyte materials possessing enhanced capacities useful for primary and secondary battery device applications. The general formula is AxM(XOz)n, whereas A = monovalent alkali metal cation and silver; M = first-row transition metal cation; X = P, As, V. The strategy employed for the synthesis of Ag+-based cathode materials deals with the incorporation of transition metal cations possessing multiple oxidation states comparable with reduction potentials of Ag2V4O11 (SVO). SVO is a state-of-the-art commercial material for the high-rate/power primary



Molecular view of AxM(XOz)n

For More Information Contact: Chris Gesswein| agesswe@clemson.edu | (864) 656-0797 | CURF Reference No. 09-009

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Li-ion battery applications in medical devices such as implantable cardioverter defibrillators (ICDs). The new materials have extended capacity at ~3 V due to the reductions of Ag(1+) to Ag(0) and M(n+) to M(m+)/Mn+ (n = m + a, a ≥ 1). For the secondary battery materials, the use of combined solid state and soft (ion-exchange) chemistries facilitates the development of new open-framework solids that otherwise cannot be isolated via direct synthesis. Additionally, these materials exhibit facile ion-transport.

App Type	Country	Serial No.	Patent No.	CURF Ref. Number	Inventors
Utility	United States	13/201,238	US9,077,037	09-009	Dr. Shiou-Jyh Hwu
PCT	PCT/US2010/023980	NA	NA	09-009	Dr. Shiou-Jyh Hwu

About the Inventor

Dr. Shiou-Jyh Hwu is a Professor of Inorganic Chemistry at Clemson University. He received his Ph.D. in Chemistry from Fu-Jen Catholic University in 1978 and a Ph.D. in Inorganic Chemsitry from Iowa State University in 1985. Prior to his career at Clemson, he conducted postdoctoral research in materials chemistry and superconductivity at Northwestern University and served on the faculty at Rice University. His research interests pertain to extended solids containing magnetic nanosturctures, pours and polar solids via salt inclusion synthesis, and extended solids with periodic arrays of quantum dots.

For More Information

To learn more about this technology, please contact:

Chris Gesswein

Technology Commercialization Officer

agesswe@clemson.edu

(864) 656-0797