Research & Reviews: Journal of Material Science
DOI: 10.4172/2321-6212.1000156

e-ISSN: 2321-6212
p-ISSN: 2347-2278
www.rroij.com

Nanotechnology Enabled Electrode Materials for Rechargeable Sodium-Ion Batteries: An Ideal Resolution to Global Energy Crisis

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Received date: October 03, 2016, **Accepted date:** October 03, 2016, **Published date:** October 10, 2016

Editorial

Editorial Corner: A Personnel View

Electrification of motor vehicles offers an interesting solution towards addressing the global energy crisis. In addition, the continuously depleting fossil energy resource and ever increasing global population mandates the search for highly productive and sustainable energy storage technologies. In recent decades, lithium-ion batteries have incarcerated the global portable electronic market with specialized applications in consumer electronics in addition to hybrid electric vehicles. The first commercial Lithium-Ion Battery (LIB) was introduced by the electronic giants Sony in 1991 and thereafter consistent research efforts were undertaken to enhance battery characteristics with special emphasis on fabrication costs and safety measures. In recent years, the desire for green and sustainable energy devices visualizes a very large scale production of LIBs to meet the rising demands of electric vehicle market. Nevertheless, the relatively lesser abundance of Lithium source is of immediate and significant research efforts are underway to develop radical alternates to LIBs. Sodium, the immediate cousin of Lithium in the periodic table, share same number of valences electrons as Li and hence similar chemical properties. Likewise, the environmental abundance and favorable cost of Sodium offers a virtuous possibility of employing Na as the alkali source for large scale fabrication of alkali ion based batteries.

Although, Sodium–Ion Batteries (NIBs) make use of same electrode materials as LIBs, the intercalation chemistry in NIBs is quite different from LIBs, owing to the relatively larger size of Na+ ion in contrast to Li+.The difficulties associated with Na+ intercalations has limited their widespread applications, however a serious hunt in on to unearth novel electrode materials that offer superior energy and power densities for NIB applications. The rapidly evolving science of nano metric systems and the availability of state of art characterizations for nanoscale objects offer the advantage of engineering the functional systems at molecular scales, so as to develop novel multifunctional electrode materials that offers advanced material behaviors that are quite different from the bulk materials. The advent of nanotechnology offers a wide variety of nano structured materials starting from carbon based anode materials such as nanowires and nanotubes that offers enhanced structural stability and excellent conductivities to nano sized TiO2 and CuO offering excellent cycle stability and improved current capacity. Nanostructured materials are also being extensively studied as cathode materials for NIBs with nano sized iron oxide and manganese dioxide materials exhibiting improved electrochemical performances. However, to extract maximum device performance, a thorough understanding of all the electrochemical principles involved is the need of the hour. However, the future research on NIBs must focus on improvising the mass loading of the nanostructured electrode materials in addition to achieving an appreciable improvement of tap density of electrode materials. Research emphasis must also be laid on low cost synthesis of nanostructured electrode materials that offer improved battery characteristics. To summarize, Nanotechnology opens up the technological gateway towards the design and development novel high performance electrode materials for NIB applications and hence a significant breakthrough in the overall performance enhancement of NIBs may be expected in the near future.