Electrochemical Devices for Energy Storage Applications

Sodium-ion battery anode materials and its future prospects and challenges

Nithyadharseni Palaniyandy, Mesfin A. Kebede

https://www.taylorfrancis.com/books/e/9780367855116

Abstract

So far lithium ion batteries (LIBs) have been considered to be prominent energy storage devices owing to its high specific energy and power densities. However, the potential scarcity of lithium resources makes it expensive and its low safety make it necessary to look for new alternative electrochemical batteries. Sodium is less expensive and abundant, as it is the fourth most abundant element in the earth's crust and is uniformly distributed around the world. Sodium-ion batteries (SIBs) adopt the same technology and electrochemistry principle as LIBs, however, the charge carriers are Na(sup+) instead of Li(sup+). Recently, SIBs have continued to receive tremendous exposure due to their natural abundance (earth's crust and sea water) [2.6 wt. %, compared to lithium (0.06%)], cost effectiveness, and similar chemical and electrochemical properties to the LIBs. However, the drawbacks such as higher redox potential (2.71 V vs Standard hydrogen electrode (SHE), standard hydrogen electrode), higher atomic mass (23 g mol 1), and the large ionic radii (1.02 Å) of sodium metal leading to a lower energy density of electrode material, face a challenge for the choice of the electrode materials for the SIBs. Therefore, it's necessary to use suitable nanostructured anode/cathode materials in order to occupy the sodium ions during the insertion and de-insertion process. There are many reports available on nanostructured SIBs electrode materials elsewhere (Nkosi et al. 2017; Palaniyandy et al. 2019). However, it is very challenging to discover appropriate electrode materials to accommodate Na(sup+) ions, to realize the fast insertion and de-insertion due to the larger ionic radii of Na(sup+) ions than Li(sup+) ions, and to overcome the sluggish diffusion kinetics of Na(sup+) ions.