Development of electrode materials for the rechargeable Na-ion batteries.

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ABSTRACT

In the field of rechargeable batteries Lithium-ion plays a key role and adopted world over due to its high energy density and power capability. Many applications powered by Lithium-Iron rechargeable batteries start from smaller energy requirements such as portable electronics to powering of hybrid vehicles which constitute to the green energy concept. The initial studies of rechargeable batteries started at the period 1970-1980s by focusing both on Lithium and Sodium. It was Lithium with higher energy density which was more concentrated for its lucrative and higher energy density. Later as the limited availability of Lithium and high costs made researchers concentrating on Sodium for its high abundance compared with Lithium.

This research work was based on synthesizing and characterizing of cathode materials and anode materials for sodium ion recharge able batteries and applications in real cells. Sodium Manganese oxide, Sodium Cobalt oxide, Sodium Nickel oxide, Sodium Nickel Boron Oxide were the cathode materials under investigation. The electrode materials developed for anodes were Sodium Titanium dioxide and Sodium Graphene oxide in which the Sodium graphite oxide was developed as a value addition to the Sri Lankan Kahatagaha Graphite.

Manganese was used as the transition metal with the Sodium, however the Sodium Manganese oxide cathode material gave a lesser retain capacity, of 30 mAh/mg. In the development of Sodium Cobalt oxide where Cobalt was the transition metal was more advanced with the retention capacity of 40 mAh/g for Na_xCoO_2, x=0.7.The novel-cathode material developed was the Sodium Nickel Boron Oxide where the needle type crystals appeared with the addition of 5% Boron. The optimum retain capacity 131.46 mAh/g and the cyclability of 192 correspond to 5% Boron impurity level.

Possible usage of Titanium dioxide as the Anode materials was tested with 256 cycles for Sodium ion battery where a phase change from Anatase to Rutile was observed at the synthesis. The Sodium Graphite Oxide was also made as anodes using domestic graphite of 99% purity where Sodium metal was used as reducing agent which gave a retention capacity of 46.129 mAh/g. These studies were carried out by advanced characterizing techniques and using different techniques to justify the results obtained. The scope of this study was to seek the possibility of use of sodium in the place of lithium in the future rechargeable batteries to meet the growing demand at a low cost. .