**511/E1**

## Electrochemical properties of sodium nickel oxide cathodes used for sodium-ion rechargeable batteries

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An emerging technology in the field of rechargeable batteries is the use of sodium-ion in place of lithium-ion because ofthe high abundance, low cost and safety of the former. Transition metal oxides with layered structures and alternating layers of Na and M (M = 3d transition metal such as Ni, Co, Mn, Fe, Cu) residing in the oxygen octahedral interstices have been extensively studied. Some of them have shown very interesting transport properties. For example, sodium nickel oxide intercalated with $Na^+$, is one of the materials that has shown fascinating results compared to conventional cathode materials.

In our study, the synthesis of $Na_xNiO_2$ active material was made using solid state reactions at 700 $^0$C and the material development was studied by x-ray diffraction (XRD) characterization techniques. The $Na_xNiO_2$ active cathode material was used for the construction ofhalf cells. The XRD characterization of $NaNiO_2$ confirmed the presence of the monoclinic crystalline structure. Scanning Electron microscopic (SEM) images of the cathode materialshowed the presence of micron level cavities with cuboid shaped particles constructed with a hexagonal unit cells. The specific band gap of the material was determined as 5.16 eV.by UV-Visible spectroscopy.

The synthesized material was used as the cathode of the sodium-ion battery on a stainless steel plate by spreading a slurry made by grinding $Na_xMnO_2$ (95%) and acetylene black (5%), with polyvinylidene fluoride (PVdF), dissolved in 1-methyl-2-pyrrolidinone (NMP) as the binder (AM mass is 1 mg $cm^{-2}$). A sodium foil was used as the anode. A 1 M solution of $NaClO_4$ in propylene carbonate was used as the electrolyte.

From the Nyquist plot, the charge transfer resistance of the cathode material was obtained as 13.12 kΩ. Elicit of maximum capacity retained relative to a gram of active material was achievable for thefirst discharges of each cell at various discharging rates. It was revealed that a maximum rate of capacity in a half cell account for charging the half cell by 0.75 mA rate for 0.12 hours. Further increase of charging time beyond 0.12 hours results in a decrease in capacity. Therefore the $NaNiO_2$ composite has been identified asan effective cathode material for sodium-ion rechargeable batteries with a first discharge capacity of 131.46 mAh/g.

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