SYNTHESIS AND ELECTROCHEMICAL PROPERTIES OF $Li[Ni_xLi_{1/3-2x/3}Mn_{2/3-x/3}]O_2$

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Lithium cobalt oxide is most widely used as layered structure cathode material in Li-ion battery. But cobalt is toxic and expensive. In order develop with environmental compatible and economical cathode, lots of studies are being carried out [1]. So a new synthetic method was found in this study to get layered structure cathode of Ni-Mn series for expanding surface area and enhancing capacity.

The materials of $Li[Ni_xLi_{1/3-2x/3}Mn_{2/3-x/3}]O_2$ ($0.1 \le x \le 0.5$) are synthesized using PVA-assisted sol-gel and molten-salt synthesis method. The use of PVA is to enhance the processability of the material by achieving the homogeneity of the media and molten-salt synthesis method has been reported to be one of the most effective and simplest methods in the preparation of multi-component oxides with desirable characteristics such as good chemical homogeneity, very fine size, and narrow size distribution.

Figure 1 shows the preparation of $Li[Ni_xLi_{1/3-2x/3}Mn_{2/3-x/3}]O_2$ schematically. $Mn(NO_3)_2 \cdot 6H_2O$ and $Ni(NO_3) \cdot 6H_2O$ were used as precursors in PVA-assisted sol-gel method. To initiate PVA-metal nitrate auto-ignition, the dried precursor was placed in a furnace that has been pre heated to 300 ^oC[2]. Then $Li[Ni_xLi_{1/3-2x/3}Mn_{2/3-x/3}]O_2$($0.1 \le x \le 0.5$) were fabricated by molten-salt method (600-900 °C) using excess of lithium salts ($Li(OH) \cdot H_2O$, $Li(NO_3) \cdot 6H_2O$).

The Structure of prepared samples were examined by x-ray diffraction(XRD) and scanning electron microscope (SEM) .With the PVA-assisted sol-gel and molten-salt synthesis, samples with a well-defined layered structure can be obtained. Figure 2 shows XRD patterns of $Li[Ni_xLi_{1/3-2x/3}Mn_{2/3-x/3}]O_2$ synthesized at 600,700,800 and 900 ^oC. The layered structure of $Li[Ni_xLi_{1/3-2x/3}Mn_{2/3-x/3}]O_2$ appeared above 800 ^oC. Figure 3 shows SEM micrographs of $Li[Ni_xLi_{1/3-2x/3}Mn_{2/3-x/3}]O_2$ with x=0.2 for samples which were synthesized at 600, 700, 800 and 900 ^oC. The size of particulates appears to be 0.2-1μm and increase with heating temperature.

The electrochemical performance of the synthesized compounds were measured in the voltage range from 2.0 to 4.8V at 40mA/g. Figure 4 shows the capacity vs. cycle number for Li/ $Li[Ni_xLi_{1/3-2x/3}Mn_{2/3-x/3}]O_2$ cell cycled between 2.0 and 4.8V using a specific currents of 40 mA/g. The lower was heating temperature the wider the surface area. But samples which were synthesized at 900 ^oC shows the best performance. It is that the fine size of particles has the large surface area but fine size cause poor contact between active materials and carbon black in making electrodes and lead to the capacity.

Reference
1. Zhonghau Lu, L.Y.Beaulieu, R.A.Donaberger, C.L.Thomas, and J.R.Dahn, .Eletrochem.Soc.,149, 778(2002)
2.HYU-BUM PARK, HO-JIN KWEON, YOUNG-SIK HONG,SI-JOONGKIM,KEON KIM.,J.Mater.Sci.,32, 57(1997)

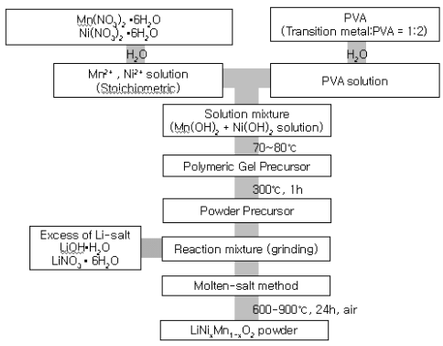


Fig 1.Flow chart for preparation of $Li[Ni_xLi_{1/3-2x/3}Mn_{2/3-x/3}]O_2$

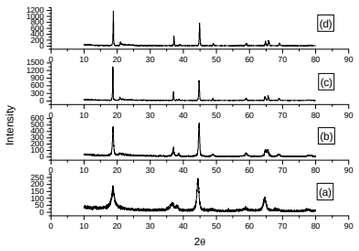


Fig 2.XRD patterns of $Li[Ni_xLi_{1/3-2x/3}Mn_{2/3-x/3}]O_2$ with x=0.3 by heat treatment (a) 600, (b)700, (c) 800 and (d)900 ^oC for24h

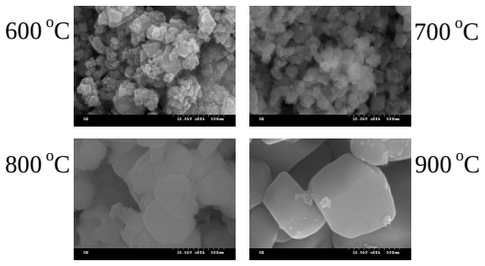
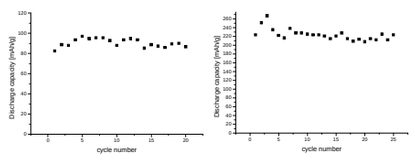


Fig 3. SEM of micrographs of $Li[Ni_xLi_{1/3-2x/3}Mn_{2/3-x/3}]O_2$ with x=0.2



(a) (b)

Fig 4. The cycle number vs. capacity for $Li[Ni_xLi_{1/3-2x/3}Mn_{2/3-x/3}]O_2$ with x=0.5 by heat treatment (a) 600 and (b) 900 ^oC