Synthesis and charge-discharge properties of LiF-$Ni_xMn_{1-x}O$ composite as a cathode material for Li-ion batteries

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In our recent research, LiF-MO (M = Mn, Fe, Co, Ni) composites synthesized by the mechanical milling worked as the cathode material of lithium-ion batteries. The LiF-NiO and LiF-MnO composites showed the highest discharge voltage and capacity, respectively[1]. The discharge capacity of LiF-MnO composite was highest and the discharge voltage was lower than LiF-NiO. Therefore, it is predicted that discharge voltage can be improved by adding NiO to MnO while maintaining high discharge capacity of LiF-MnO composite. In this study, we synthesized LiF-$Ni_xMn_{1-x}O$ composites from LiF and the solid solution of NiO and MnO, to obtain high energy density and characterized the composites.

Experimental

$Ni_xMn_{1-x}O$ were synthesised by the mechanical milling for 6 h and calcine in vacuum for 6 h. LiF-$Ni_xMn_{1-x}O$ composites in a molar ratio of 1:1 were synthesized by the mechanical milling of LiF and $Ni_xMn_{1-x}O$ for 72 h. The synthesized composites were investigated by XRD, charge-discharge measurements, and XPS. The cathode sheets were fabricated using the synthesized composite sample (70 wt%), KETJENBLACK (20 wt%), and polyvinylidene fluoride (10 wt%). The charge-discharge measurements were performed using a stainless steel cell for voltages of 2.0-4.8 V (versus Li/Li^+). The test cell was composed of a sheet of the synthesized composite as the cathode, a piece of lithium foil as the anode, and 1 M $LiPF_6$-EC/EMC (1:1 by volume) as the electrolyte.

Results & Conclusions

We confirmed $Ni_xMn_{1-x}O$ and LiF-$Ni_xMn_{1-x}O$ composites were synthesized from XRD measurement. Figure shows the discharge curves of LiF-$Ni_xMn_{1-x}O$ composites. The discharge capacities of samples exceeded 150 mAh^{-1}. The average discharge voltage increased with the amount of Ni. The discharge capacity changed by adding Ni and reached the maximum value at Ni : Mn = 2:8 to be 279 mAh^{-1}. The energy density was also greatest value at Ni : Mn = 2:8, 868 $Whkg^{-1}$. The energy density of LiF-MnO(Ni : Mn = 0:10) composite was 610 $Whkg^{-1}$. Energy density improved by 42 % compared with LiF-MnO composites. Adding NiO to LiF-MnO composites was effective in improving energy density.

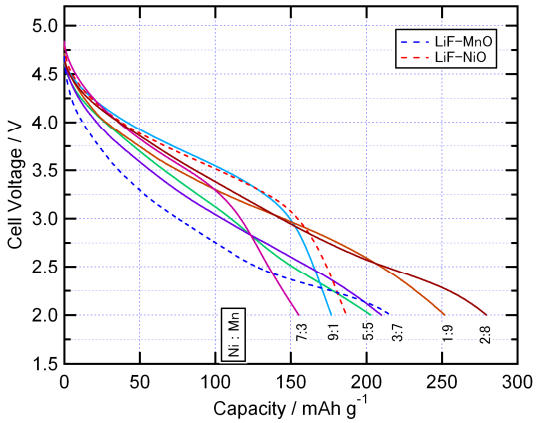

Fig. The discharge curve of LiF－$Ni_xMn_{1-x}O$ composites.

References:

[1] Y. Tomita, H. Nasu, Y. Izumi, J. Arai, S. Otsuka,Y. Yamane, K. Yamada, Y. Kohno, K. Kobayashi, J.Power Sources, 329 (2016) 406-411