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Synthesis and Characterization of Ru doped spinel $LiNi_{0.5}Mn_{1.5}O_4$ with Improved High-rate Performance

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High operation voltage and reversible capacity make $LiNi_{0.5}Mn_{1.5}O_4$ with spinel structure a promising candidate for the cathode of next generation lithium ion batteries (1). However, its low conductivity resulting in small accessible capacity and poor cyclic performance at high current rates restricts its application in high power application such as electric vehicles. Nano-sized $LiNi_{0.5}Mn_{1.5}O_4$ has demonstrated greatly improved high-rate performances through decrease the charge transport length (2-3). However, the use of nanometric material with large surface area may cause detrimental reaction with electrolyte, poor inter-particle contacts and low electrode density. Doping 3d transition metals such as Cr, Fe, Co and Cu (4-7) has been proved as an effective way to improve the electrochemical performance of the $LiNi_{0.5}Mn_{1.5}O_4$. While doping 4d transition metal with heavier atomic mass is rarely reported mainly due to the consideration of damage of theoretical capacity. Recently our group using 4d transition metal oxide RuO_2 synthesized the novel spinel $LiNi_{0.5-2x}Ru_xMn_{1.5}O_4$ (x=0.01,0.03,0.05) by simple solid state reaction. Their crystal structure, morphology, chemical composition, and conductivity have been characterized by X-ray diffraction (XRD), scanning electron microscopy (SEM), transmission electron microscopy (TEM) and electrochemical impedance spectrum (EIS). The Rietveld refinement analysis of XRD profiles suggests that all synthesized products including $LiNi_{0.5}Mn_{1.5}O_4$ adopt cubic spinel structure with a space group of $Fd\bar{3}m$ (Fig 1). Selected area electron diffraction (SAED) patterns in [100] zone also confirm the refinement results. The EDS results on single particles indicate that Ru has been successfully doped into the crystal lattice. SEM morphology shows that the particle size ranges between 0.5 and 1 μm. EIS measurement shows that after doping Ru, the room temperature electrical conductivity is several times higher than that of the non-doped $LiNi_{0.5}Mn_{1.5}O_4$ (Fig 2). Electrochemical performances were measured through cycling batteries between 3 and 5 V at various C rate (1C=147mA/g). The Ru doped $LiNi_{0.5}Mn_{1.5}O_4$ spinels show outstanding rate capabilities. At 0.2C discharge rate, all of them could deliver nearly 130mAh/g. At 10C discharge rate, the $LiNi_{0.4}Ru_{0.05}Mn_{1.5}O_4$ can deliver 117mAh/g while the $LiNi_{0.5}Mn_{1.5}O_4$ can only release only 58mAh/g. Cyclic performance was tested at 10C charge/discharge rate for 500 cycles. The $LiNi_{0.5}Mn_{1.5}O_4$ initially can deliver 66mAh/g, and less than 40mAh/g can be released at 500th cycle. While, the $LiNi_{0.4}Ru_{0.05}Mn_{1.5}O_4$ exhibits excellent cyclic performance, which initially can offer 111mAh/g and still maintain 93mAh/g at the 500th cycle (Fig 3). The large accessible capacity and excellent cyclic performance can be attributed to the great improvement in conductivity through doping Ru.

REFERENCES

1. Ohzuku, T. and R.J. Brodd, J. Power Sources, 174, 449 (2007).
2. Shaju, K.M. and P.G. Bruce, Dalton Transactions, 40, 5471 (2008)
3. J. C. Arrebola, A. Caballero, M. Cruz, L. Hernan, J. Morales, E. R. Castellon, Adv. Funct. Mater. 16, 1904. (2006)
4. T. F. Yi, C. Y. Li, Y. R. Zhu, J. Shu, R. S. Zhu, J. Solid State Chem. 13, 913 (2009)
5. Y. Ein-Eli, J. T. Vaughey, M. M. Thackeray, S. Mukerjee, X. Q. Yang, J. McBreen, J. Electrochem. Soc. 146, 908 (1999)
6. A. Ito, D. Li, Y. Lee, K. Kobayakawa, Y. Sato, J. Power Sources 185, 1429 (2008)
7. J. Liu, A. Manthiram, J. Phys. Chem. C 113, 15073 (2009)

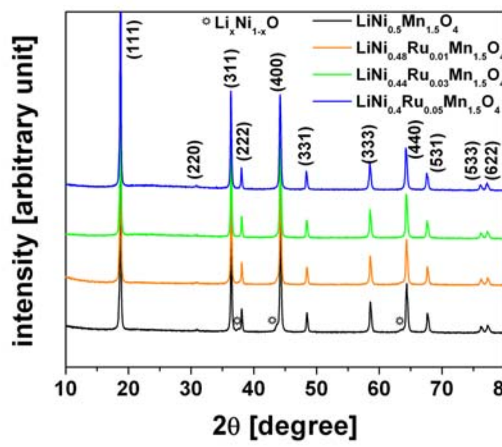

Fig 1(XRD profiles of the $LiNi_{0.5-2x}Ru_xMn_{1.5}O_4$ (x=0, 0.01, 0.03 and 0.05).)

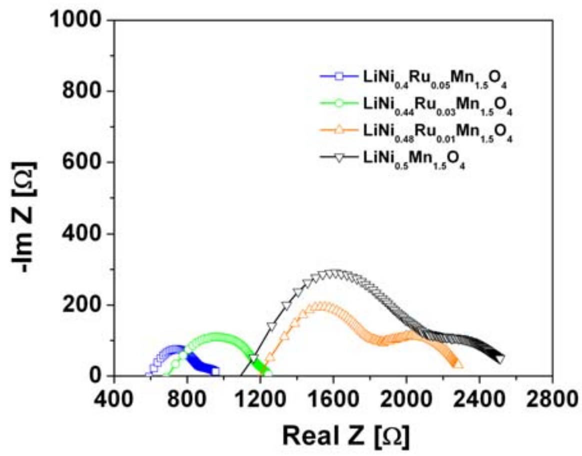

Fig 2 (EIS comparison of the $LiNi_{0.5-2x}Ru_xMn_{1.5}O_4$ (x=0, 0.01, 0.03 and 0.05).)

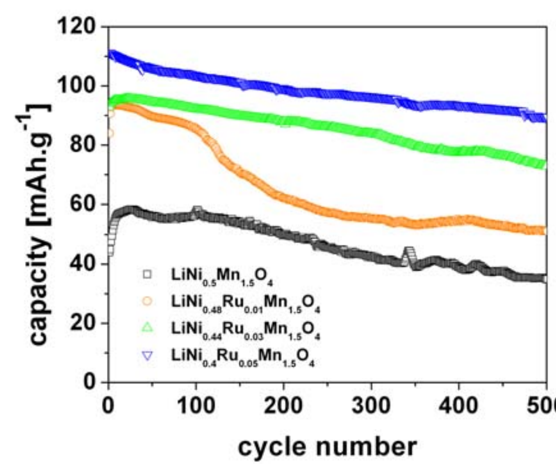

Fig 3 (Cyclic performance of the $LiNi_{0.5-2x}Ru_xMn_{1.5}O_4$ (x=0, 0.01, 0.03 and 0.05) at 10C charge/discharge rate.)