P2-Type Layered Sodium Manganese Oxide as Cathode Materials for Na-Ion Batteries

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As demand for electric vehicles and large scale energy storage systems has recently increased, the development of inexpensive batteries is needed. In this connection, Na-ion batteries are attracting much attention as an alternative to expensive Li-ion batteries because of abundant sodium resources. However, the energy density of Na-ion batteries is slightly lower than that of the Li-ion batteries. Much effort has been devoted to developing the high capacity electrode materials for improving the energy density of Na-ion batteries. [1,2]
P2-type manganese-based oxides have been focused as promising cathode materials because of a high reversible capacity and inexpensive manganese resources. However, P2-type manganese-based oxides showed poor cycle performance, which is attributable to the Jahn-Teller effect of Mn^{3+}, OP4 phase transition at high voltages, and complex phase transitions during charging and discharging due to Na^{+}-vacancy ordering. [3]
In this presentation, we demonstrate the failure mechanism of the P2-type layered manganese-based oxides. We prepared Li- and V-doped sodium manganese oxides, and their reaction mechanisms were compared using ex situ X-ray absorption spectroscopy and in situ X-ray diffraction. Li-doped sodium manganese oxide with one-phase reaction showed better cycle performance than V-doped sodium manganese oxide with complex two-phase reaction. This suggests that the two-phase reaction mechanism can affect the failure of the P2-type layered manganese-based oxides. Moreover, we clarify the role of structural stability in the capacity fading of the P2-type layered manganese-based oxides.

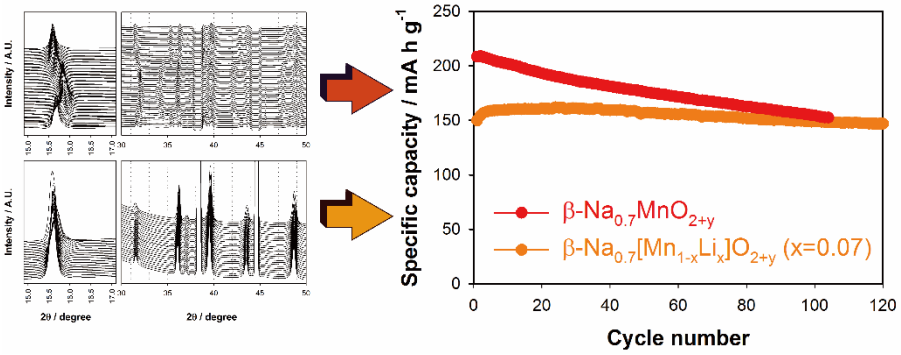

Figure. In situ synchrotron XRD patterns and cycle performance of β-$Na_{0.7}[Mn_{1-x}Li_x]O_{2+y}$ (x=0, 0.07)

References:
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