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Synthesis and characterization of Ni and Ti substituted Li_2MnO_3 positive electrode material for lithium-ion battery

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Li-excess positive electrode material ($LiMO_2$-Li_2MnO_3 solid solution, M=$Ni_{1/2}Mn_{1/2}$ or $Ni_{1/3}Mn_{1/3}Co_{1/3}$) is a good candidate as its high-capacity (250 mAh/g) and acceptable discharge voltage above 3.5 V for high energy-density lithium-ion battery to EV and PHEV application. Especially, $LiNi_{1/2}Mn_{1/2}O_2$-Li_2MnO_3 solid solution ($Li_{1+x}(NiyMn_{1-y})_{1-x}O_2$, 0<x<1/3, 0<y<0.5) is a most attractive as "Co-free" positive electrode material. Synthesis of this material is quite difficult, because homogeneous transition metal distributed precursor can be hardly obtained. AIST has a solution using "co-precipitation hydrothermal calcination method", which was found during the preparation of a new 3 V-class positive electrode material, $LiFeO_2$-Li_2MnO_3 solid solution. In this work, the synthetic method applies to $LiNi_{1/2}Mn_{1/2}O_2$-Li_2MnO_3 system. As shown in Fig. 1, the homogeneous precursor can be prepared by low-temperature co-precipitation Ni-Mn hydroxide and hydrothermal treatment with an oxidizer, $KClO_3$ and Li-source, $LiOH.H_2O$ at 220°C. The precursor calcined with $LiOH.H_2O$ at 850°C under N2 atmosphere to obtain better initial electrochemical performance. To improve cycle performance under full-cell configuration, Ti ion substituted for Mn ion by using 30% $Ti(SO_4)_2$ aq. solution. Although further effort to establish more facile synthetic method must be needed, the Ni- and Ti- substituted Li_2MnO_3 is an attractive candidate as high-capacity "Co-free" positive electrode material. We develop Li-excess LiNiO2 as high-capacity and better cyclability using thermal decomposition of Li_2NiO_3. AIST found a new 3.5 V-class Fe- and Ni substituted Li_2MnO_3 positive electrode material with NEC and Tanaka Chemical Co. These materials are also "Co-free" ones.

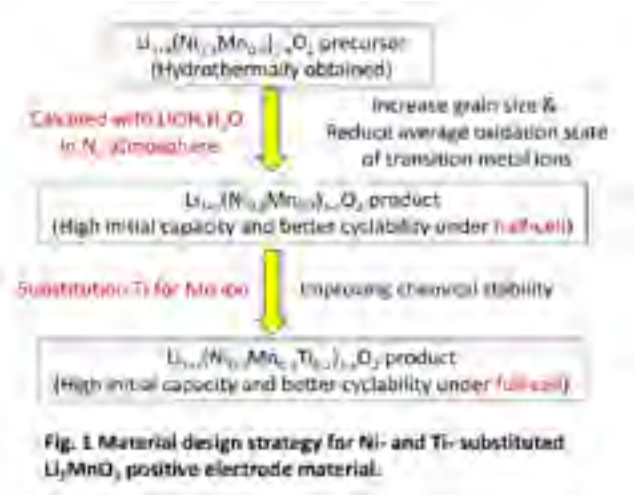

Fig. 1 Material design strategy for Ni- and Ti- substituted Li_2MnO_3 positive electrode material.

Biography

Mitsuharu Tabuchi is an Inorganic Synthetic Chemist using wet-chemical process for oxide-based positive electrode material of lithium-ion battery. He has extensive experience in the synthetic construction to get homogeneous $LiFeO_2$-Li_2MnO_3 solid solution. The constructed synthetic route is also effective for preparing $LiNi_{1/2}Mn_{1/2}O_2$-Li_2MnO_3. He also has characterization experience using 57Fe Mössbauer Spectroscopy and X-ray Rietveld analysis to know the charge compensation mechanism for $LiFeO_2$-Li_2MnO_3 system.

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