

# Our recent progress for developing high-capacity and Li-excess “Co-free” positive electrode materials with layered rock-salt structure

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Li-excess positive electrode materials ( $x\text{LiMO}_2-(1-x)\text{Li}_2\text{MnO}_3$  solid solution,  $M=\text{Mn, Fe, Co}$  and  $\text{Ni}$ ) are attractive candidate for large-scale Lithium-ion battery (LIB) for EV and PHEV applications, because they have high specific capacity above 200 mAh/g. Although most of researchers have focused on 4V-class positive electrodes like  $\text{LiNi}_{1/2}\text{Mn}_{1/2}\text{O}_2$  or  $\text{LiNi}_{1/3}\text{Mn}_{1/3}\text{Co}_{1/3}\text{O}_2$  as the  $\text{LiMO}_2$  end-member, we have studied electrochemically-inactive  $\text{LiFeO}_2$  as the end-member to develop inexpensive “LFM and LFMT systems” (see Fig. 1) [1, 2]. Partial reduction of tetravalent Mn ions in the  $\text{Li}_2\text{MnO}_3$  component led to finding new system like “LTM one” [2]. However, these materials had low average discharge voltage below 3.3 V vs. Li. To overcome this low voltage, we shifted our research to the  $x\text{LiFe}_{1/2}\text{Ni}_{1/2}\text{O}_2-(1-x)\text{Li}_2\text{MnO}_3$  (LFNM) system, because it had high discharge-voltage around 3.5 V [3]. Now both a battery manufacturer and a material supplier support our research to check the possibility for practical use of the LFNM system on a national project [4]. In existing LNM and LNMT systems, the electrochemical performance has been drastically improved by calcination in  $\text{N}_2$  atmosphere instead of air one [5]. The Li-excess LN system can also be obtained by thermal decomposition of  $\text{Li}_2\text{NiO}_3$  and it exhibited better cycle durability than that of typical LN system for high charging cut-off 4.8V [6]. We intend to develop these materials to improve their electrochemical performance aiming to practical use.

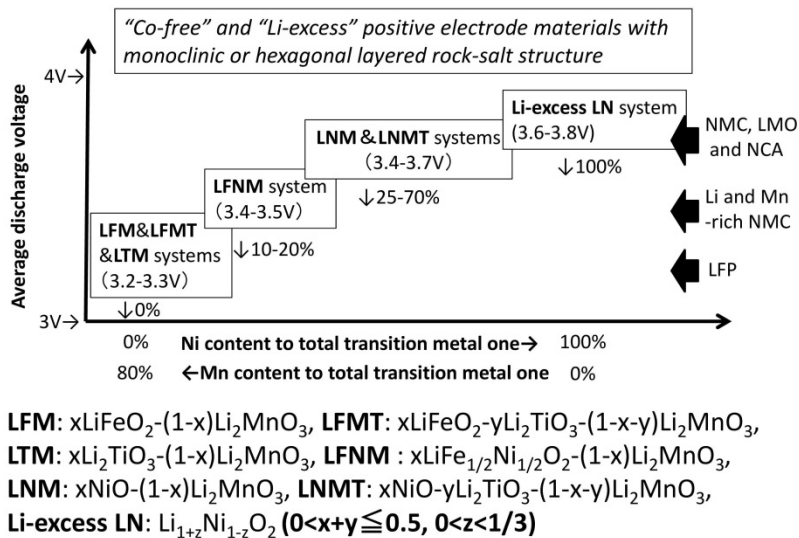


Fig. 1 Our recent progress for “Co-free” Li-excess positive electrode oxide materials to replace previous positive electrode materials

**References:** [1] M. Tabuchi, Y. Nabeshima, T. Takeuchi, K. Tatsumi, J. Imaizumi, Y. Nitta, J. Power Sources 195 (2010) 834-844. [2] M. Tabuchi, Y. Nabeshima, T. Takeuchi, H. Kageyama, J. Imaizumi, H. Shibuya, J. Akimoto, J. Power Sources 221 (2013) 427-434. [3] M. Tabuchi, Y. Nabeshima, T. Takeuchi, H. Kageyama, K. Tatsumi, J. Akimoto, H. Shibuya, J. Imaizumi, J. Power Sources 196 (2011) 3611-3622. [4] R. Yuge, S. Kuroshima, A. Toda, T. Miyazaki, M. Tabuchi, K. Domae, H. Shibuya, N. Tamura, J. Power Sources 365 (2017) 117-125. [5] M. Tabuchi, H. Kageyama, K. Takamori, Y. Imanari, K. Nakane, Electrochimica Acta 210 (2016) 105-110. [6] M. Tabuchi, N. Kuriyama, K. Takamori, Y. Imanari, K. Nakane, J. Electrochem. Soc. 163 (2016) A2312-A2317.