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High Performance $LiNi_{0.5}Mn_{1.5}O_4$ Spinel Li-ion Battery Cathode Development

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Due to its high theoretical capacity (147 mAh/g), high operating voltage (~5V vs. Li/Li^+ of Ni^{2+}/Ni^{4+} couple), and inherent cycle stability (Mn^{4+} state, no Jahn-Teller distortion of Mn^{3+}), $LiNi_{0.5}Mn_{1.5}O_4$ (LNMO) spinel is a promising cathode active material for high energy density lithium ion batteries [1, 2, 3] that can potentially be used in a wide range of applications including consumer electronics, electric vehicles, military and space. However, some performance issues of LNMO need to be addressed before its practical commercialization. These include extended cycle life, high rate capability, and cycle stability at elevated temperatures (e.g. 55°C).

We will present efforts at ADA Technologies, Inc. to optimize LNMO performance via material and operation approaches. In addition, stable electrolytes [4] and oxide coatings with atomic layer deposition (ALD) technique are used to address cycle stability issue of LNMO at high temperatures.

Figure 1 shows capacity retention vs. cycle number for LNMO/Li half cells at 1C charge and 2C discharge rates and at room temperature (RT). Optimized ADA LNMO demonstrated much more stable cycle behavior compared with that of a commercial LNMO.

Figure 2 shows rate performance of LNMO/Li coin half cells at room temperature. With comparable electrode loadings, rate capability of ADA LNMO is much better than the commercial LNMO, with more than 50% and 80% of the low rate capacity at 100C and 80C rate, respectively.

Figure 3 shows cycle stability test for LNMO/Li half cells first at 50°C and then at 55°C after 75 cycles at 1C/2C (charge/discharge) rates. Optimized ADA LNMO demonstrated stable high temperature cyclability close to that at RT after about 200 cycles. The cell containing the commercial LNMO faded rapidly when cycled at 55°C. The results suggest inherent material property of high temperature stability of ADA LNMO. Figure 3 shows Al_2O_3 coated LNMO via ALD method exhibited improved high temperature cyclability, especially at longer cycles, despite its higher initial cell resistance, compared with the uncoated LNMO.

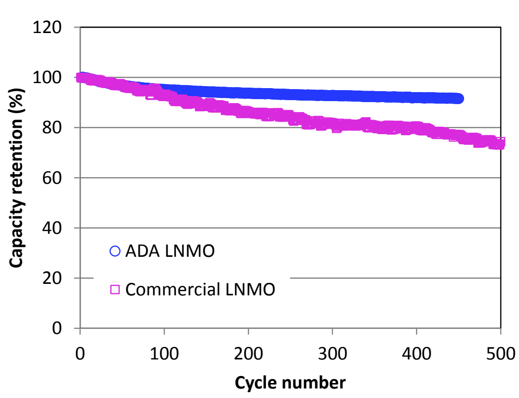

Figure 1. Capacity retention vs. cycle number of LNMO/Li half coin cells at 1C/2C (charge/discharge) rates at RT.

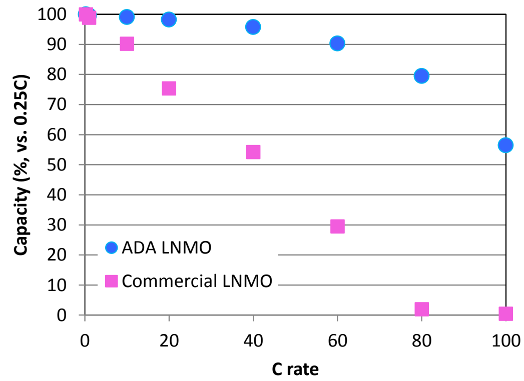

Figure 2. Discharge capacity at various C-rates vs. that at 0.25C rate for LNMO/Li half coin cells at RT.

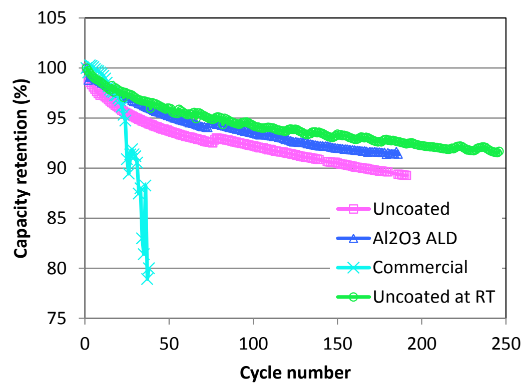

Figure 3. High temperature cycle test (50°C and then 55°C after 75 cycles) for LNMO/Li half coin cells.

References

1. Q. Zhong et al, J. Electrochem. Soc., **144**, 205 (1997).
2. K. Amine et al, J. Power Sources, **68**, 604 (1997).
3. Jing Mao et al, Electrochimica Acta, **63,** 381 (2012).
4. W. Xing et al, **221st** ECS Meeting Transactions, 2012.