A Multi-Functional Binder for High-Capacity Lithium-rich Layered Oxide Battery Cathode

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High-energy Li-ion batteries are well-suited for electric vehicle (EV) applications. For the success of long-driving EV, increasing the specific energy density of Li-ion batteries toward more than doubled compared to commercial batteries is on demand.[1] Li-rich layered oxide, represented by $x\mathrm{Li_2MnO_3}\cdot(1-x)\mathrm{LiMn_{1-y-z}Ni_yCo_zO_2}$ (LMNC), is a promising high-capacity cathode material for high-energy batteries, whose capacity increases by increasing the charge cut-off voltage to above 4.6 V versus $\mathrm{Li/Li^+}$, and more than doubled energy density than that of a commercial battery is possibly attained.[1,2] Its performance upon high-voltage operation (> 4.2 V versus $\mathrm{Li/Li^+}$) however is limited, due to instable cathode-electrolyte interface, and the occurrence of metal-dissolution, particle cracking and structural degradation, particularly, at elevated temperatures.[2] We have developed a new multi-functional binder (MF), which mitigates the degradation problems of cathode coated with conventional polyvinylidenefluoride (PVdF) binder, through superior binding ability to cathode surface element and the formation of a robust surface structure at the cathode.

In the commercial electrolyte of 1M $\mathrm{LiPF_6}$/EC:EMC without any electrolyte additive, the full-cell that consists of LMNC cathode coated with MF binder and graphite anode exhibits excellent capacity retention of 89% at the 100th cycle even in the harsh operation condition of 55 °C between 2.5 and 4.7 V. This is so far the best and first performance ever reported for high-voltage full-cell at elevated temperature without any electrolyte additive. On the contrary, a very rapid capacity fade is observed with the full-cell with the cathode coated with PVdF binder.[3] Improved high-voltage and high-temperature cycling performance and interfacial stabilization of the full-cell by the effects of our novel MF binder would be discussed in the meeting.

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