Supporting Information

Increased Performance Improvement of Lithium-Ion Batteries by Dry Powder Coating of High-Nickel NMC with Nanostructured Fumed Ternary Lithium Metal Oxides

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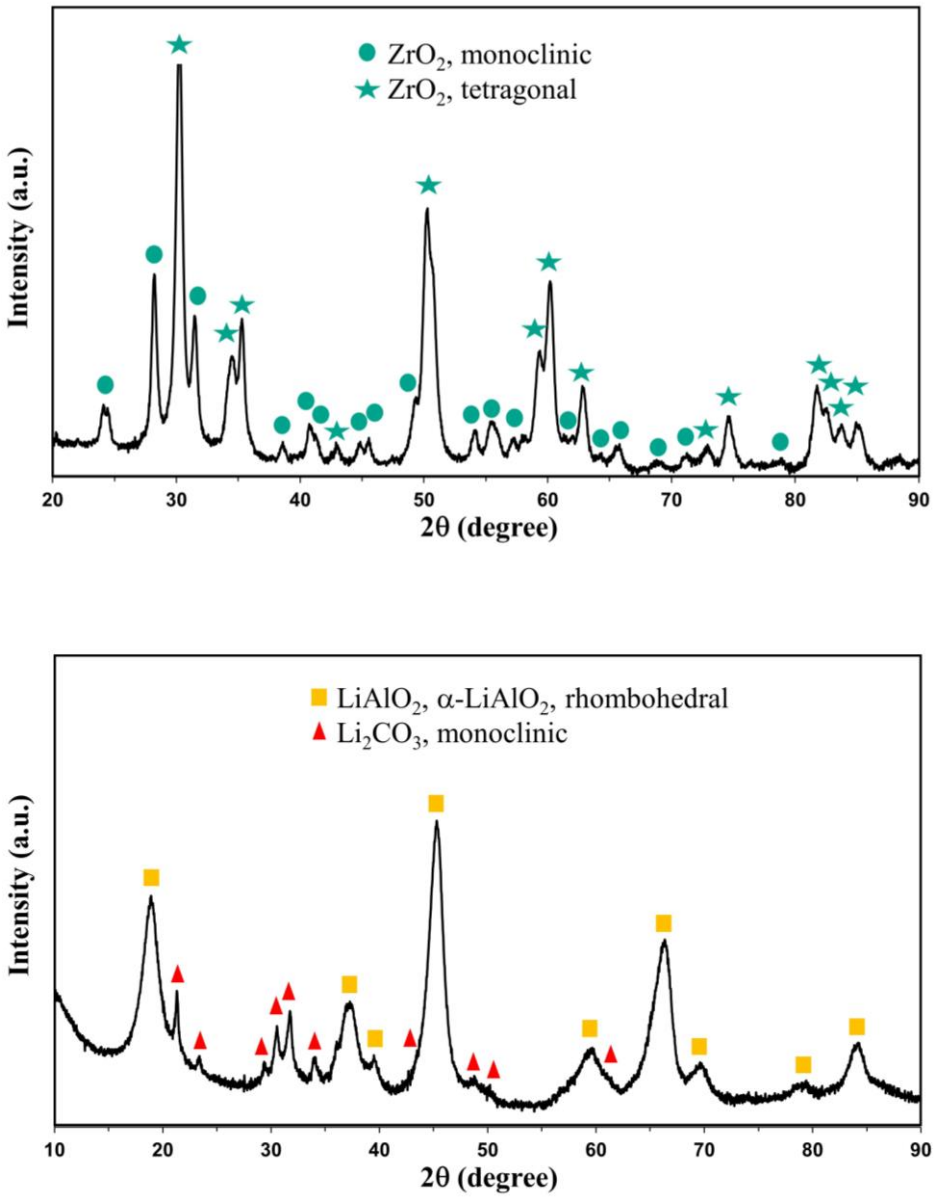

Figure S1. Continued.

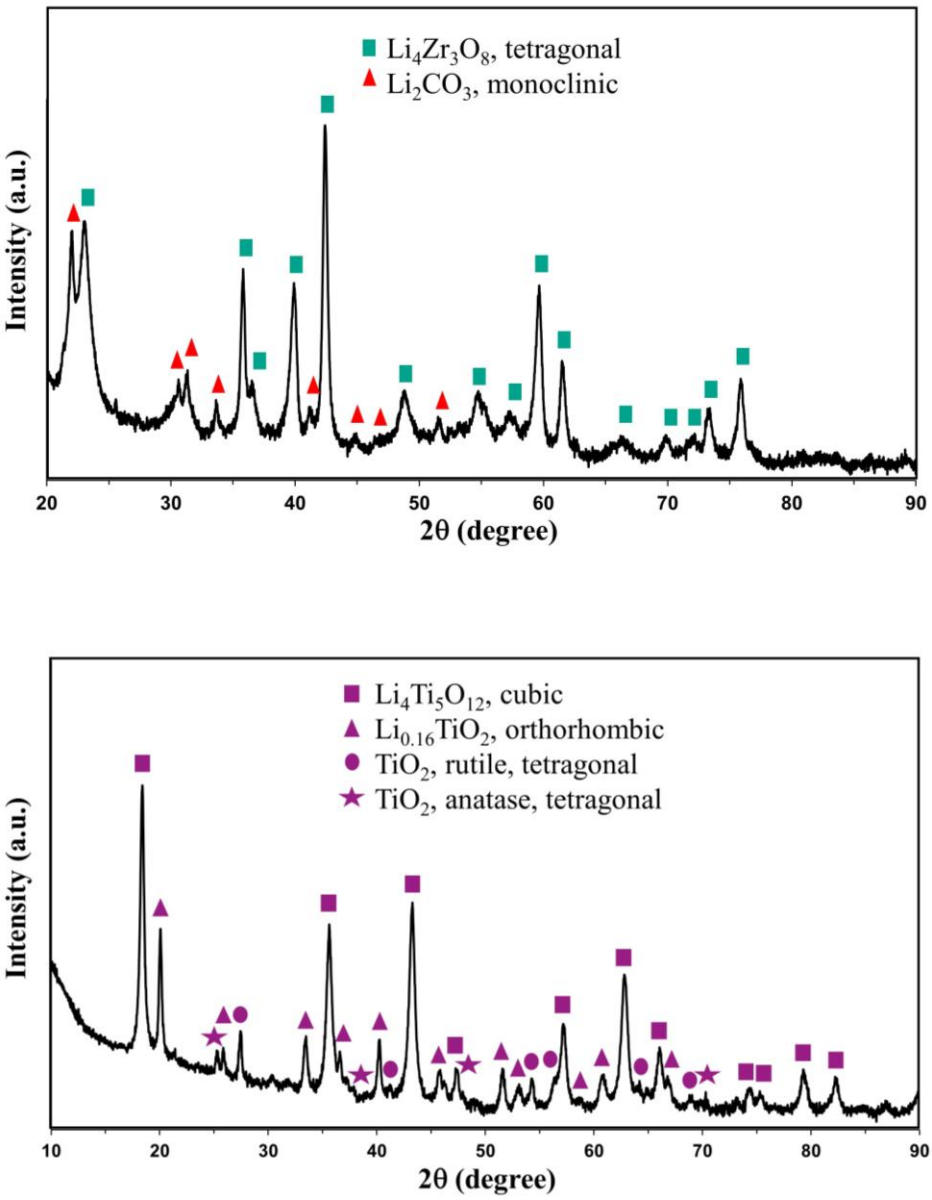

Figure S1. XRD patterns of fumed ZrO_2, $LiAlO_2$, $Li_4Zr_3O_8$, $Li_4Ti_5O_{12}$. Fumed ZrO_2 shows mostly tetragonal phase, $LiAlO_2$ shows the α-phase (rhombohedral), $Li_4Zr_3O_8$ is tetragonal and $Li_4Ti_5O_{12}$ has mostly a cubic structure.

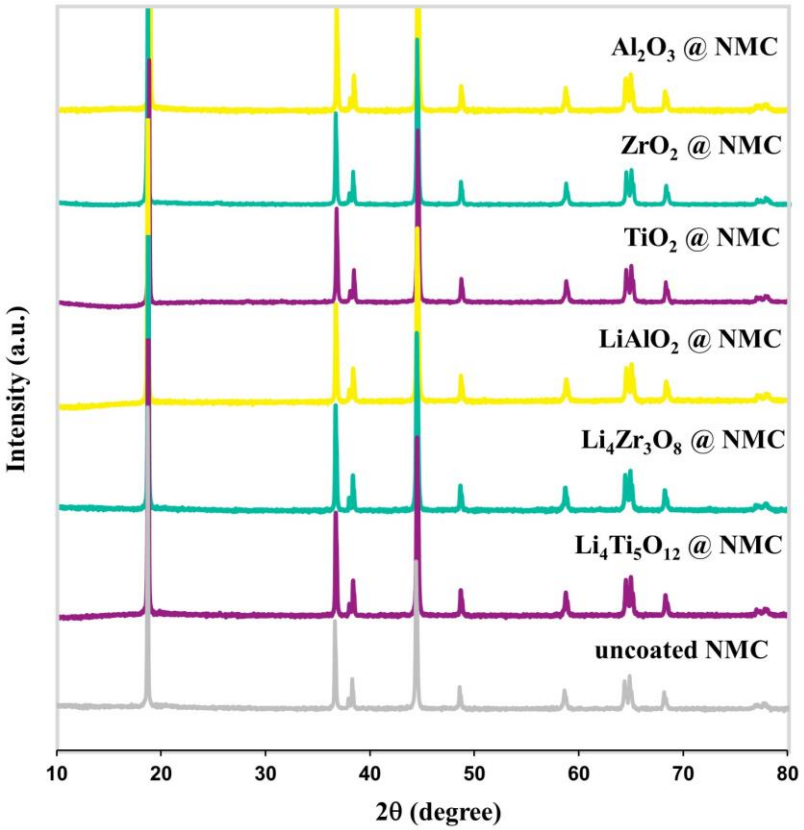

Figure S2. XRD patterns of NMC701515 coated by 1 wt % fumed Al_2O_3, ZrO_2, TiO_2, $LiAlO_2$, $Li_4Zr_3O_8$ and $Li_4Ti_5O_{12}$ compared to uncoated NMC.

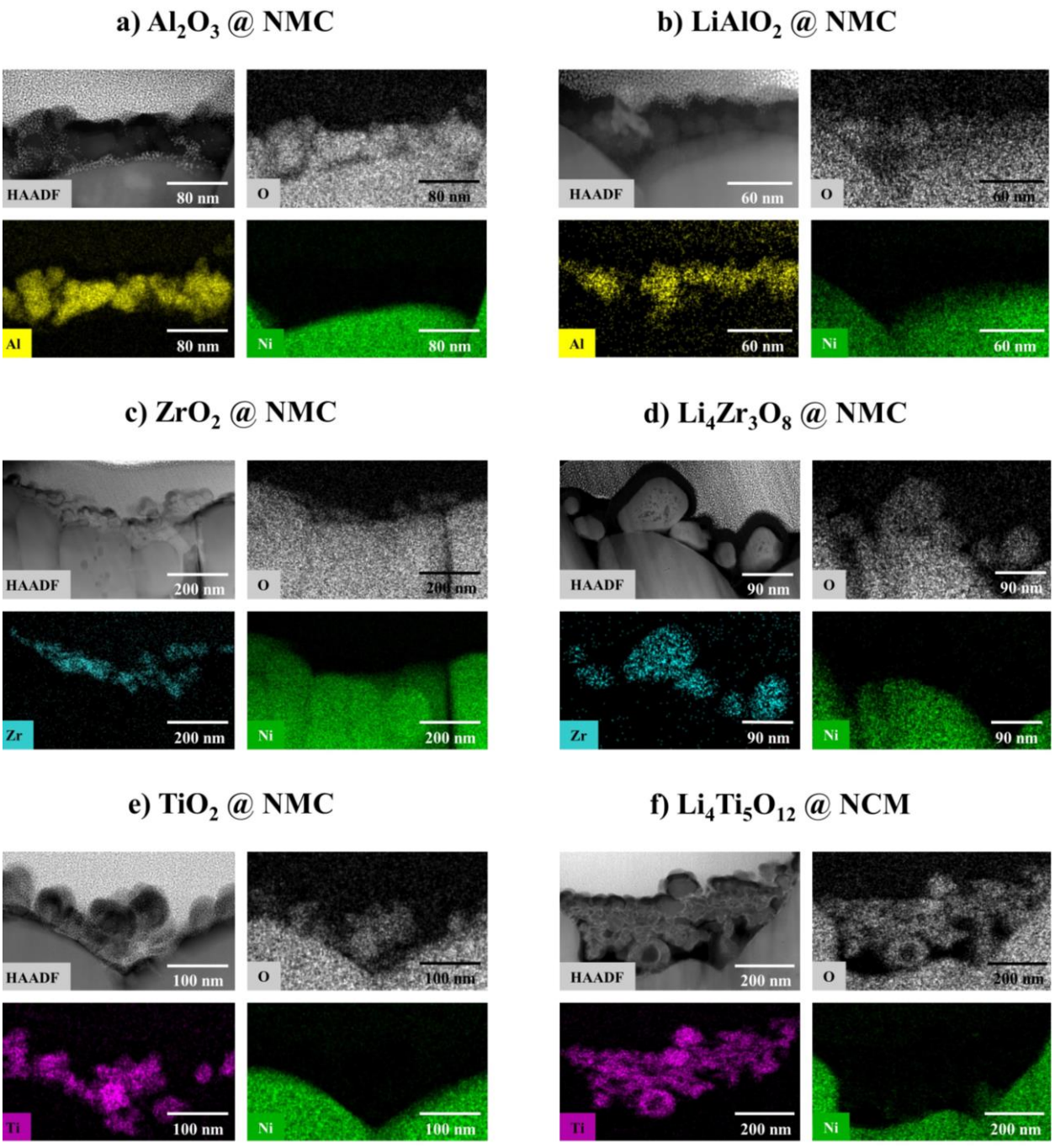

Figure S3. HAADF-STEM Z-contrast images and STEM-EDX analysis of cross-sections of NMC701515 coated with 1 wt % of the respective coating agent (a: Al_2O_3, b: $LiAlO_2$, c: ZrO_2, d: $Li_4Zr_3O_8$, e: TiO_2, f: $Li_4Ti_5O_{12}$). The distribution of nickel, manganese and cobalt is identical, therefore only the mapping of nickel is presented.

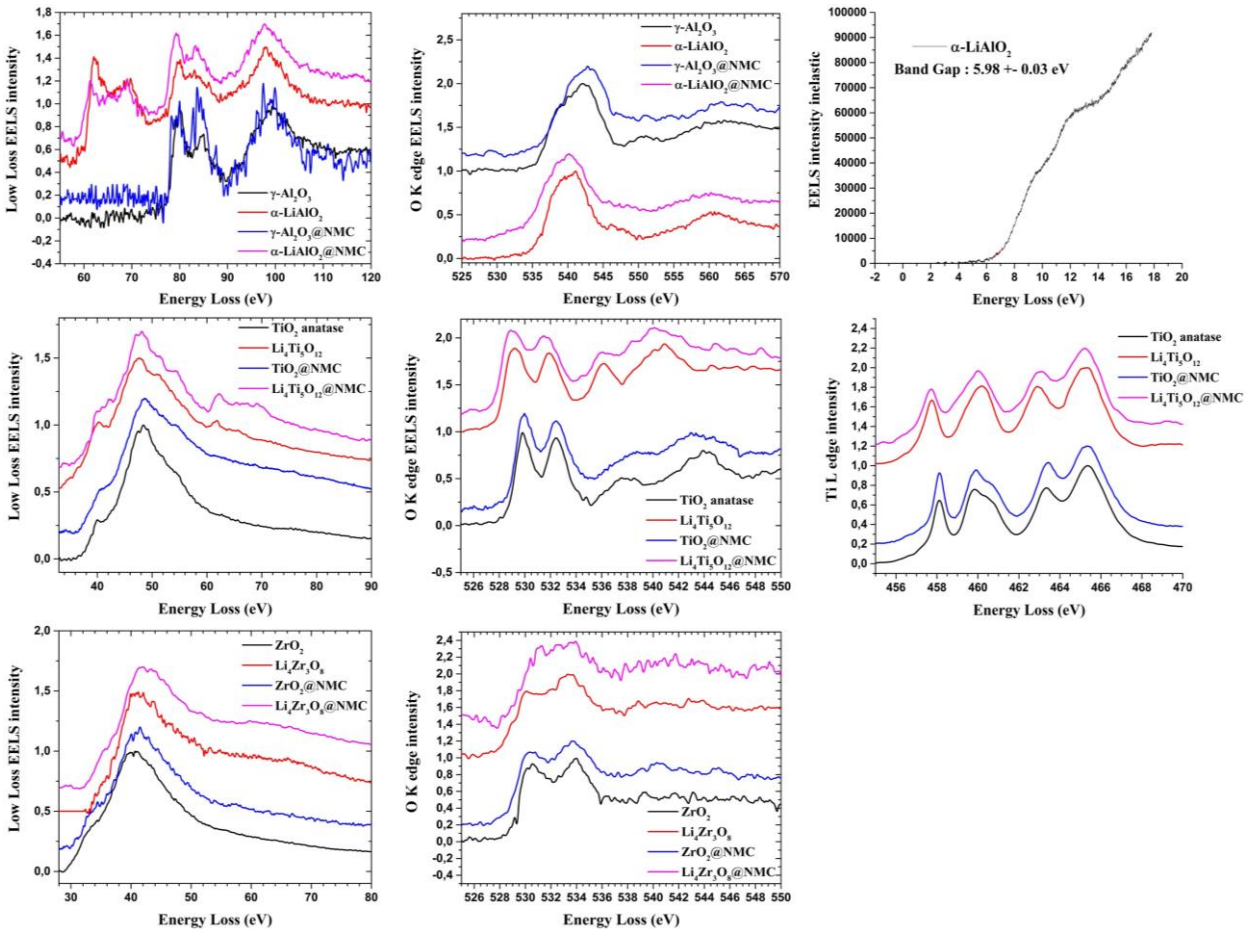

Figure S4. Electron energy-loss near edge structure (ELNES)-spectra/fine structures of the low loss regions and O K-edges of the respective coating materials, as well as the Ti L edge of the Ti-containing coating agents, before coating and after coating on high-nickel NMC. Comparison reveals that the chemical composition of the coating materials is not affected by the high-intensity dry coating process. These fine structures confirm the phases of the different coatings as anatase for TiO_2, γ-Al_2O_3 and $Li_4Ti_5O_{12}$. The band gap determination of $LiAlO_2$ confirms the structure as α-$LiAlO_2$.

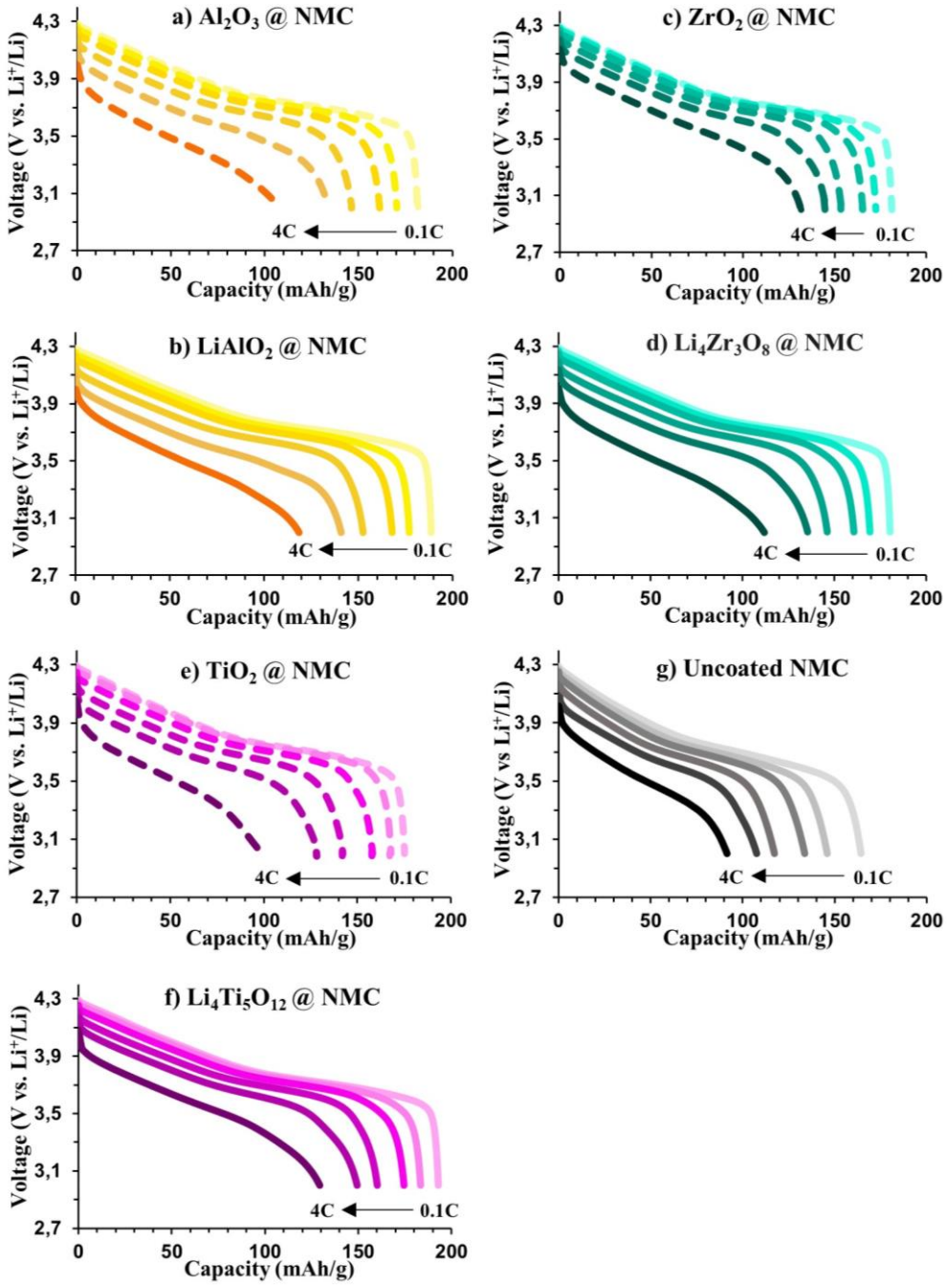

Figure S5. Galvanostatic discharge profiles of NMC coated with 1 wt % of the respective coating material (a: Al_2O_3, b: $LiAlO_2$, c: ZrO_2, d: $Li_4Zr_3O_8$, e: TiO_2, f: $Li_4Ti_5O_{12}$) and uncoated NMC (g) cycled between 3.0 – 4.3 V at room temperature at various discharge rates (C-rates).

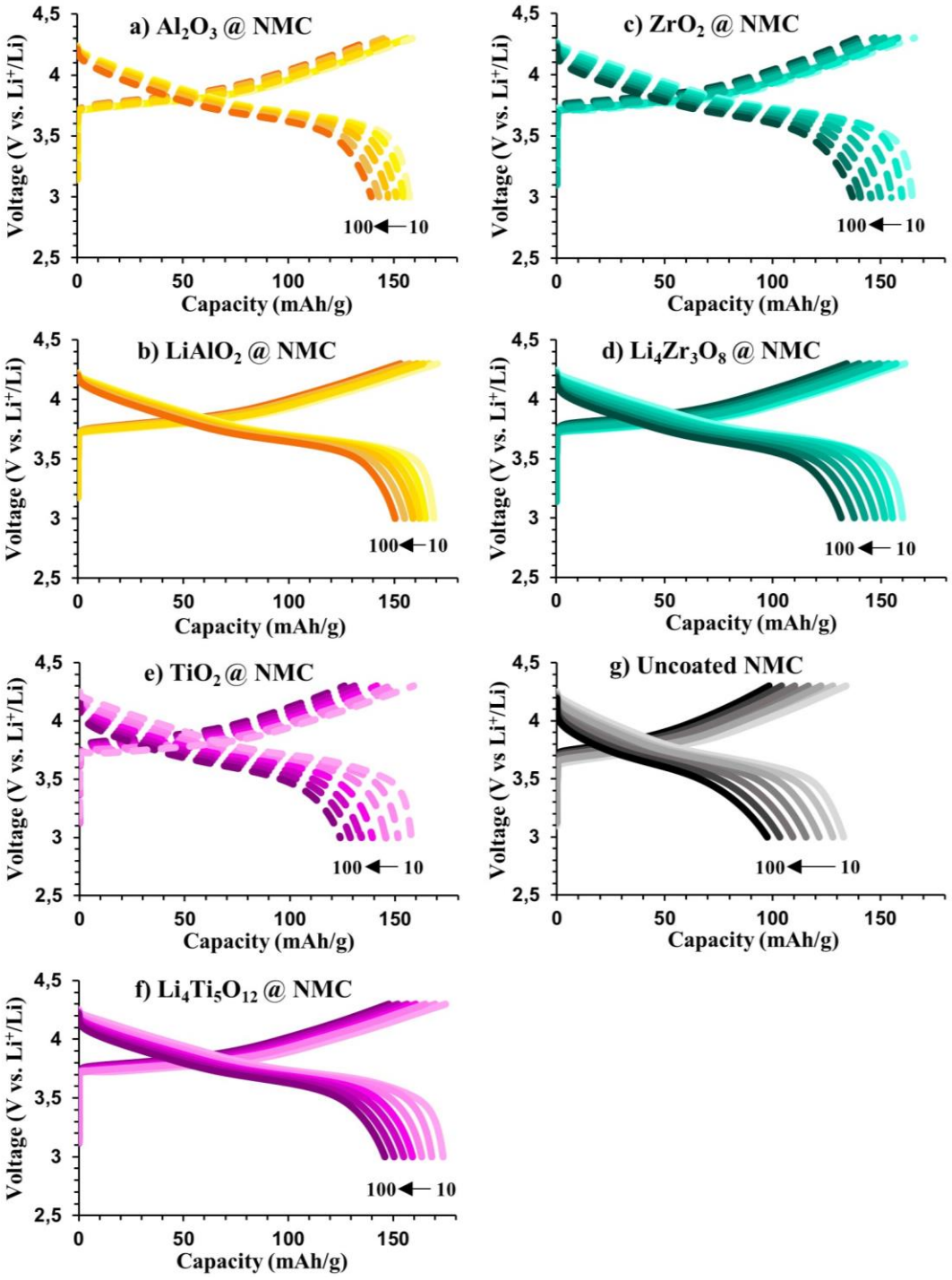

Figure S6. Galvanostatic charge and discharge profiles of the coated NMCs and uncoated NMC cycled between 3.0 – 4.3 V at room temperature (Discharge rate cycle 10-100: 0.5C, charge and discharge curves in steps of 15 cycles): a) Al_2O_3, b) $LiAlO_2$, c) ZrO_2, d) $Li_4Zr_3O_8$, e) TiO_2, f) $Li_4Ti_5O_{12}$ coated NMC and g) uncoated NMC.