Summary Report for EMC Award in 2018

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1. FeO_x-ALD modified Li-rich layered cathode

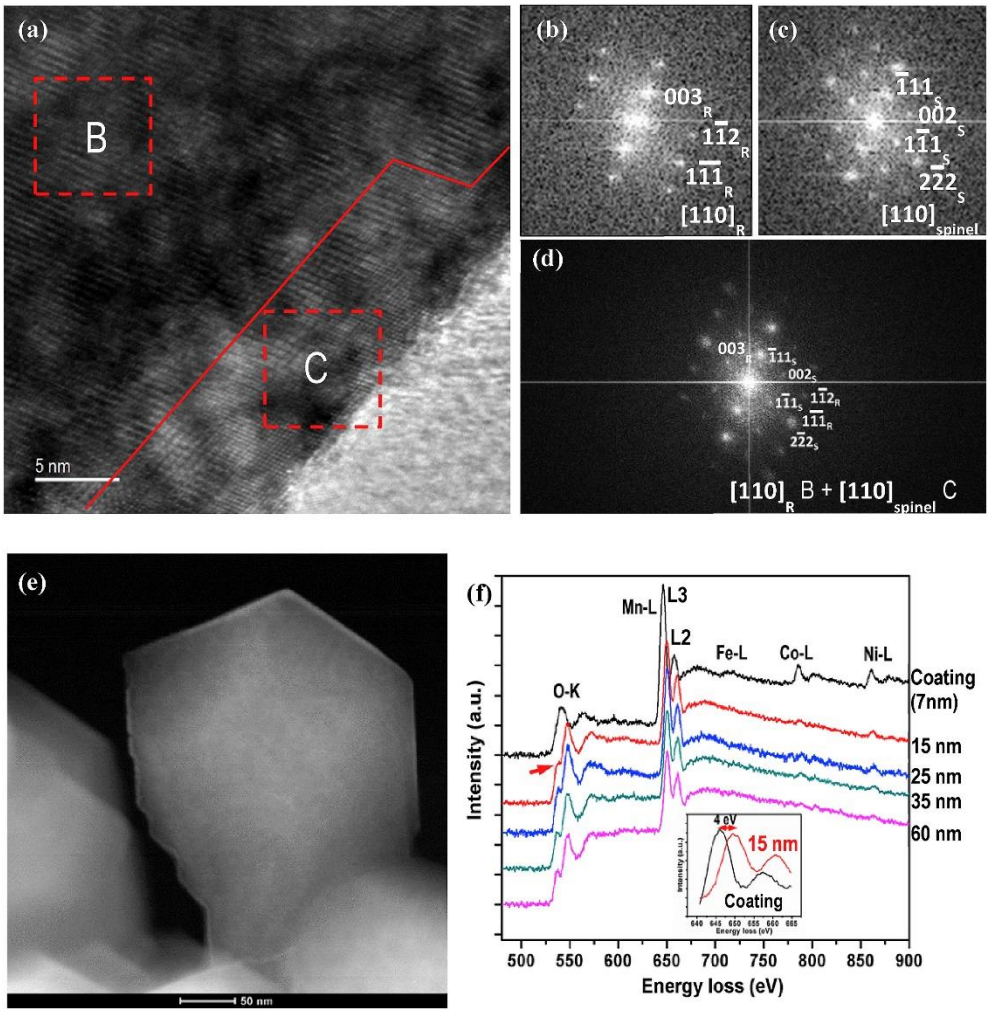

Fig. 1. (a) High-resolution TEM image of an 150 cycles of FeOx ALD coated Li-rich layered cathode particle after annealing (A150Fe), (b, c, and d) fast Fourier transform patterns from the region B and C denoted in Fig. 1a, (e) STEM-high-angle annular dark-field (HAADF) image of A150Fe particles, (f) EELS spectra of five STEM spots

acquired from the coating and towards the interior of the particle (e.g., 15 nm means that the EELS was taken 15 nm under the surface).

Description: In this work, FeO_x-ALD and annealing were used to modifiy a Li-rich layered cathode for Li-ion battery. TEM technology was used to provide valence and structure information of the modified particles. In Fig.1, a structure evolution was found on the surface of the particles by comparing Fig. 1c for the surface and Fig. 1b for the bulk; STEM-EELS showed a Fe diffusion into the lattice of the particles, as a 7nm-deep scan displayed signal of Fe L-edge.

Related publication: Y. Gao, Z. Shang, X. He, T. White, J. Park, X. Liang, Cooperating effects of conformal iron oxide (FeOx) ALD coating and post-annealing on Li-Rich layered cathode materials, *Electrochimica Acta* **2019**, 318, 513-524

2. Al-doped ZnO_2 coated $Li_4Ti_5O_{12}$ (LTO)

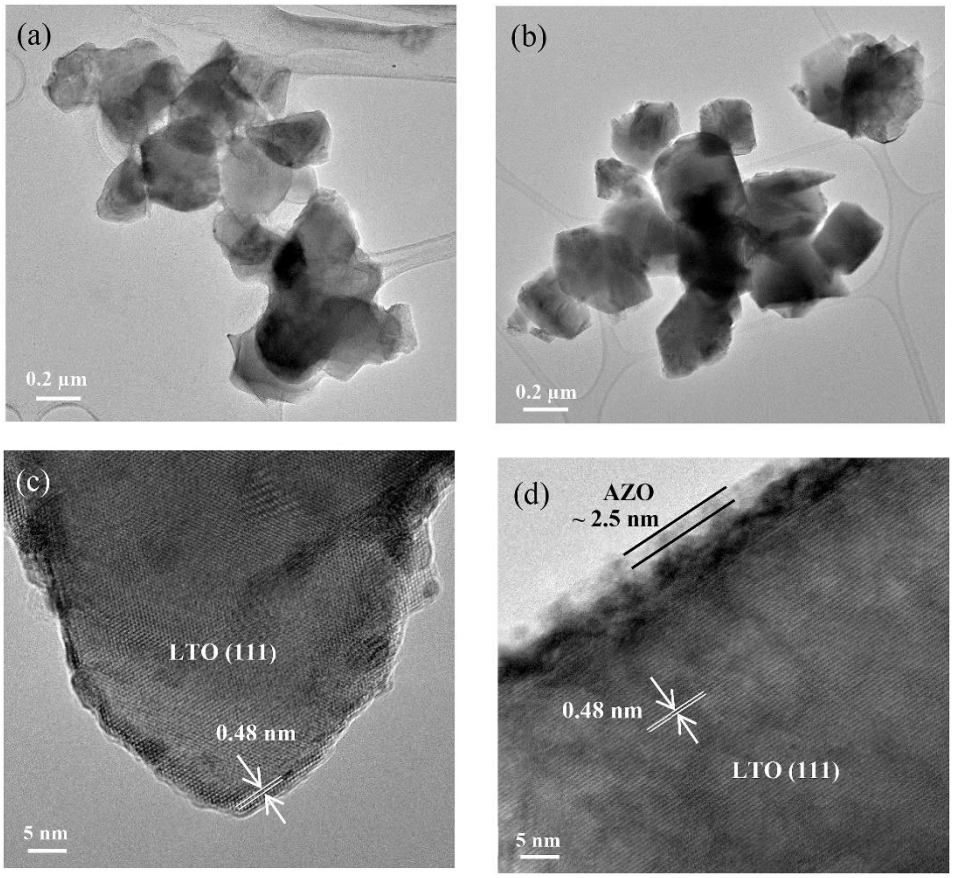

Fig. 2. TEM images of (a) uncoated (UC) LTO and (b) 10 cycles of Al-doped ZnO_2 (AZO) ALD at 250 °C coated LTO (250-10AZO) particles, and the edge of (c) one UC LTO particle and (d) one 250-10AZO particle.

Description: In this work, an Al-doped ZnO_2 thin film was coated on LTO particle surface by ALD for Li-ion battery anode. We visualized the thin film using high-resolution TEM as shown in Fig. 2., the thickness was ~2.5 nm on the surface of LTO particles.

Related publication: Y. Jin, H. Yu, Y. Gao, X. He, T. White, X. Liang, $Li_4Ti_5O_{12}$ coated with ultrathin aluminum-doped zinc oxide films as an anode material for lithium-ion batteries, *Journal of Power Sources* **2019**, 436, 226859