

Reversible cation migration and large hysteresis in layered structures material for sodium ion batteries

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Sodium ion batteries are promising for the large-scale energy storage due to the low cost and earth abundance of the sodium resource. Despite tremendous efforts have been made to improve the battery performance, some fundamental mechanism issues still have not been sufficiently understood. One of such issues in the most popularized layer structure cathode is the large voltage hysteresis which would highly related to the energy efficiency thus hinder its widely used as the energy storage facility in the future. Here for the first time, we present a systematic study of the origin of voltage hysteresis in the layer structure materials and disclosed its relationship with the transition metal migration. The complete and consistent picture of the reversible cation metal ion migrate to the sodium layer for sodium ion battery material is presented based on the STEM and in-operando XRD technic combined with the Fourier mapping of difference electron density. This reversible transition is depicted by monitoring the evolution of c-lattice parameter upon cycling. It is demonstrated that during charging, the transition metal ion transferred into the sodium layer due to the large voltage polarization. Our research suggests the underlying cation migration should be seriously considered for the future battery design towards conventional use.

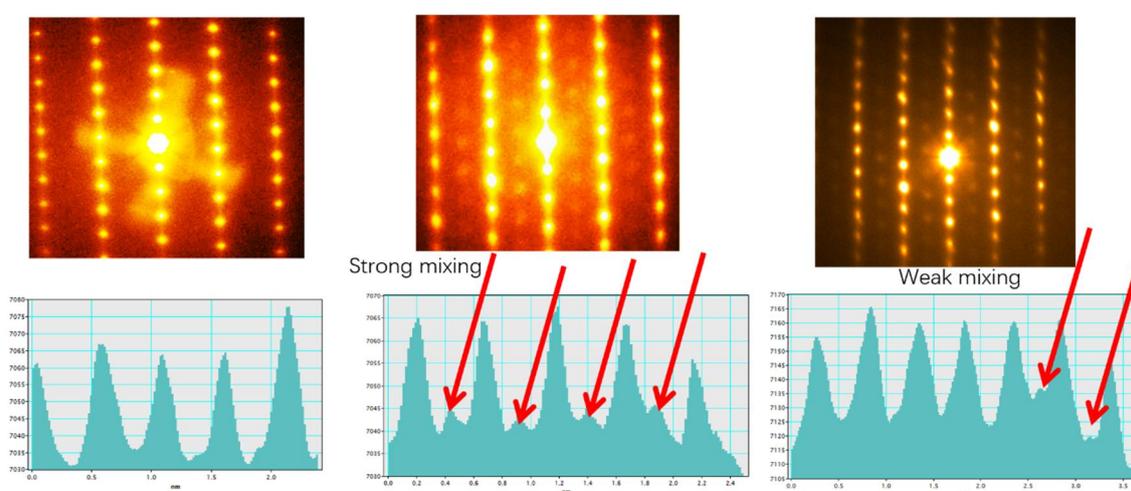


Figure 1. STEM figures of the pristine material, charged material and discharged material from the left to the right respectively.