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Rate and Composition Dependence on the Structural–Electrochemical Relationships in P2–$Na_{2/3}Fe_{1-y}Mn_yO_2$ Positive Electrodes for Sodium-Ion Batteries

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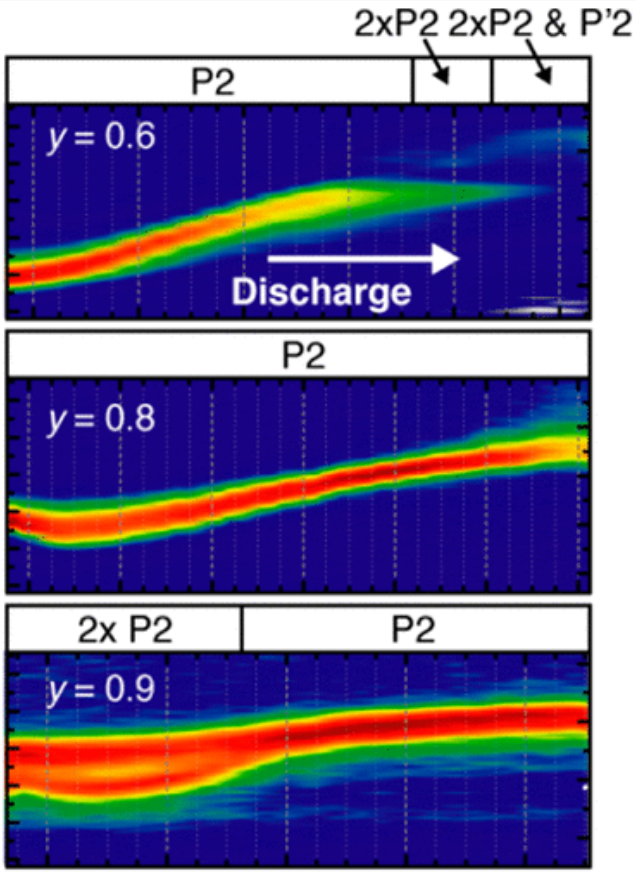
Abstract



Structural–electrochemical compositional evolution of attractive cathode candidates for sodium-ion batteries is illustrated. Varying the Fe/Mn ratio plays a significant role in phase evolution, which ranges from a simple solid solution or two-phase transitions to more complex combinations and sequences of phase transitions dependent on the Na concentration. Further complexity is added by the kinetic limitations placed on the compositions with applied current and associated material utilization. This work provides a standardized set of electrochemical and structural data for members of the $Na_{2/3}Fe_{1-y}Mn_yO_2$ series, exploring the phase evolution at a selected rate of 15 mA g^{-1}, comparing this with literature data at various current rates, and focusing on the evolution of the y = 0.9 at higher and lower current rates. The y = 0.8 composition shows the highest capacity, while y = 0.9 shows slightly better capacity retention at 15 mA g^{-1}. Structurally, the y = 0.8 features a solid-solution evolution throughout the charge–discharge process, while the y = 0.9 shows a solid solution and two-phase evolution, yet shows better capacity retention. Such studies illustrate how chemical tuning and electrochemical current influences structural evolution with sodium insertion/extraction and how this in turn influences electrochemical performance.