Study of the effects of annealing conditions and lithium content on the electrochemical performance of Li$_{1.2}$Mn$_{0.53}$Ni$_{0.13}$Co$_{0.13}$O$_2$ synthesized via spray pyrolysis

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xLi$_2$MnO$_3$·(1-x)LiMO$_2$ (M= Mn, Ni, Co) materials with layered structures have received attention as high-capacity, low cost, and safe cathode materials for lithium-ion batteries [1-3]. Earlier a spray pyrolysis synthesis method was developed by this group for the production of layered, high energy cathode materials [4]. Synthesis conditions affect surface area, and the surface area of the powders can significantly influence the electrochemical properties. Increasing annealing duration will promote coarsening of the materials, and reduce the surface area. In the present study, the annealing conditions of the material are varied, and the effect on electrochemical performance is studied. The effect of excess lithium content on the structure is also studied, to account for potential evaporative lithium loss during the annealing process.

Figure 1 shows the initial cycling profile of Li$_{1.2}$Mn$_{0.53}$Ni$_{0.13}$Co$_{0.13}$O$_2$ annealed at 900°C for 2, 5 and 20 hours. Increasing the duration of the annealing reduces both the charge and the discharge capacity of the materials. Figure 2 compares the XRD patterns of the materials annealed for different durations. No phase separation can be observed, but the intensity of the peaks between 20-25° 2θ, which correspond to the Li$_2$MnO$_3$-type domains in the structure, changes the annealing time. This indicates that the surface area reduction is coupled to a structural reorganization in the material. Figure 3 shows the effect of excess lithium content on the initial charge and discharge capacity of the material. Increasing the amount of lithium content by approximately 3.5% leads to a reduction in discharge capacity of the material. Results related to the effect of lithium content and the duration of the annealing on the stability of the material will be presented.

Figure 1. Initial charge and discharge profile of Li$_{1.2}$Mn$_{0.53}$Ni$_{0.13}$Co$_{0.13}$O$_2$ annealed at 900°C for 2, 5 and 20 hours

Figure 2 XRD spectra of Li$_{1.2}$Mn$_{0.53}$Ni$_{0.13}$Co$_{0.13}$O$_2$ annealed at 900°C for 2, 5 and 20 hours

Figure 3 Initial charge and discharge profile of Li$_{1.2}$Mn$_{0.53}$Ni$_{0.13}$Co$_{0.13}$O$_2$ with various amount of excess Li

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References: