Αγγλική Περίληψη

The ever-increasing environmental pollution in conjunction with the energy needs of modern society have shifted the research interest in reducing the CO_2 emissions and developing new energy storage systems with high energy density such as lithium-ion batteries. Spinel $LiNi_{0.5}Mn_{1.5}O_4$ (LNMO) is one of the most promising high-voltage cathode materials for future applications due to its advantages of large reversible capacity, high thermal stability, low cost, environmental friendliness and high energy density. The aim of the current work was the synthesis of nano-structured LNMO materials via **L**iquid **P**hase **S**elf-propagating **H**igh-temperature **S**ynthesis (LPSHS) and **A**erosol **S**pray **P**yrolysis (ASP) routes for lithium-ion battery applications. In the case of LPSHS method the parameters that were investigated were the calcination treatment and the quantity of complexation agent (fuel) in the precursor solution through the reactants/fuel molar ratio. XRD, SEM, TEM and Raman analysis were performed in order to study the morphology, phase composition, crystallization and to determine whether the resulted LNMO spinel belongs to the ordered ($P4_332$) or disordered (Fd-$3m$) crystal phase. The materials with different reactants/fuel molar ratio were further evaluated with respect to their electrochemical activity where the results showed that increasing the molar ratio improved the electrochemical performance of the LNMO even at higher charge-discharge rates. In the case of ASP method, a parametric study was performed at a laboratory-scale unit. XRD, SEM, TEM, BET and Raman analysis were performed in order to investigate the effect of synthesis temperature, residence time (carrier gas flow), precursor solution concentration and fuel addition on phase composition, crystallization, morphology, surface area and crystal phase of the material. Depending on the presence or absence of the complexation agent (fuel) in the precursor solution, two different morphologies emerged from the parametric study, “fuel solution” & “no-fuel solution” materials, which were chosen for up-scaling in a pilot-scale ASP unit. The resulted LNMO powders were heat-treated at appropriate calcination profiles in order to receive either the ordered or the disordered crystal phase and were further evaluated with respect to their electrochemical activity. The electrochemical results showed that the “no-fuel solution” materials exhibited electrochemical activity unlike the “fuel solution” materials while the best material demonstrated high specific capacity values at low charge-discharge rates, however lower activity in higher rates.