Characterization of Particulate Sol-gel Synthesis of Orthorhombic $LiMnO_2$ and Cubic Spinel $LiMn_2O_4$ Via Citric Acid Assistance with Different Solvent as a Cathode Material for Lithium-ion Batteries

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Lithium batteries have the highest energy density of all rechargeable batteries and are favoured in application , where low weight or small volume are desired forexample: laptop computers, cellular telephones and electric vehicles.

Recently lithium manganese oxides ($LiMnO_2$ and $LiMn_2O_4$) has attracted a great deal of attention as a promising cathode material for rechargeable lithium-ion batteries because this material is environment benign and relatively inexpensive compare with lithiated cobalt which is promising candidate material for cathodes in lithium-ion batteries.Conventionally $LiMn_2O_4$and $LiMnO_2$ are prepared by the solid state and precipitation reaction which causes $LiMn_2O_4$and $LiMnO_2$ powders to exhibit strongly agglomerated state and large grain size due to high temperature reaction. Therefore, post-calcination treatments such as grinding and sieving are necessary for obtaining $LiMn_2O_4$ and $LiMnO_2$ with small particle size.[1].

In this study, we report the synthesis of $LiMn_2O_4$ and $LiMnO_2$ powders with uniform nanosized particle using an aqueous solution of metal nitrates containing ethanol and distilled water as a solvent and citric acid as a chelating agent at considerably lower temperature and shorter heating time as compared with solid state reaction and other reported solution techniques.Different ratios of $^{ethanol}/_{water}$ and citric acid to metal ions (R) have been used for investigating the role of ethanol and citric acid in the formation of $LiMn_2O_4$ and $LiMnO_2$ powders . The precursor powders were heated at various temperatures for 4h under a flow of argon and air, to examine the reaction processes for the formation of the single-phase $LiMn_2O_4$ and $LiMnO_2$ powders.

For the synthesis of single – phase $LiMn_2O_4$ powder, homogeneity and reactivity of the precursor powder are enhanced with an increase in the amount of citric acid in the starting solution. When the amount of citric acid is low , an impurity phase, Li_2MnO_3, is formed but this phase is observed in XRD patterns of $LiMnO_2$ when R<1.On the other hand when the ethanol to water ratio (R') is higher than 2 only single phase of both $LiMn_2O_4$ and $LiMnO_2$ is observed.

Physical properties of these compound are discussed in the light of structural [x-ray diffraction (XRD) in Fig1. and scanning electron microscope (SEM) in Fig2.] and spectroscopic (FTIR) in Fig3. thermal behaviour of salt precursor was studied by thermogravmetric analysis (TGA) in Fig4.

References:

[1] Chung-Hsin Lu; S.K.Saha, Journal of Sol-Gel Science and Technology **,20**,(2001),27-34

Figures:

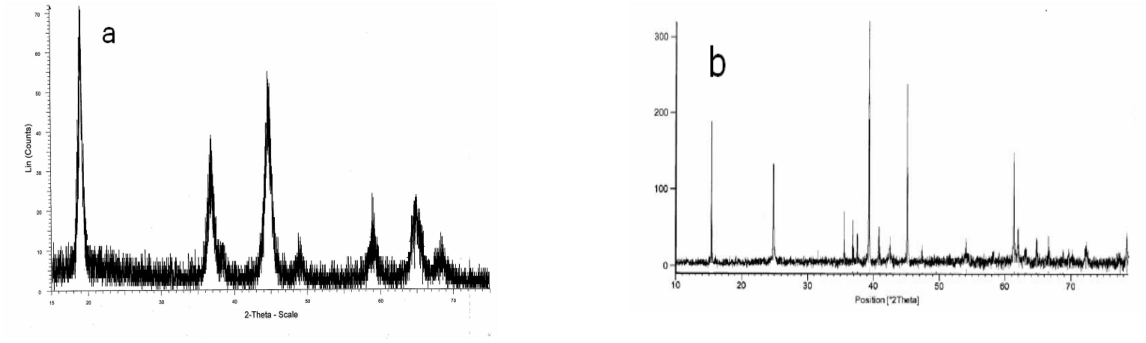

Fig 1. XRD patterns of a) $LiMn_2O_4$ at 400° c b) $LiMnO_2$ at 800°c via sol-gel method

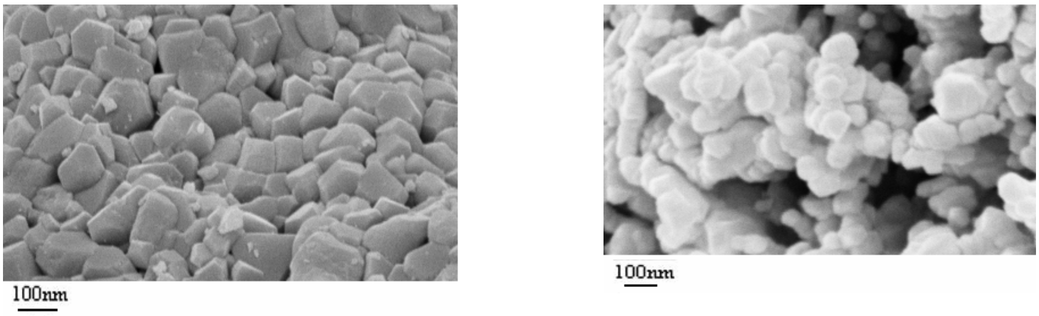

Fig 2. SEM image of a)$LiMn_2O_4$ b) $LiMnO_2$

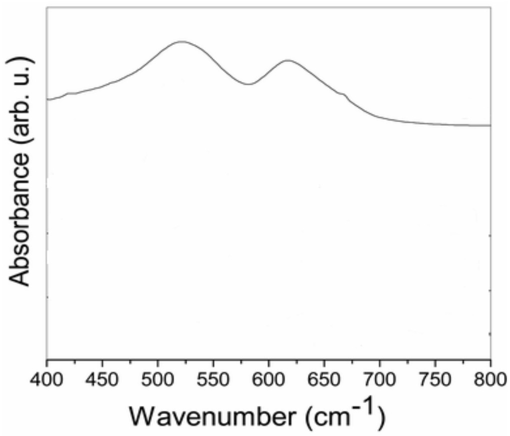

Fig 3. FTIR of the Lithium manganese oxide

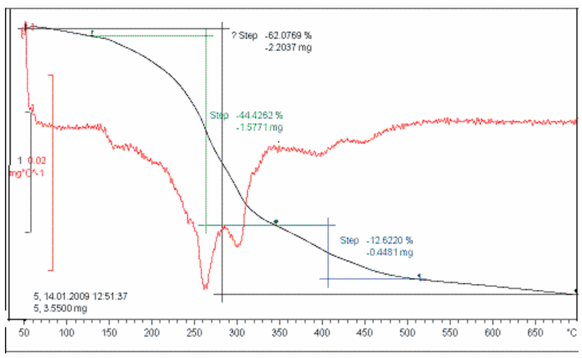

Fig 4. TGA curve for Lithium Manganese oxide