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on Semiconductor and Electronics, Information and Communications Technology and Energy

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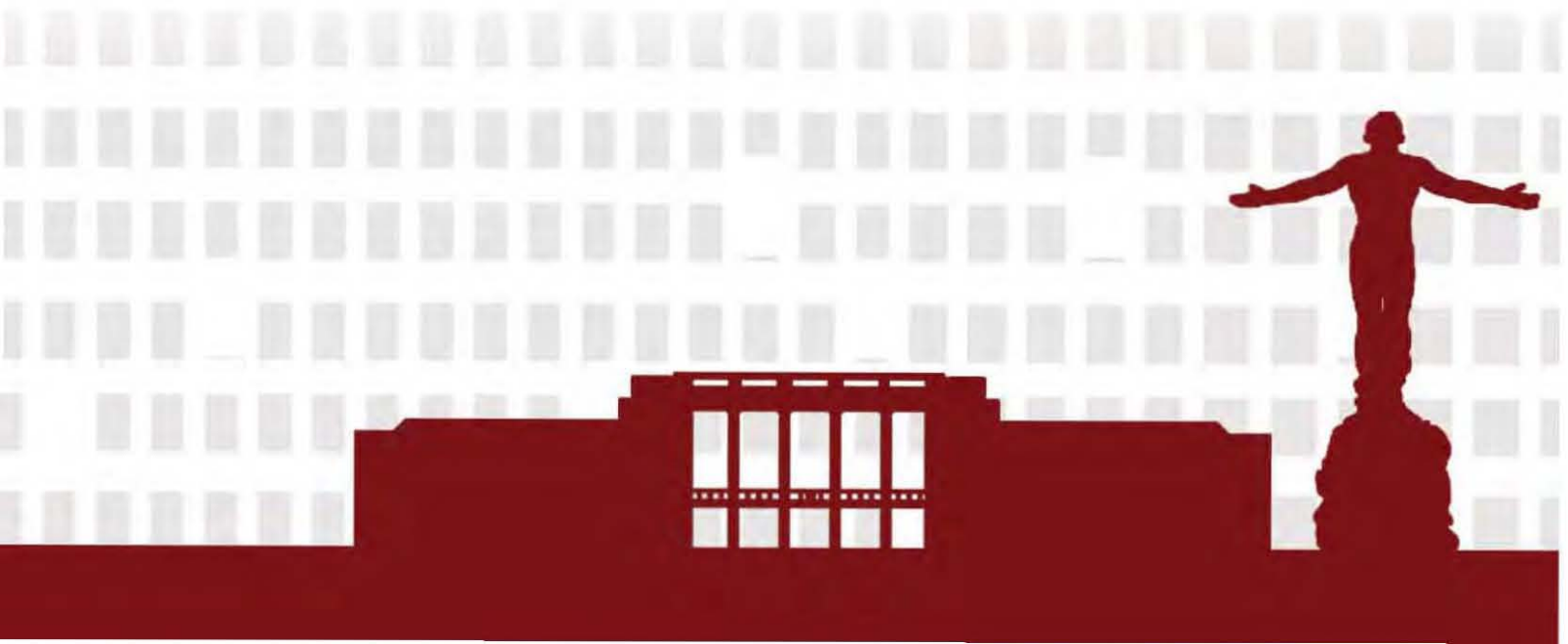
Metro Manila, Philippines



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SYNTHESIS AND CHARACTERIZATION OF LITHIUM IRON PHOSPHATE-BASED CATHODE MATERIAL FOR LI-ION BATTERIES

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ABSTRACT

Lithium iron phosphate ($LiFePO_4$) is a potential cathode material for lithium-ion batteries due to its promising characteristics. In this study, $LiFePO_4$ was synthesized via a modified rheological phase method. The material was characterized for its thermal, structural, and morphological properties. TG analysis revealed that formation of LFP may start at 300°C. XRD results reported an orthorhombic $LiFePO_4$ structure with (311) as the dominant peak. The FTIR spectra matched that of a commercial LFP. SEM images showed agglomeration of particles. EDS detected the presence of Fe, P, O, and C elements. Li was not detected due to limitation of equipment. Based on the results, the study was successful in synthesizing nanograined LFP.

Keywords: Lithium-ion Battery, Lithium Iron Phosphate, NanograinedCathode

Introduction

There is an increasing demand in renewable and sustainable energy in order to address environmental concerns and meet the energy demands of modern society. At present, lithium-ion batteries (LIBs) represent the top of technology in electrical devices due to its promising battery chemistry [2]. In order to meet the demands of new applications, improvement of Li-ion batteries thru the use of alternative materials and processes must be developed.

Lithium iron phosphate is regarded as a potential cathode material for lithium-ion batteries due to its high theoretical capacity of $170mAhg^{-1}$, high cycling performance, moderate operating voltage of 3.45V vs Li^+/Li, low toxicity, and low cost. However, LFP has intrinsic electrochemical limitations such as low conductivity and slow diffusion of lithium ions [2]. In order to address these limitations, nanostructured synthesis with carbon coating of LFP has been studied.

Methodology

Predried $FePO_4.2H_2O$ and $LiOH.H_2O$ precursors were mixed in a stoichiometric ratio in a hot ethanol solution of stearic acid. After rigorous stirring, the mixture was dried at 150°C for 5 hours. The sample was calcined at 400°C and then subjected to XRD, FTIR, and SEM-EDS analysis.

Results and Discussion

Figure 1 shows the stacked XRD pattern of the synthesized LFP. The diffraction peaks were indexed to orthorhombic $LiFePO_4$ (JCPDS 83-2092) with (311) as the dominant peak. There were no peaks for carbon detected which means that the carbon yielded is amorphous and of low content. The lattice parameters reported are a = 10.32248Å, b = 6.00475 Å, and c = 4.69762 Å, which are close to those reported in literature. As seen from the figure, the crystallinity increases as the synthesis time increases. The TG curve (not shown) reveals that LFP starts forming at 300°C.

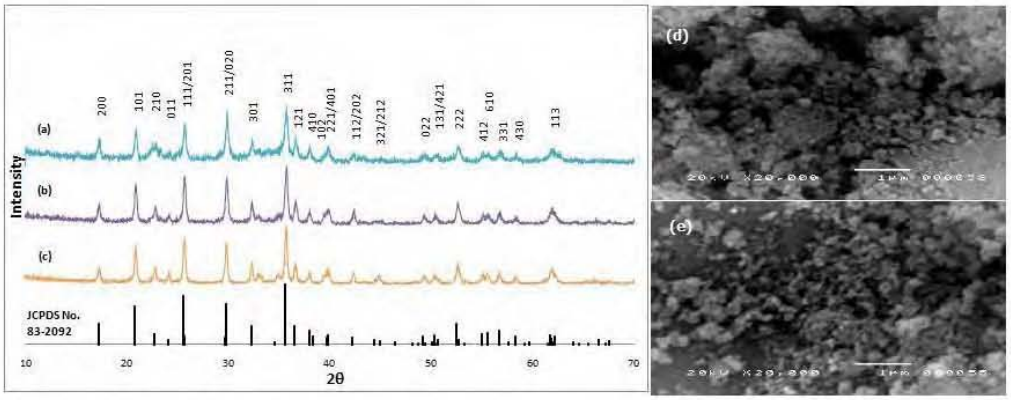

Figure 1. XRD stack pattern of samples calcined at 400°C (a) without excess carbon, (b) with excess carbon, (c) with excess carbon and additional calcination time; and SEM images (d) without excess carbon and (e) with excess carbon

The FTIR spectra (not shown) of the samples matched that of a commercial LFP. Fig. (d) and (e) shows the SEM images of the samples wherein particle agglomeration can be observed. Using Image J software, the particle sizes were approximated to be 190 nm and 213nm for the sample without and with excess carbon, respectively. EDS analysis (not shown) revealed the presence of Fe, P, O, and C. Li was not detected due to equipment limitations.

Conclusions

The study successfully demonstrated the synthesis of $LiFePO_4$. Structural and morphological results reveal an orthorhombic structure and agglomerated grains having an ultrafine particle size. Further study is on-going for the electrochemical properties of the synthesized LFP.

Acknowledgement

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