Comparison of $LiMnPO_4$ made by Combustion and Hydrothermal Syntheses

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Among the olivine-structured metal phosphate family, $LiMnPO_4$ exhibits a high discharge potential (4V), which is still compatible with common electrolytes, making it interesting for use in the next generation of Li ion batteries. The extremely low electronic conductivity of this material severely limits its electrochemical performance, however. One strategy to overcome this limitation is to make $LiMnPO_4$ nanoparticulate to decrease the diffusion distance. Another is to add a carbon or other conductive coating in intimate contact with the nanoparticles of the main phase, as is commonly done with $LiFePO_4$.

The electrochemical performance of $LiFePO_4$ is highly dependent on the quality of the carbon coatings on the particles [1-2], among other variables. Combustion synthesis allows the co-synthesis of nanoparticles coated with carbon in one step. Hydrothermal synthesis is used industrially to make $LiFePO_4$ cathode materials [3] and affords a good deal of control over purity, crystallinity, and particle size. A wide range of olivine-structured materials has been successfully prepared by this technique [4], including $LiMnPO_4$ in this study.

In this paper, we report on the new synthesis of nano-$LiMnPO_4$ by a combustion method. The purity is dependent upon the conditions used for synthesis, including the type of fuel and precursors that are chosen. The fuel to nitrate ratio influences the combustion temperature, which determines the type and amount of carbon found in the $LiMnPO_4$ composites. This can further be modified by use of carbon structural modifiers added during a subsequent (optional) calcination step.

Figure 1 shows a transmission electron microscopy (TEM) image of the spherical nano-sized $LiMnPO_4$ particles typically formed by combustion synthesis. The average particle size is around 30 nm, in agreement with values obtained by the Rietveld refinement of XRD patterns. The small size of the particles cause the peak broadening evident in the pattern of combustion formed $LiMnPO_4$, shown in Figure 2. Figure 2 also shows a pattern of hydrothermally prepared $LiMnPO_4$, which is sub-micron in size.

In this presentation, we will show how the crystallographic parameters, particle size, particle morphology, and carbon content and structure impact the electrochemical properties of the $LiMnPO_4$/C composites produced by these methods.

References

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Acknowledgments

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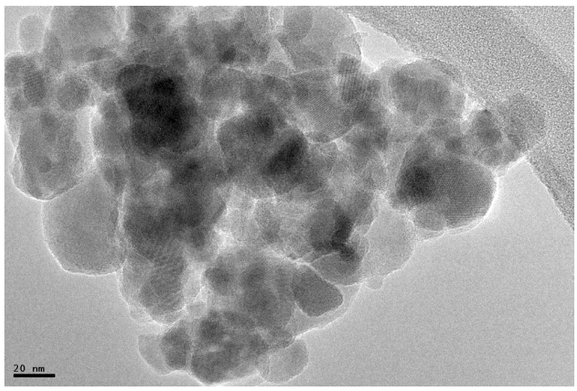

Figure 1. TEM image of nanosized $LiMnPO_4$ by combustion synthesis

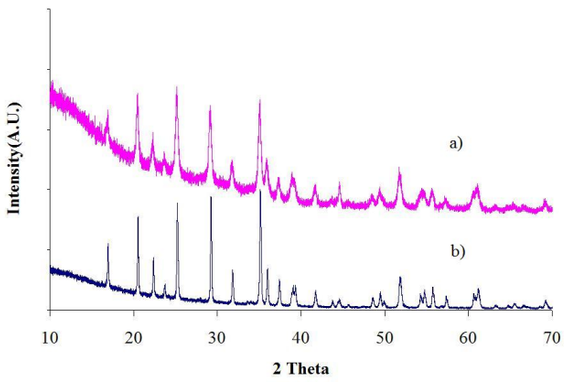

Figure 2. X-ray diffraction patterns of a) nanometric $LiMnPO_4$ made by combustion synthesis and b) hydrothermally prepared sub-micron $LiMnPO_4$.