Influence of Addition of VGCF on $LiFePO_4$ Cathode Materials in Li-ion Batteries

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1. Abstract

Electrochemical properties of olivine-type $LiFePO_4$ composite cathode materials prepared by adding VGCF (Vapor-Grown Carbon Fiber) were investigated in this study. The $LiFePO_4$ and VGCF/$LiFePO_4$ samples were characterized by X-ray diffraction (XRD) and scanning electron microscope (SEM). Results of experiments indicated that VGCF/$LiFePO_4$ cathode exhibited good rate capability and high energy density. By adding VGCF content of 10%, the first discharge capacity of 139mAh/g can be achieved under an average discharge voltage of 3.4V at room temperature. This attributed that the addition of VGCF enhanced high electronic conductivity.

2. Experimental

The VGCF/$LiFePO_4$ composites were prepared by the solid-state reaction of Li_2CO_3 (>99%, J. T. Baker), Fe(Ⅱ)$C_2O_4{\cdot}H_2O$ (98.5%, SHOWA), $(NH_4)_2HPO_4$ (98.5%, SHOWA), and VGCF (VGCF–H, SHOWA). These precursors were dispersed into ball milling then thoroughly mixed. The $LiFePO_4$ was synthesized in a purified Ar atmosphere to prevent the formation of Fe^{3+} compounds as impurities. The mixture was first decomposed at 350℃ for 10hr to expel the regroup in Ar gas, then sintered for 10hr at temperature 700℃ in Ar gas.

The XRD (Philips 1700) with Cu kα radiation was used to identify the crystal structure. The powder morphologies using the SEM were observed (LEO 1530).

Electrochemical characterization of the $LiFePO_4$ cathode materials was carried out by using a coin-type cells (size 2032). All electrode preparation and sealing were performed in a dry air atmosphere. These cathodes were made by mixing the VGCF containing $LiFePO_4$ powder with polyvinylidene difluoride (PVDF) binder in a weight ratio of 91:9. The slurry was prepared by blending these precursors with N-methylpyrrolidone (NMP). The solvent was evaporated at 100℃ under vacuum, then the dried cathode mixture was compressed into pellets on an aluminum foil. The electrolyte was a solution of 1M $LiPF_6$ in a 1:1 mixture of ethylene carbonate (EC) and dimethyl carbonate (DMC) (SAMSUNG Chemicals). A lithium metal foil was used as the anode and a microporous polypropylene sheet was used as the separator.

3. Results and Discussion

The $LiFePO_4$ and VGCF/$LiFePO_4$ powders with 5-32 μm in particle size are shown in Fig. 1(a) and Fig. 1(b), respectively. The $LiFePO_4$ powder is olivine-type structure, as shown in the XRD pattern (Fig. 2). The typical charge-discharge curves of $LiFePO_4$ and VGCF /$LiFePO_4$ were illustrate in Fig. 3. The result shows that the addition of 10% VGCF to $LiFePO_4$ cathode shows a higherspecific capacity of 139mAh/g.

References

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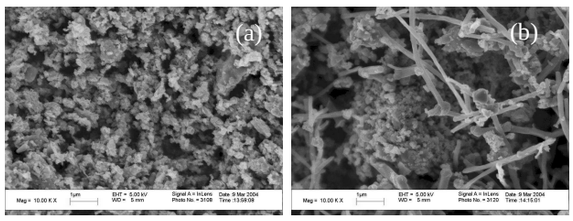

Fig. 1. SEM micrograph of $LiFePO_4$ powder (a) $LiFePO_4$ (b) $LiFePO_4$ + VGCF 10%.

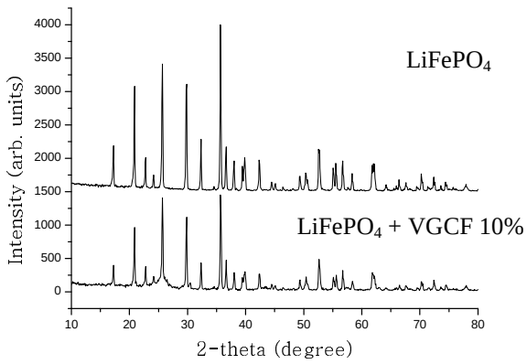

Fig. 2. XRD patterns of the $LiFePO_4$ and VGCF/$LiFePO_4$ powder.

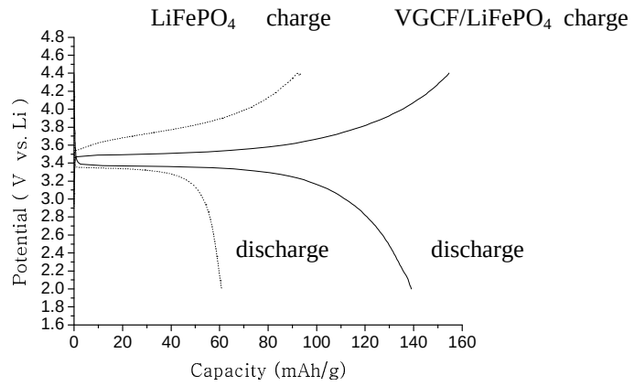

Fig. 3. Typical charge-discharge curres for $LiFePO_4$ and VGCF/$LiFePO_4$ cathodes at acurrent density of 0.14 mA/cm^2.