

Carbon Nano-Painting: Application to non-Phosphate Oxyanions, e.g. Borates

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Boron compounds have found little use in rechargeable lithium batteries other than as dopants of lamellar oxides. FeBO_3 ($\bar{V} \approx 1.6 \text{ V vs. Li}^\circ/\text{Li}^+$) was suggested as an anode [1,2] and LiFeBO_3 ($\bar{V} \approx 2.9 \text{ V}$) was used as a cathode [3]. This study [3] showed that LiFeBO_3 has a capacity of less than 5% of theoretical (220 mA/g) even on the first cycle. LiFeBO_3 crystallizes in the monoclinic system C2/c [4]. In the environment of iron atoms, the five oxygens form a trigonal-bipyramidal coordination shell.

In this study we report a new route for the synthesis of electronically (carbon coated) conductive LiFeBO_3 particles. In a typical preparation, appropriate amounts of $\text{FeC}_2\text{O}_4 \cdot 2\text{H}_2\text{O}$, LiBO_2 and cellulose ester were mixed and then fired at 700°C for 24 h under argon. The carbon represents less than 2%, by weight, of the final product. The crystallographic structure has been confirmed by X-ray powder diffraction.

Electrochemical performances were evaluated at 80°C using a coin cell and a polymer electrolyte. Cyclic voltammetry and galvanostatic cycling curves of cells with either LiFeBO_3 , with/without carbon, are shown in Fig. 1 and 2. A capacity of about 156 mA/g at an average voltage of 2.9 V vs. $\text{Li}^\circ/\text{Li}^+$ was obtained at the first discharge (lithium de-insertion) and was stable on cycling.

The nano-painting concept appears here to be applicable to a variety of oxides, whose low electronic conductivity had up to now precluded their use as cathode materials.

LiFeBO_3 , with its large theoretical capacity, has an energy content roughly similar to that of LiFePO_4 . This study is only preliminary, and progress is likely to be reported for the use of this promising cathode material in rechargeable lithium batteries.

References

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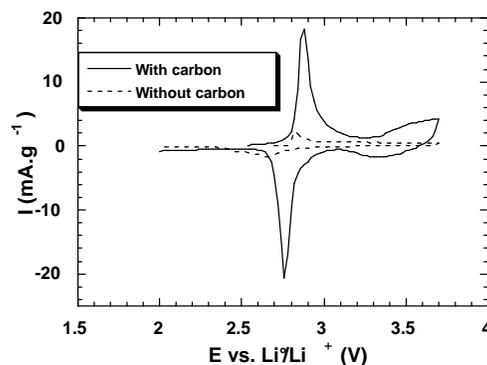


Fig. 1 : Cyclic Voltammetry of LiFeBO_3 at a sweep rate of 20 mV/h in the potential range 2 V \leftrightarrow 3.7 V

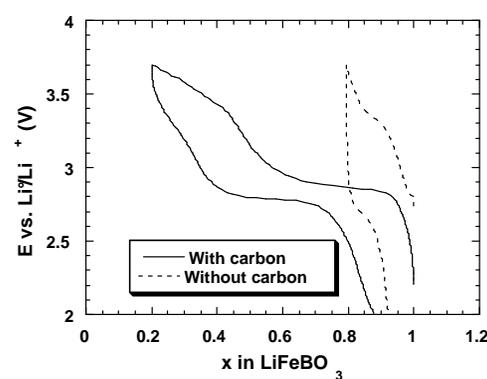


Fig. 2 : Charge-discharge curves for LiFeBO_3 at C/12 in the potential range 2 V \leftrightarrow 3.7 V