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

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Boron compound have found little use in rechargeable lithium batteries other than dopant of lamellar oxides. $FeBO_3$ ($\overline{V} \approx 1.6$ V vs. Li°/Li^+) was suggested as anode [1,2] and $LiFeBO_3$ ($\overline{V} \approx 2.9$ V) was used as 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-bipyramid 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 $FeC_2O_4.2H_2O$, $LiBO_2$ and cellulose ester were mixed and then fired at 700 ºC 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 ºC 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. Li°/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.

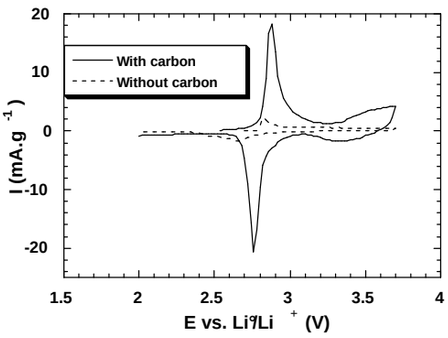

Fig. 1 : Cyclic Voltammetry of $LiFeBO_3$ at a sweep rate of 20 mV/h in the potential range 2 V <=> 3.7 V

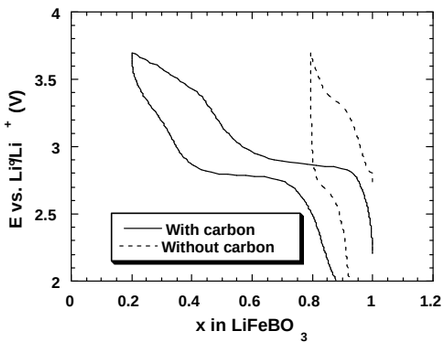

Fig. 2 : Charge-discharge curves for $LiFeBO_3$ at C/12 in the potential range 2 V <=> 3.7 V

References

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