NANOSTRUCTURED ELECTRODE MATERIALS FOR LITHIUM-ION BATTERIES

Churikov A.V., Isupov V.P. [(1)], Starodubtsev N.F. [(2)], Pridatko K.I.
Saratov State University,
83 Astrakhanskaya Str., Saratov 410012, Russian Federation
(1) Institute of Solid State Chemistry and Mechanochemistry, Siberian Branch of RAS,
Novosibirsk, Russian Federation
(2) Esma Corp., Troitsk, Russian Federation
* Fax: +7(8452)271491 E-mail: churikikovav@info.sgu.ru

Introduction

Lithium-ion batteries currently dominate on the market of rechargeable power sources for various electronic devices. For 15 years of their development under severe competition (including electrochemical systems of other types) lithium-ion cells have practically reached perfectness in both design and material aspects. However, the Li-ion concept has been recently shown to have development potentialities due to transfer from traditional anode materials to nanostructured composites based on Sn, Si, Al etc. Replacement of common intercalation materials by lithium-rich alloys may offer an essential gain in capacity at the expense of a sophistication of synthesis techniques [1].

Results and Discussion

Repeating lithium insertion/extraction acts may be accompanied by sharp variations of the active particle volume and subsequent destruction of the electrode material. To neutralize this effect, two ways have been proposed, namely, reduction of the particle sizes down to few micro- and even nanometers, introduction of inert components into the active material to damp volume changes.

We have employed a mechanochemical synthesis technique to prepare a tin-containing nanocomposite by means of mechanical activation of a FeSn intermetallic compound inactive to lithium absorption. This may be accompanied by FeSn breakage down into a tin-rich active lithium-accumulating phase $FeSn_2$ and a Fe_5Sn_3 phase inert to lithium and serving a matrix to damp mechanical stresses. The mechanochemical synthesis regime was optimized. The materials synthesized were electrochemically tested for the depth, rate and reversibility of lithium insertion/dissolution in a non-aqueous electrolyte. To perform these tests, an electrode production technique was designed and its experimental conditions (binder content, pressure, cycling mode) were optimized. The most promising nanocomposite samples were screened for mock-up tests.

Several electrodes were prepared by means of sputtering. These samples were thin (30-300 nm) tin and C_{60} fullerene layers on a copper support. The tin component contributes mostly to the total electrochemical capacity, the effect of fullerene being insignificant. The electrochemical behaviour of fullerene-titanium compositions is considered. The samples under study show certain activity in reversible electrochemical lithium intercalation from a non-aqueous electrolyte; however, at present their specific characteristics do not meet the current requirements to commercial electrodes.

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Reference

1. K.I.Pridatko, A.V.Churikov. Composite anode lithium-accumulating materials alternate to carbonic ones. Electrochemical power engineering. 2005; 5 (1) 16-29.