ELECTRODE MATERIALS BASED ON LITHIUM-TITANATE-OXIDE

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ABSTRACT

The article deals with materials based on spinel structure of lithium-titanate-oxide for positive electrodes lithium-ions accumulators. The spinel type electrode material is one of the most promising materials for currently lithium-ion power sources. Obtaining electrochemical characteristics were investigated and it was enquired application of electrode masses in present storage battery industry.

1. INTRODUCTION

The article works with materials for lithium-ion batteries based on lithium-titan-oxide structure. The spinel lithium titanate $Li_4Ti_5O_{12}$ is one of the promising electrode materials due to good stability, low cost and satisfactory safety, but there is problem with low conductivity of the material, which can be improved by appendage metal ions (Mn^{4+}, Ni^{2+} etc.) [3].

The electrode material $Li_4Ti_5O_{12}$ is used primary in systems with high charge and discharge rate because of possibility high current drain. This characteristic of the material is allowed by virtue of disposal particles into spinel type structure. The spinel-type electrode material $Li_4Ti_5O_{12}$ can be served as headstone for positive electrodes due to good stability and generally good capacity [1] same as alternative masses to graphite in negative electrode lithium-ion accumulators because of fast charging ability [2].

2. EXPERIMENTAL

The purpose of this work was obtained electrochemical characteristics prepared samples based on electrode materials $Li_4Ti_5O_{12}$. It was proceded measurements in glove box with argon atmosphere (< 0.1 ppm O_2, < 0.1 ppm H_2O) and results were evaluated by utilizing standard technique - cyclic voltammetry and galvanostatic method.

Spinel-type electrode material $Li_4Ti_5O_{12}$ was delivered by company ELMARCO s. r. o. (Liberec, Czech Republic).

The electrode was assembled from active mass ($Li_4Ti_5O_{12}$) and nickel mesh, which was used as carrier. The electrode was inserted into 3-electrode setup in experimental glass cell with 1 molar electrolyte based on lithium salt $LiPF_6$ in mixture of aprotic solvents - ethylene carbonate and dimethyl carbonate (ratio 1:1). Pure lithium subserved role counter and reference electrode in measuring system.

2.1. MEASURING METHOD

The weight of investigation sample and parameters of cyclic voltammetry used on research are described thereunder.

Cyclic voltammetry	scan rate	0,004 V/s
	potential window	0.5 V ÷ 2.5 V
Galvanostatic method	potential	0.5 V ÷ 2.7 V
	setting current	6.5 mA
Weight of material	18.5 mg	

Autolab PGSTAT 30 was assessed for setting up cyclic voltammetry and recording achieving results.

3. RESULTS AND DISCUSSION

Aim of this work was acquiring concept of electrochemical behaviour material in cycling process and basic electrochemical properties (primary capacity). The examined material was transferred after executed experiments to HRTEM laboratory (laboratory high resolution electron microscopy), where images of its structure were acquired. Results are presented via figures and graphs.

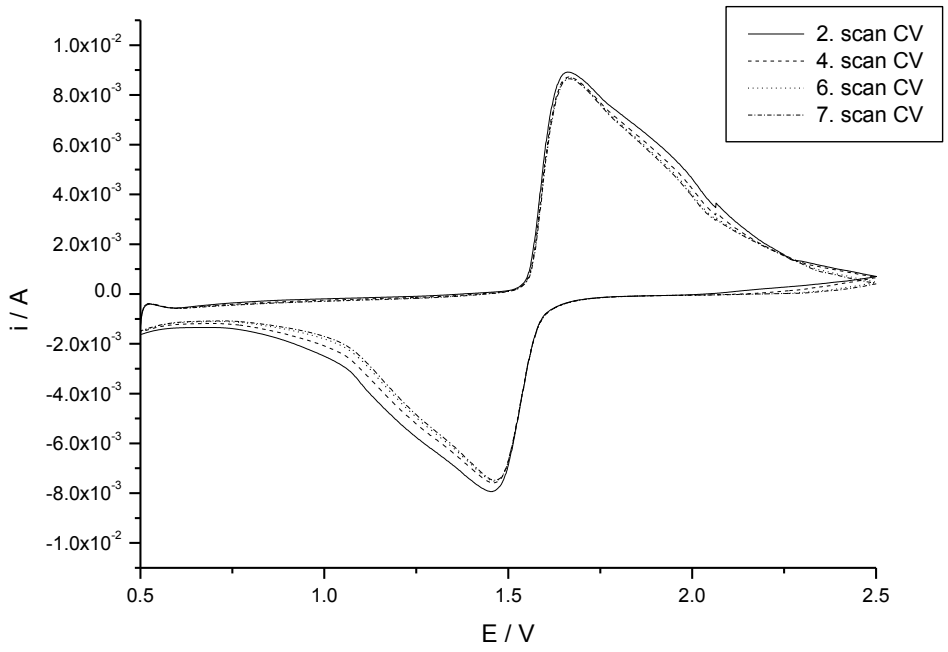

Figure 1: Cyclic voltammetry 100% $Li_4Ti_5O_{12}$

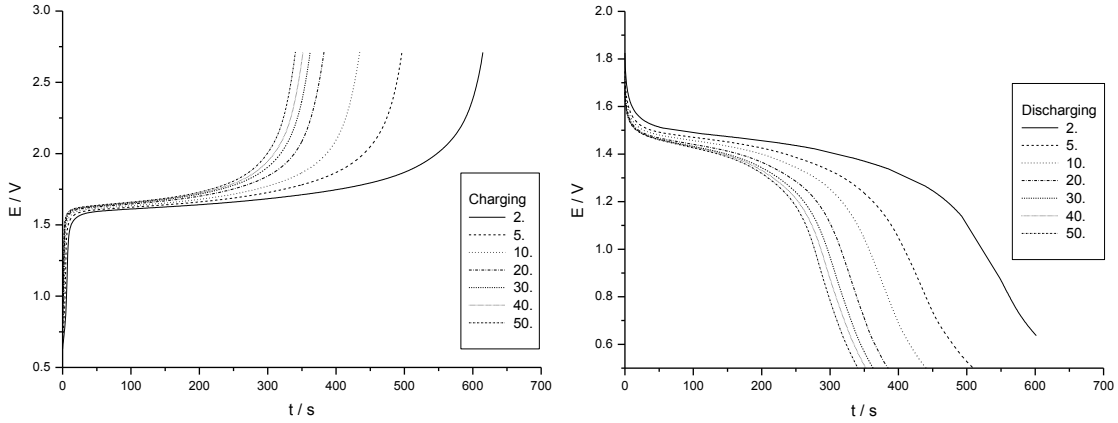

Figure 2: Galvanostatic measurements 100% $Li_4Ti_5O_{12}$

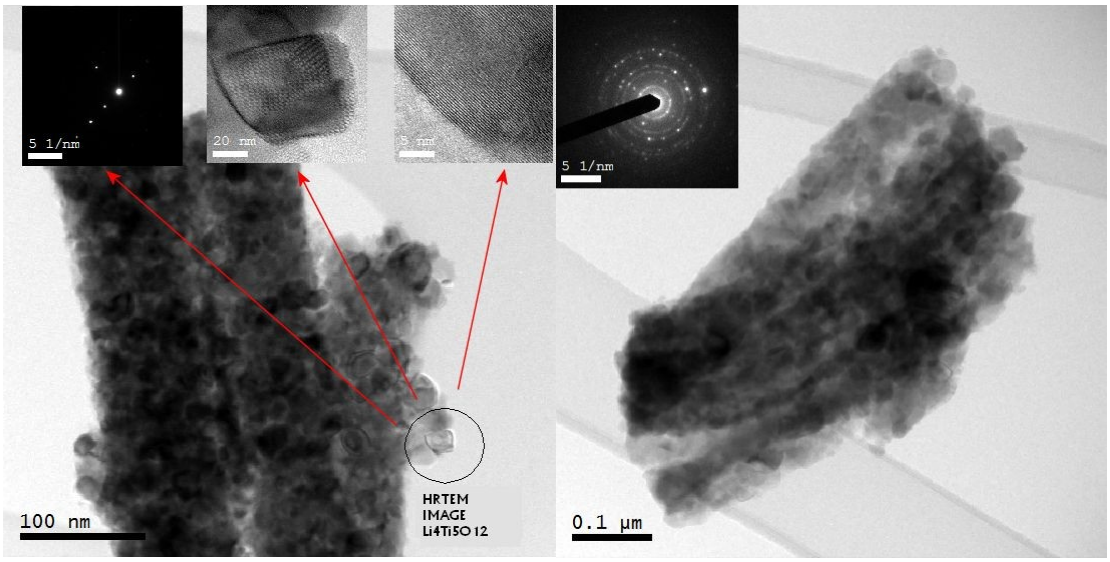

Image 1: HRTEM images $Li_4Ti_5O_{12}$

4. CONCLUSION

Performed measurement of $Li_4Ti_5O_{12}$ point to electrode material with good results in the field of stability and utility, that is represented by quite full reversibility electrochemical reaction and almost insensible decrease oxidation and reduction peaks. Electrochemical effectiveness reaches quality values c. 90%.

Stability of material can be improved by increasing time of charging and discharging or by appendages metal ions [3] in case of degradation in following cycling processes.

In the field of capacity, it wasn't reached exactly value of theoretical capacity of the material (175 mAh/g), but initiatory scans show 120 mAh/g active mass, what is considered as good results. Unavailability theoretical capacity is caused in this case by bigger volume of active mass on nickel mesh. Therefore the intercalation structure $Li_4Ti_5O_{12}$ cannot gain all lithium ions and electrochemical entire capacity isn't reached. This situation can be change

by appendage conductive mixtures such as carbon nanotubes, expanded graphite etc. and by using micro layer research mass on material carrier (e.g. conductive glass).

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