

High Stable $\text{Li}_4\text{Ti}_5\text{O}_{12}$ as Negative Electrode for Electrochemical Generator: Micro vs Nano

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Introduction

$\text{Li}_4\text{Ti}_5\text{O}_{12}$ has a good reversibility and has no structural change (zero-strain insertion material) in the charge discharge process. $\text{Li}_4\text{Ti}_5\text{O}_{12}$ was always demonstrated as a good candidate as negative electrode for solid state lithium ion batteries^[2-5] and liquid type^[1-6]. In this work, we report here a zero-strain insertion material in contact with liquid, gel, solid polymer electrolyte by showing the DST and X-ray diffraction measurement for $\text{Li}_4\text{Ti}_5\text{O}_{12}$ together with SEM observation, electrochemical discharge and charge, and slow cyclic voltammetry. This will show the effect of the additives on the synthesis of Nano- $\text{Li}_4\text{Ti}_5\text{O}_{12}$. The intent of the present paper is to extend these studies by providing a systematic analysis of a series of with different morphologies microstructure and nanostructure

Experimental

The Li-Ti-O ternary phase were prepared by two methods: conventional method, heating a mixture two of TiO_2 Anatase and Li_2CO_3 at 800° for 12h under a nitrogen steam. The second method used was high energy ball milling (HEBM) of precursor to form nanocrystalline phases. These materials were then heat treated in order to obtain the desired phases. The samples were characterized by X-ray diffractometer, DST and scanning electron microscopy before intercalation. The discharge (intercalation)-charge (deintercalation) cycling for the $\text{Li}_4\text{Ti}_5\text{O}_{12}$ electrode was carried out using 4 cm^2 lab cell (two electrodes) with lithium metal. The initial cell chemistry for the negative electrode is based on: Li metal (-) / Electrolyte / $\text{Li}_4\text{Ti}_5\text{O}_{12}$ (+).

The $\text{Li}_4\text{Ti}_5\text{O}_{12}$ working electrode was preparing by adding 50% Volume to SPE and painting it on the aluminium Exmet. For liquid and gel type electrolyte working the electrode was preparing by adding 90% wt. to PDVF and painting it on the aluminium Exmet. The electrode was dried under vacuum at 85°C for 24h before use. The discharge-charge cycle and slow cyclic voltammetry for this electrode were carried out using the galvanostatic, potentiostatic methods (Macpile^R, Claix, France). All experiments were formed at 25, 60 and 80°C .

Results

The color of the prepared samples for both methods were white and gray, indicating that the samples were electronic insulators and conductors respectively. Galvanostatic curve shows the initial discharge - charge capacities at rate C/24 of nanostructure (Fig.1). The initial open circuit voltage (OCV) was 2,2V. During the discharge the voltage drops quickly down to below 2V and decrease as the reaction proceeds until the voltage reaches about 1,5V. The cell were cycled between 1,2V and 2V (Fig.2). The cell has long life and very good cyclability. We believe that zero-strain insertion materials and a lithium ion conductive solid polymer are necessary for the implementation of long cycle life, high volume and safe solid state lithium ion polymer batteries.

References

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Fig.1

