Ain Shams University

Faculty of Science

Chemistry Department

Preparation and characterization of anodes by electrodeposition for lithium ion batteries from ionic liquids

A Thesis Submitted by

SHERIEF AHMED REYAD AL KIEY

(M.Sc in Chemistry - 2013)

Doctor of Philosophy (Ph.D)

To

Chemistry Department

Faculty of Science

Ain Shams University

2019

Approval Sheet

Ph.D Thesis

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SHERIEF AHMED REYAD AL KIEY

Supervised By

Prof. Dr. Sayed Sabet Abd El Rehim ***Prof. Dr. Ali El Warraky***

Faculty of Science, Ain Shams University National Research Centre

Prof. Dr. Sherif Zein El Abedin

National Research Centre

Thesis Approval Date / /

Faculty Approval / /

University Approval / /

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Examiners Committee **Approved**

Prof. Dr. Sayed Sabet Abd El Rehim
Professor of Physical Chemistry
Faculty of Science, Ain Shams University

Prof. Dr. Sherif Zein El Abedin
Head of Physical Chemistry Department,
National Research Centre

Prof. Dr. Ahmed Metwally Abd El Aziz
Faculty of Engineering, German University in Cairo

Prof. Dr. Mohamed S. El Deeb
Professor of Physical Chemistry
Faculty of Science, Cairo University

Date: / / **2019**

Preparation and characterization of anodes by electrodeposition for lithium ion batteries from ionic liquids

Sherief Al kiey

Abstract

Lithium ion batteries have attracted considerable attention because of the high energy density, long cycle life, reasonable production cost and the ease of manufacturing. As the capacity of the current Li ion batteries is limited by the low theoretical capacity of the conventional graphite anode, the aim of the present thesis is the synthesis and characterization of high capacity anodes for lithium ion batteries as a possible replacement to the conventional graphite anode by electrodeposition from ionic liquids.

Ionic liquids have received significant attention as promising alternatives to conventional electrolytes in different electrochemical processes due to their unique physicochemical properties.

- The water absorption tendency of the ionic liquid electrolyte $[Py_{1,4}]TfO$ / 0.1 M $SnCl_2$ under ambient atmosphere and its influence on the hydrolysis of Sn(II) species and on the electrodeposition of tin was studied. It was shown that the employed ionic liquid electrolyte strongly absorbs water under ambient conditions. The presence of water as well as the hydrolysis product affects the electrochemical behavior of the employed electrolyte and the morphology of tin electrodeposits.

- The electrodeposition of Sn, In and Sn-In alloys were investigated from two different ionic liquids 1-butyl-1-

methylpyrrolidinium trifluoromethylsulfonate ([$Py_{1,4}$]TfO) and 1-ethyl-3-methylimidazolium trifluoromethylsulfonate ([EMIm]TfO) at room temperature. The electrochemical behavior in the two ionic liquids was investigated by CV. The surface morphology of the electrodeposits depends on the deposition potential and the percentage of Sn in Sn-In alloy was found to be dependent on the applied potential.

- The electrochemical deposition of Sn, Sb and Sn-Sb films and nanowire arrays from the ionic liquid [$Py_{1,4}$]TfO via a template assisted electrodeposition process using track etched polycarbonate membranes were shown. High quality free standing Sn, Sb and Sn- Sb alloys nanowires arrays were prepared.

- The electrochemical behavior of In from two ionic liquids [EMIm]TfO and [EMeOIm]TfO was studied using cyclic voltammetry and potentiostatic. The surface morphology and composition of indium thin films was investigated using scanning electron microscopy (SEM) and energy dispersive x-ray (EDX). The insertion of methoxy group into the side chain of the imidazolium based cation has a strong effect on the electrodeposition pathway of In in comparison to [EMIm]TfO. In addition, In nanowire arrays were electrodeposited using template assisted electrodeposition method using track etched polycarbonate membrane (PC) from two ionic liquids.

- The performance of the electrochemically made films/ nanowire arrays as anodes for Li ion batteries was briefly demonstrated.

Acknowledgement

First of All, Praise be to Allah, Who guided us to this; and in no way could we have been guided, unless Allah has guided us.

First and foremost I would like to express my deepest gratitude to Prof. Dr. Sayed Sabet Abd El Rehim for his supervision, continuous support and valuable discussions. I appreciate so much the fruitful discussions with him.

Also, I would like to express my tremendous gratitude and appreciation to Prof. Dr. Sherif Zein El Abedin as a supervisor for his continuous support, kind help, very interesting discussions. Also a big thanks to my supervisor Prof. Dr. Ali Abd El Fattah El Warraky and Prof. Dr. Hala Kamal Farag for their support and help.

Also, I would also like to thank my colleagues at the National Research Centre. The financial support from National Research Centre is gratefully acknowledged.

Finally, I would like to express my deepest gratitude and sincere appreciation to my parents, my Sons Ahmed and Sama and my wife and I ask Allah to bless them.

Sherief Ahmed Reyad Al Kiey

Contents

Chapter 1

Introduction

List of Tables

Table

List of Figures

Fig. 3.3. XRD patterns of the hydrolysis product of $[Py_{1,4}]TfO$/ 0.1 M $SnCl_2$, obtained after air exposure for one month, without and with calcination at 200 ^oC and 500 ^oC.

Fig. 3.4 a) SEM micrograph of the obtained hydrolysis product after treatment with hot water b) EDX profile of obtained product. c) XRD patterns of the obtained product.

Fig. 3.5. Cyclic voltammograms of the ionic liquid $[Py_{1,4}]TfO$ containing 0.1 M $SnCl_2$, recorded on copper substrates, after air exposure for different intervals: a) freshly prepared electrolyte, b) after air exposure for one week, c) after air exposure for one month. Scan rate: 10 mV s^{-1}.

Fig. 3.6. SEM micrographs of the Sn deposits obtained potentiostatically in a) freshly prepared 0.1 M $SnCl_2/[Py_{1,4}]TfO$ (Inset: SEM micrograph of higher magnification) and in b) 0.1 M $SnCl_2/[Py_{1,4}]TfO$ after air exposure for one month.

Fig. 4.1. Cyclic voltammograms of Sn, In and Sn-In electrodeposits on copper electrode in 0.1 M $SnCl_2$, 0.1 M $InCl_3$ and 0.1 M ($SnCl_2$-$InCl_3$) /$[Py_{1,4}]TfO$ with a scan rate of 10 mV s^{-1} at room temperature.

Fig. 4.2. SEM micrograph of Sn electrodeposited from 0.1M $SnCl_2/[Py_{1,4}]TfO$ on copper by potentiostatic electrodeposition at different potentials a) -0.8 V for 1 hour b) EDX profile of electrodeposited Sn.

Fig. 4.3. a) SEM micrograph of a In electrodeposits from 0.1 M InCl3/[Py1,4]TfO by potentiostatic electrodeposition at -2.2 V b)

EDX profile of the electrodeposited In film for1 h on copper substrate.

Fig. 4.4 a)SEM micrograph of Sn-In film electrodeposited from 0.1M SnCl2 - InCl3/[Py1,4]TfO by potentiostatic electrodeposition at -2.0 V b) EDX profile of the obtained electrodeposit on copper for 1h.

Fig. 4.5. XRD patterns of the electrodeposited Sn-In films obtained on copper substrate from [Py1,4]TfO hour.

Fig. 4.6. Cyclic voltammograms of 0.1 M $SnCl_2$, 0.1 M $InCl_3$ and 0.1 M ($SnCl_2$-$InCl_3$) /[EMIm]TfO recorded on copper with a scan rate of 10 mV/s at room temperature.

Fig. 4.7. Cyclic voltammograms of 0.1 M $SnCl_2$ in [$Py_{1,4}$]TfO (black) and 0.1 M $SnCl_2$ in [EMIm]TfO recorded on copper substrate at a scan rate of 10 mV/s.

Fig. 4.8. SEM images of a) the electrodeposited Sn after constant potential deposition at - 1.2V for 1 h on copper substrate from [EMIm]TfO b) EDX spectrum of Sn film c) Microstructure of In electrodeposited from[EMIm]TfO at -1.6V for 1 h d) EDX spectrum of In film.

Fig. 4.9 a) SEM image of Sn-In electrodeposited potentiostatically potential of -1.7 V from 0.1 M $SnCl_2$+ 0.1 M $InCl_3$/ [EMIm]TfO on copper substrate b) its EDX profile of the obtained electrodeposit.

Fig. 4. 10. Cyclic voltammograms of 0.1 M $SnCl_2$, 0.1 M $InCl_3$ and 0.1 M $SnCl_2$ + 0.1 M $InCl_3$ in the ionic liquid [EMIm] TfO on Au-sputtered PC membrane with a scan rate of 10 mV/s .