Optimisation of the Titanium oxysulfides (TiO_yS_z) performance used as positive electrode in lithium microbatteries

[1]E. Saoutieff, [1]L. Le Van-Jodin, [1]C. Secouard, [2]M. Proust
[1]CEA LITEN, 17 Rue des Martyrs, F-38054 Grenoble, France
[2]STMicroelectronics, Advanced Technologies R&D, 16 rue Pierre et Marie Curie, B.P.7155, F-37071 Tours Cedex 2, France

Introduction

An all solid-state-microbattery is defined as a stack of thin layers (~ 15µm) including the active part (electrodes and electrolyte), protective layers and current collectors. [1]
$LiCoO_2$, $LiMn_2O_4$ and V_2O_5 are commonly used as positive electrode material. As reported in the literature, $LiCoO_2$ and $LiMn_2O_4$ operate reversibly around 4 V/Li^+/Li. [2]
In this work, the stack Li/LiPON/TiOS is studied. Titanium oxysulfide thin films (TiO_yS_z) are used as positive electrode material. This material was selected because of their specific potential (reversibly insert of lithium below 3V vs. Li^+/Li) well adapted for the considered application.
Correlation between microstructure, chemistry and performance of the active material is reported.

Experimental

Thin films of TiO_yS_z were deposited by sputtering process (PVD) on 8" Si wafer. Power, H_2S flow rate and deposition temperature were modified to optimized TiO_yS_z performances.
TiO_yS_z deposition rate and microstructure were determinate by weighing and SEM analyses. The electrochemical properties were measured by galvanostatic cycling and EIS. The chemical composition was studied by X-Ray Photoelectron Spectroscopy.

Results and discussion

The increase of the deposition temperature, from room temperature to 150°C, improves the capacity and the fading rate. The new material shows an excellent cycle life with fading rate of -0.05% per cycle and a capacity of around 70 µA.h.cm^{-2}.µm^{-1} between 1V and 3V vs. Li^+/Li (fig.1).

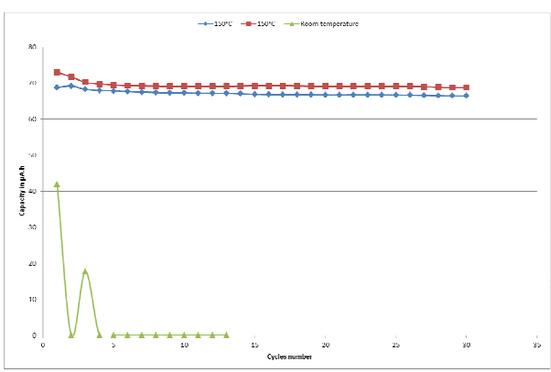

Figure 1: Evolution of the capacity with deposition temperature over 30 cycles, 150°C (red and blue curves), room temperature (green curve)

The SEM micrograph of the cross section shows a dense TiOS layer (fig.2).

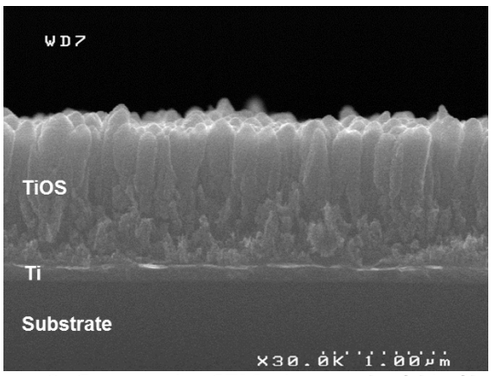

Figure 2: Cross section SEM micrograph of thin film of Ti/TiOS

Conclusion

The TiO_yS_z material is suitable to be used as positive electrode in microbattery. The three parameters power, H_2S flow rate and deposition temperature allowed the deposition of TiO_yS_z with a capacity of 70 µAh cm^{-2} µm^{-1} and an excellent cycle life.

References

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