CATHODIC ACTIVE MATERIAL FOR LITHIUM BATTERIES

G. TARALUNGA, E. M. RUS** and D.a M. CONSTANTIN***

**University of Agricultural Sciences and Veterinary Medicine,Manastur Str.3-5, 3400 Cluj-Napoca, ROUMANIA*

***"BABEŞ-BOLYAI" University, Faculty of Chemistry and Chemical Engineering, 11 A. Janos, 3400 Cluj-Napoca, ROUMANIA, e-mail* norus@chem.ubbcluj.ro

Introduction

It is well known that lithium batteries are one of the most promising devices for light and compact power sources because of their high power, high energy density and long cycle life.

Various types of active materials for rechargeable lithium batteries have been investigated by research groups worldwide. Among these, titanium disulphide has been thought to be one of the desirable cathode materials for a high energy density secondary battery [1-3]. Its high current characteristics and good reversibility are due to the fact that the electrochemical reaction is an intercalation reaction of lithium into the van der Waals layer of titanium disulphide [4,5].

This paper presents some theoretical aspects concerning the intercalation of Li^+ into TiS_2 electrodes. The physical and structural characteristics and the electrochemical behaviour of the TiS_2 electrodes were investigated by X-ray diffraction, and charge-discharge curves in galvanostatic regime.

Experimental

We obtained TiS_2 by reaction between $TiCl_4$ and H_2S at 550^0C:

$$TiCl_4 + 2H_2S \xrightarrow{475-550^0C} TiS_2 + 4HCl \qquad (1)$$

The reaction occurred in a tubular quartz reactor, placed vertically and having external heating system. The temperature in the reactor was rigorously maintained in 475-550^0C range to avoid the decomposition of H_2S and the formation of undesired compounds (TiS_2, $TiOCl_2$).

The physical and structural characteristics of prepared TiS_2 powder were determined by gravimmetric analysis and X-ray diffraction [6].

TiS_2 electrodes were realized from prepared TiS_2 as active mass, graphite as electronic conductor, and teflon as binder, having different compositions.

The electrochemical behaviour of these electrodes has been investigated by charge-discharge curves in galvanostatic regime, at room temperature. The charge-discharge curves were performed for Li/ TiS_2 button batteries.

Results and discussion

The gravimmetric analysis of TiS_2 powder, having a dark tint and golden lustre, that the values for titanium content are very near of theoretical value (42.76%wt) [6].

The X-ray diffraction pattern of TiS_2 prepared powder contained the specific diffractional lines of titanium disulphide (Fig. 1).

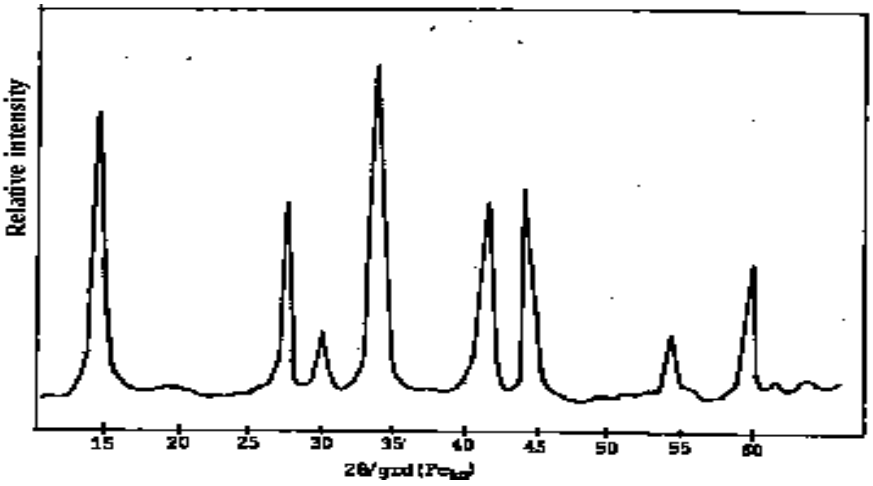

Fig.1. *X-ray diffractional patterns of TiS_2.*

From the experimental data, corresponding to the different cycles, were calculated the discharge capacities, C_{disch}, charge capacities C_{ch}, the utilization coefficient of active material, u, and efficiency of batteries r_F. The electrochemical characteristics of TiS_2 depolarisants are shown in Table 1.

As can be seen from Table 1, the best performance was obtained with the batteries without graphite in composition of the cathode. For these cells were obtained 20 charge-discharge cycles, with good efficiencies (77-94%) at high utilized degree of active mass.

Table 1. *Electrochemical characteristics of TiS_2 electrodes.*

Cycle	C_t [mAh/g]	t_{disch} [h]	C_{disch} [mAh/g]	t_{ch} [h]	C_{ch} [mAh/g]	r_F [%]	u [%]
Electrode composition: 93.33 %wtTiS_2; 0%wt graphite; 6.67%wt teflon							
1	223	7.5	210.26	8	224.28	93.74	96.28
5	223	7	196.25	8	224.28	87.50	88.00
20	223	6.2	173.83	8	224.28	77.50	77.94
Electrode composition: 89.2 %wtTiS_2; 4.47%wt graphite; 6.33%wt teflon							
1	213.18	7	205.42	8	234.76	87.49	96.36
5	213.18	6	176.07	8	234.76	74.99	82.59
Electrode composition: 85.4 %wtTiS_2; 8.53%wt graphite; 6.08%wt teflon							
1	204.08	6.7	205.44	7.5	229.98	89.32	100.66
5	204.08	6	183.98	7.5	229.98	79.89	90.15
12	204.08	5	153.32	7.5	229.98	66.66	75.12

The electrochemical behaviour of the electrodes is influenced by the crystalline structure of active material, TiS_2, by preparation conditions, and by electrode composition (graphite and teflon ratio).

The galvanic system with TiS_2 cathodes is reversible, observing plateau regions on charge-discharge curves, which corresponds to intercalation and deintercalation of lithium ions.

The reversibility of the electrode processes descrease with the number of charge-discharge cycles, because the oxidation process becomes more difficult in the presence of lithium ions.

References

1. L. Aselage, E.E. Hellstrom, *J. Electrochem. Soc.,***134**, 1932, (1987).
2. S.S. Wang, *J. Electrochem. Soc.,* **135**, 1675, (1988).
3. E.J. Plichta, W.K. Behl, D. Vujic, W.H.S. Chang, D.M. Schleich, *J. Electrochem. Soc.,* **139**, 1509, (1992).
4. G.L. Henriksen, D.R. Wissers, A.A. Chilenskas, *J. Power Sources*, **54**, 134, (1995).
5. K. Kanehori, F. Kirino, T. Kudo, K. Miyauchi, *J. Electrochem. Soc.*, **138**, 2216, (1991).
6. Georgeta Ţarălungă, *Ph. D. Thesis,* "Babeş-Bolyai" University Cluj-Napoca, Romania, 1998.