GEL SUPERCAPACITORS OF DOUBLE LAYER TYPE

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ABSTRACT

This work parses the present construction and capacity of gel supercapacitors. In introduction is described principle of supercapacitors based on double layer effects. In measurement part is described influence of separators to capacity of supercapacitors.

1 INTRODUCTION

First of all, I would like to introduce you the principle of supercapacitors based on double layer effects. Let us imagine a metal electrode submerged in the electrolyte. In water solution, we are limited with potencial, of water decomposition on hydrogen and oxygen. The critical potential is 1,224 volts theoretically.

When we apply on chemically inert electrode higher positive potential with respect to the electrolyte, it will accumulate negative ions and repel positive ions. So a space charge will be created several tens nanometre thick, which is in theoretical electrochemistry called the electric double layer. The capacity of the spatial charge is high due to higher concentration of charge carriers. We are talking about tens or hundreds farads on cubic centimetre. Their creation or disappearance is physical process, which is not bound with any reconstruction of chemical structures or compounds and is perfectly reversible. The lifetime of supercapacitors is very long therefore.

When we use inert carbon with big specific surface area as electrode material (till 2000 square metres on gramme) and joined by suitable binding agent and pressed on current collector, we obtain such supercapacitors with mentioned attributes. The main disadvantage of supercapacitor is low potential span. Using aqueous solutions reduces potential span to 1,1 until 1,2 volts. Exceeding this limit causes the formation of gaseous hydrogen and oxygen in the capacitor. We can solve this problem with using organic solvents, like those used in lithium batteries. Propylene carbonate, ethylene carbonate, diethoxyethanu, acetonitrile and so on are suitable. Voltage span of these capacitors is increased to 2,3 - 2,4 volts. The energy stores in a capacitor is proportional to the second power of voltage. Therefore, the energy density is increased 4 to 5 times by organic solvents.

2 CONSTRUCTION OF SUPERCAPACITORS

2.1 ELECTRODES

The electrodes are created from metal screen, carbon, binding agent and conditioner. As a carbon I used expanded carbon. As a binding agent I chose Sokrat and as a conditioner I used Hydrogen ammonium carbonate (Tab.1). I had to add water to ingredients so ingredients created paste. I spreaded paste on the metal screen and placed the screen with paste to oven on 120 °C. I took the screen out after 20 minutes and I leached in water and again I placed the screen to oven on 120 °C.

Exp. carbon [g]	NH4HCO3 [g]	Sokrat [g]
0,100	0,210	0,250

Tab. 1: *Ingredients of electrode of supercapacitor*

2.2 GEL ELECTROLYTES

- 10 ml….0,5 mol.l^{-1} electrolyte with $LiCLO_4$, 10 ml….Dentacryl, 8 g….Superakryl
- 10 ml….0,5 mol.l^{-1} electrolyte with $NE_{T4}BF_4$, 10 ml….Dentacryl, 8 g….Superakryl

0,5 mol.l^{-1} electrolyte $\rightarrow$ 2,66 g $LiCLO_4$ + 50 ml propylencarbonate

0,5 mol.l^{-1} electrolyte $\rightarrow$ 5,42 g $NE_{T4}BF_4$ + 50 ml propylencarbonate

$E_{T4} = (CH_3CH_2)_4$

2.3 SEPARATORS

As separator I used glass tissue and hardened gel electrolyte.

2.4 CONSTRUCTION

I put in the electrode to Petri dish that I suffused with the gel electrolyte. Next I put separator on electrode then I added the gel electrolyte. Finally I put in second electrode to Petri dish and I added the electrolyte again (Fig. 1). The supercapacitors created in this way hardened in 12 days. I had to put weight on the supercapacitors for time harden.

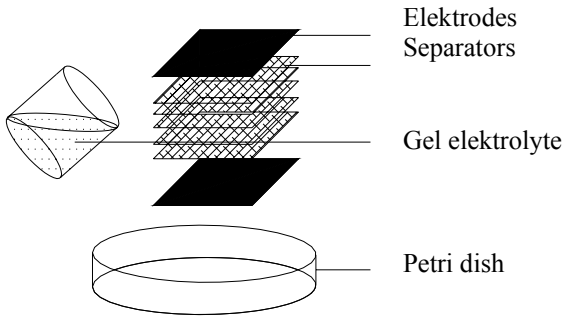

Fig. 1: *Construction of supercapacitors*

3 MEASUREMENT OF SUPERCAPACITORS

3.1 MEASUREMENT

I measured the supercapacitors on measuring device Autolab in programme GPES.

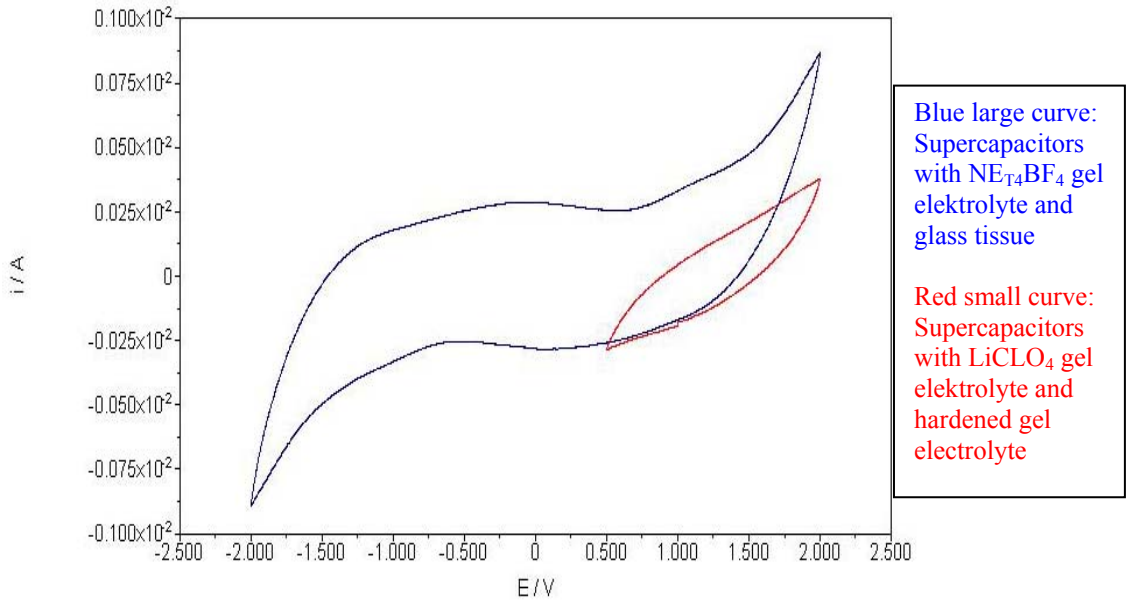

Fig. 2: *The graph of cyclic voltametri*

3.2 RESULTS

I read current values from the graph of cyclic voltametri (Fig. 2) and I constituded the results to formula:

$$C = \frac{1}{2}\frac{\Delta I}{v} \qquad (1)$$

where C [F] is capacity, delta I [A] is difference currents and v [V/s] is rate of change potential in volts per second (v is 0,01 V/s). The value is subtract for 1V.

simple	Kapacity [mF]
Supercapacitors with $NE_{T4}BF_4$ gel elektrolyte and glass tissue	12,5
Red curve: Supercapacitors with $LiCLO_4$ gel elektrolyte and hardened gel electrolyte	25

Tab. 2: *Capacity results*

4 CONCLUSION

Main intention of this work was determine adventage and disadventage of separators.

Adventage hardened gel electrolyte as separator is easily set width between electrodes (how will hardened gel electrolyte wide such will width between electrodes). While with glass tissue as separator I have to use minimally 4 screen of glass tissue because influence weight partially cut separator into the electrode so is fewer widht between electrodes. Results is: electrodes are connect.It is bad. When I weight supecapacitors where were use hardened gel electrolyte, electrodes can't connect. I have to put on weight when I create supercapacitor, because electrodes swim in elektrolyte.

If we use more conditioner than the capacity is rising as well. On the figure 1. we can see sample where is used a little bit NH_4HCO_3 and on the figure 3 we can see sample where is used more conditioner. Bigger air tunnels are situated on the figure 4, which are created quantity added conditioner.

Fig. 3: *Electrode with 0,111g NH_4HCO_3*

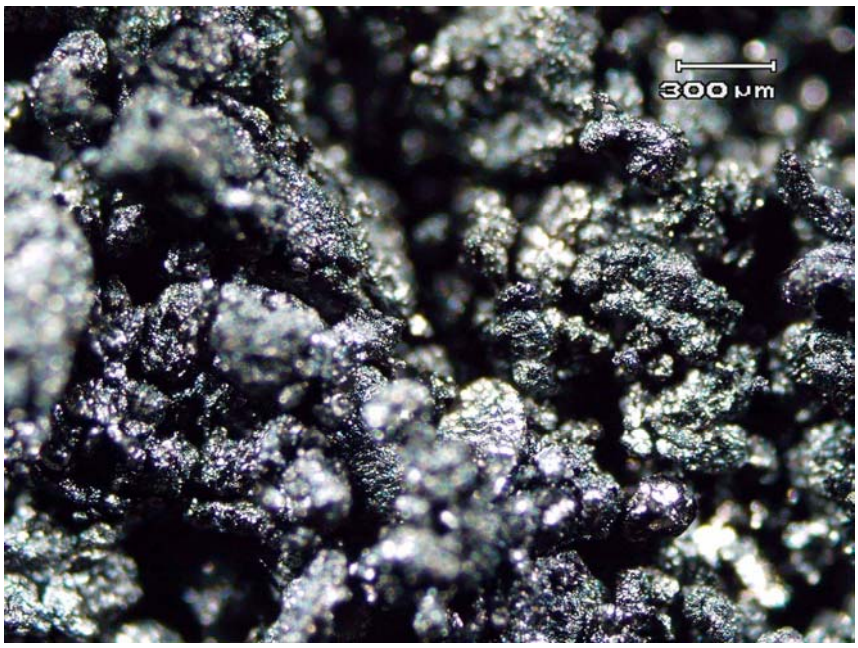

Fig. 4: *Electrode with 0,244g NH_4HCO_3*

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