PREPARATION AND ANALYSIS OF THE GEL SUPERCAPACITORS

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ABSTRACT

This work describes method of construction of the gel supercapacitor and how we can improve the attributes of the gel supercapacitor.

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. 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 similar aprotic solvents are suitable. Voltage span of these capacitors is increased to 2,3 - 2,4 volts. The energy stored 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 THE GEL SUPERCAPACITORS

2.1 ELECTRODES

The electrodes can be created from (for example):

Carbon	Binding agent	Solvent	Conditioner
Expanded graphite	Sokrat	Acetonitril	NH_4HCO_3
Nanosorb	Teflon	PC	$NE_{T4}BF_4$
Soot A	-----	DMF	$LiBF_4$
Soot B	-----	DMS	-----

Tab. 1: *Ingredients of electrode of supercapacitor*

PC – propylencarbonate, DMF – Dimethylformamid, DMS – Dimethylsulfoxid, NH_4HCO_3 -Hydrogenammoniumcarbonate, $NE_{T4}BF_4$(*) – Tetraethylamoniumtetrafloroborate, $LiBF_4$ – Lithiumtetrafloroborat

(*)$E_{T4} = (CH_3CH_2)_4$

2.2 GEL ELECTROLYTE

The proportion for creation of the gel electrolyte:

- 1 ml….electrolyte, 1,5 ml….Dentacryl, 0,7 g….Superakryl

2.3 SEPARATORS

Hardened gel electrolyte is used as separator.

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 a weight on the supercapacitors for the time of hardening.

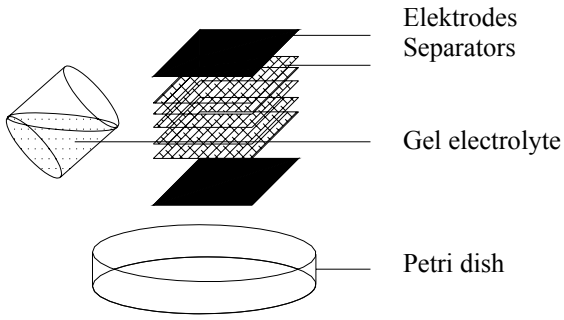

Fig. 1: *Construction of supercapacitors*

3 MEASUREMENT OF SUPERCAPACITORS

3.1 MEASUREMENT

I measured the supercapacitors on measuring device Autolab in programme GPES (cyclic voltametry).

3.2 RESULTS

The created supercapacitors has capacity about 10 F/g.

I discovered the problem that the gel electrolyte does not penetrate to indoor of electrode of supercapacitor. This problem is probably cased by high concentration and viscosity of the gel electrolytes. Then the gel electrolytes cannot get to the narrow tunnels.

4 CONCLUSION

To improve the penetration of electrolyte into the electrode, it is necessary to create special glass tank (Fig. 2) for filling the narrow tunnels by the gel electrolyte. We have to create vacuum in main body of the glass tank. Then we have to fill body by the gel electrolyte. The gel electrolyte fill the narrow tunnels due to vacuum in the body of the glass tank.

This step could increase the capacity.

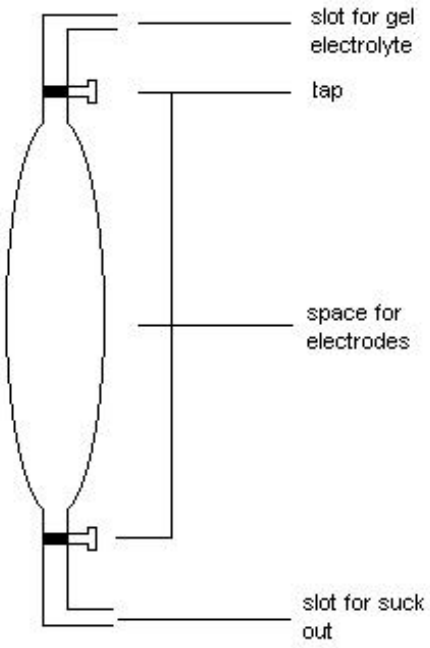

Fig. 2: *Glass tank*

ACKNOWLEDGMENTS

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REFERENCES

[1] Vondrák, J., Sedlaříková, M., a kol.: Elektrochemické kondenzátory v praxi, Sdělovací technika, 2002

[2] Vondrák, J., Sedlaříková, M.: Elektrochromizmus, superkondenzátory, lithno-iontové baterie, Sdělovací technika, 3/2001

[3] Conway, B. E.: Electrochemical supercapacitors: Scientific fundamentals and technological applications, Kluwer Academic / Plenum Publisher, New York, 1999

[4] Kocian, M.: Supercapacitors: thesis, VUT Brno, Brno, 2003