

# INFLUENCE OF MOLECULAR PROPORTION IN THE SUPERCAPATIONS

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## ABSTRACT

This work describes influence of molecular proportion in the liquid supercapations. In introduction is presented principle of supercapacitors based on double layer effects. In measurement part is presented influence of molecular proportion to the 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. 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. . In water solution, we are limited with potential, of water decomposition on hydrogen and oxygen. The critical potential is 1,224 volts theoretically. 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, acetonitrile and so on 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 SUPERCAPACITORS

### 2.1 ELECTRODES

The electrodes are prepared from metal screen, carbon, binding agent (Sokrat) and conditioner ( $\text{NH}_4\text{HCO}_3$ ). The electrodes are dried in oven on  $130\text{ }^\circ\text{C}$  at 20-30 minutes. This temperature is advantageous because we needn't to leach the electrodes in water.

	Carbon [g]	$\text{NH}_4\text{HCO}_3$ [g]	Sokrat [g]
Expanded	0.100	0.250	0.200
Nanosorb	0.100	0.250	0.200

**Tab. 1:** *Ingredients of the electrodes*

### 2.2 LIQUID ELECTROLYTES

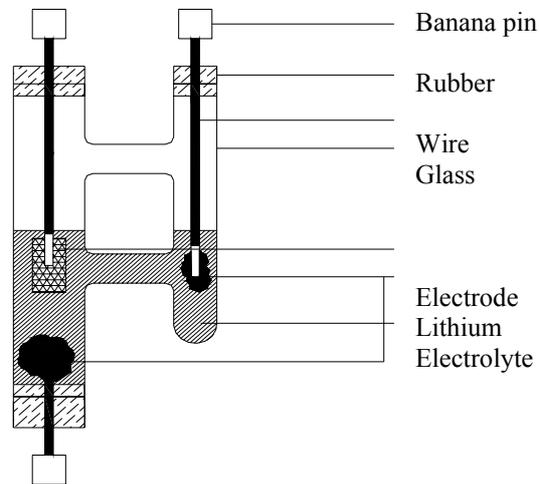
0,1 mol.l <sup>-1</sup> electrolyte	→	0.213 g LiClO <sub>4</sub>	+ 20 ml propylencarbonate
0,5 mol.l <sup>-1</sup> electrolyte	→	1.064 g LiClO <sub>4</sub>	+ 20 ml propylencarbonate
1 mol.l <sup>-1</sup> electrolyte	→	2.128 g LiClO <sub>4</sub>	+ 20 ml propylencarbonate
1,5 mol.l <sup>-1</sup> electrolyte	→	3.192 g LiClO <sub>4</sub>	+ 20 ml propylencarbonate
2 mol.l <sup>-1</sup> electrolyte	→	4.256 g LiClO <sub>4</sub>	+ 20 ml propylencarbonate
3 mol.l <sup>-1</sup> electrolyte	→	6.383 g LiClO <sub>4</sub>	+ 20 ml propylencarbonate
4 mol.l <sup>-1</sup> electrolyte	→	8.511 g LiClO <sub>4</sub>	+ 20 ml propylencarbonate
5 mol.l <sup>-1</sup> electrolyte	→	10.639 g LiClO <sub>4</sub>	+ 20 ml propylencarbonate

This mass we can define as : atomic number[-] × capacity[l] × concentration[mol . l<sup>-1</sup>]

$\text{LiClO}_4$  has atomic number 106.39 (6.94 + 35.45 + 4 × 16) then  $106.39 \times 0.02 \times 0.5 = 1.064$  g  $\text{LiClO}_4$  and 20 ml propylencarbonate.

### 2.3 MEASUREMENT TANK

This is the glass tank for measuring of supercapacitors.

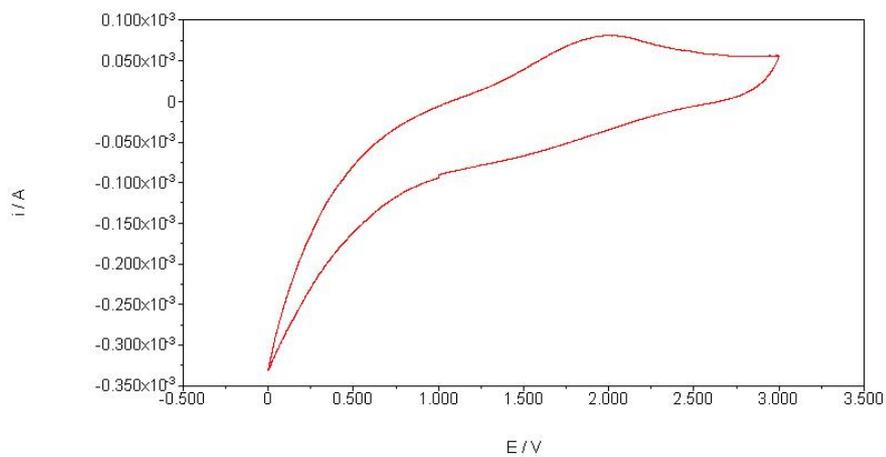


**Fig. 1:** *Measurement tank*

## 3 MEASUREMENT OF SUPERCAPACITORS

### 3.1 MEASUREMENT

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



**Fig. 2:** *The graph of cyclic voltametry for  $0,5 \text{ mol.l}^{-1}$  electrolyte*

### 3.2 RESULTS

The difference of currents is obtained from the graph of cyclic voltametry (Fig. 2) and then capacity is calculated from this formula:

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

where C [F] is capacity,  $\Delta I$  [A] is difference of currents and  $v$  [V/s] is rate of change potential in volts per second ( $v$  is 0.01 V/s). The value is evaluated for 2 V.

Elektrolyte [mol.l <sup>-1</sup> ]	Expanded graphite [F/g]	Nanosorb [F/g]
0.1	1.5	0.13
0.5	2.1	0.32
1	2.25	1.25
1.5	2.32	0.85
2	4.61	0.75
3	3.78	0.58
4	0.98	0.12
5	1.47	1.25

**Tab. 2:** *The results of capacity*

### 4 CONCLUSION

The electrical conductivity requires a strongly polar solvent with sufficiently high permittivity (water 83, propylenecarbonate 60, acetonitrile 120) and a salt soluble in the solvent in sufficient concentration. According to theories given by Stokes, Longuet and Higgins theory, the ionic mobility  $\underline{b}$  should equal to

$$b = |z| \cdot \frac{q}{6\pi\eta r},$$

where  $\underline{b}$  is the mobility of the ion,  $q$  the elementary charge of an electron,  $\eta$  dynamic viscosity and  $\underline{r}$  is the ionic radius..

The motion of ions in the double layer and therefore the specific capacity is the larger, the higher is the permittivity and therefore also the mobility. From data presented in Tab. 2 however is evident that maximum of specific capacity occurs at concentrations of the order of 1 mole . dm<sup>-3</sup>. the exact position of the maximum is dependent on the nature of the electrode material.

### ACKNOWLEDGMENTS

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