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Receiving and Capacitive Profile of Capacitors Arrangements on The Base of Butadiene-Styrene Rubber with Addition of $CdCl_2$ or $MoCl_2$ and Active Carbon

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In present studies, a method is developed for cheap capacitor materials with variable demand-dependent capacitance values in an easy way. Examination of capacitive properties was done at 20 °C. Mean capacitance range was between 0.8 and 8 F/g. The capacitive systems were examined on circuits with decade resistors and capacitors.

Key Words: Organic capacitors, Styrene-butadiene rubber, Conductive polymers, $CdCl_2$, $MoCl_2$.

INTRODUCTION

Supercapacitors have been known for many years. They are mainly used as materials- 'accelerators' in motor-car engines giving a larger power. Supercapacitors are also widely used in electrical and electronic engineering. In this paper, preparation of organic capacitors and their capacitive characteristic determined for one gram of composite as a capacitor element have been presented[1-24].

Owing to good quality and low price, butadiene-styrene rubber as a 1,4-*cis* and -*trans* mixture composed of 77 % butadiene and 23 % styrene (values given as molar fractions), which has been manufactured by Chemical Plant Dwory S.A. near Oswiecim, Poland, was used for examination. This rubber was obtained in the process of low-temperature emulsion copolymerization, No. KER® 1507.

EXPERIMENTAL

Preparation of capacitor electrolytes

Synthesis of the styrene-butadiene rubber + $CdCl_2$ or $MoCl_2$ + active carbon system

Stage-1: Dissolution of styrene-butadiene rubber with active carbon addition: Styrene-butadiene rubber is well-soluble in toluene, 40 mL of toluene is added to 3 g of fine-cut styrene-butadiene rubber. After 3 d at room temperature, the polymer becomes an oily substance. Such a dissolved rubber was supplemented with active carbon (powdery form) in different amount of 0.5, 1.0, 1.5, 2.0 and 2.5 g.

Stage-2: Synthesis of polymeric electrolyte: Before obtaining a rubber electrolyte with active carbon addition, a maximum amount of $CdCl_2$ or $MoCl_2$ possible for adding was determined. This amount was assayed and found to be 5 g of $CdCl_2$ or

$MoCl_2$. After adding a larger amount than 5 g of $CdCl_2$ or $MoCl_2$, problems related to precipitation of rubber electrolytes in the form of gel from this solution occurred in all systems. These problems consisted in a non-homogenous form of gel.

5 g of $CdCl_2$ or $MoCl_2$ was dissolved in 40 mL methanol and added to the styrene-butadiene rubber solution prepared earlier with addition of active carbon.

After stirring, rubber electrolyte precipitated from the solution almost at once. Such a rubber electrolyte system is left for 24 h after removal from the solution. After 24 h, the rubber system is subjected to electrical conductivity testing (Fig. 1).

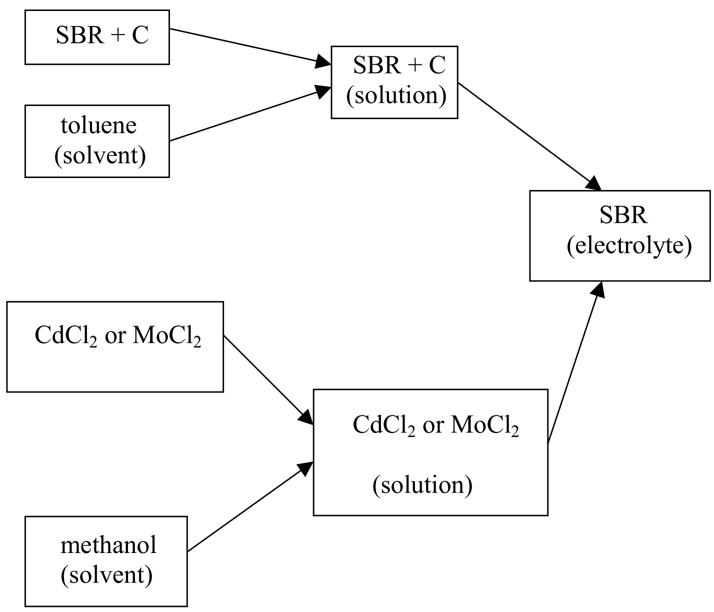

Fig. 1. Preparation of conductive styrene-butadiene rubber (SBR)

Method for examining conductivity and capacitive properties of composite systems: In order to determine the specific conductivity of obtained systems, they were examined using alternating current. For this purpose, the following test equipment was used: • AC Alternator: HEWLETT PACKARD 33120A 15 MHz Function/ Arbitrary Waveform Generator, • Multimeter: AGILENT 3458a Digital Multimeter, 81/2 digits, •Oscilloscope: HEWLETT PACKARD Infinium Oscilloscope 500 MHz, 1Gsa/s.

The systems of conductive polymers were examined on copper plates. These copper plates were earlier cleaned with carbon tetrachloriode (CCl_4) and rinsed with hot water. Subsequently, they were subject to a four-hour long chemical polishing in a solution composed of H_3PO_4 (80 %): 500 cm^3 + CH_3COOH (icy): 300 cm^3 + HNO_3 (60 %): 200 cm^3.

To two copper plates with an area of 0.88 cm^2 (square centimetres) each prepared this way, the following system was introduced: polymer + $CdCl_2$ (or $MoCl_2$) + active carbon with a thickness of 0.1 cm, Fig. 2 presents a diagram of such a measuring circuit.

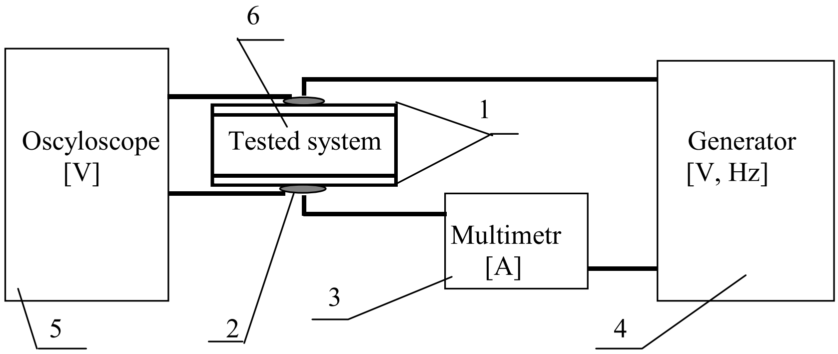

Fig. 2. Measuring diagram for the conductivity of tested polymer system: 1 = copper plates, 2 = conductor and copper plate junction, 3 = multimeter, 4 = alternator, 5 = oscilloscope, 6 = polymeric electrolyte

Below, a diagram of the circuit for measuring the capacitor properties of polymer composites is presented. Figure 3 presents a typical electronic circuit diagram of such a system.

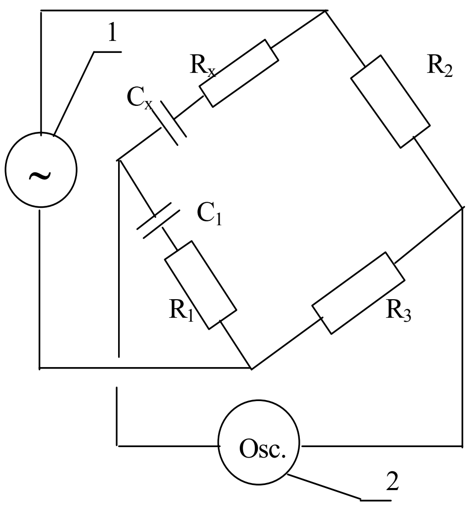

Fig. 3. Electronic AC circuit diagram for examining the capacity of polymer systems 1 = 1.5 Vpp voltage for frequency of 1 kHz produced by Hewlett Packard 33120A functional generator, 2 = Hung Chang-Oscilloscope 3502C (20MHz) oscilloscope setting, R_{1-3} = resistances set on OD-1-D7a decade resistors, C_1 - capacitance set on CD-5d decade capacitor

RESULTS AND DISCUSSION

In the table below, capacitance values expressed in Faradays are presented according to the amount of active carbon added to rubber electrolyte.

TABLE-1
MEASUREMENT RESULTS DETERMINING THE CAPACITY OF COMPOSITE SYSTEM FOR 0.5-2.5 g OF ACTIVE CARBON WITH A CONSTANT VALUE OF $CdCl_2$ OR $MoCl_2$ BEING 5 g

Chemical compound	Quantity of active carbon (g)				
	0.5	1.0	1.5	2.0	2.5
	Capacitance of system (F/g)				
$CdCl_2$	0.9	2.3	4.7	6.2	8.0
$MoCl_2$	0.8	1.9	3.3	5.6	7.1

The capacitive characteristic of polymer composite is presented above. The range of polymer system modification with active carbon brings about variable values of capacitance. As the amount of added active carbon increases, the capacitive properties grow proportionally, almost in a linear way. It can be assumed that such polymer systems with capacitor properties have predictable capacitance values, depending on the amount of active carbon added.

Conclusion

The capacitive systems obtained from styrene-butadiene rubber with addition of $CdCl_2$ or $MoCl_2$ and active carbon can be used as materials in electronic and electrical industry.

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