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Receiving and The Capacitive Profile of The Capacitors Arrangements on The Base of Natural Rubber with The Addition of $MnCl_2$ or $SnCl_2$ and The Active Carbon

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A method to receive cheap capacitor materials with variable demand-dependent capacitance values is presented in an easy way. Examination of capacitive properties was done at 20 °C. Mean capacitance range was between 4.7 and 28.8 F/g. The capacitive systems were examined on circuits with decade resistors and capacitors.

Key Words: Organic capacitors, Natural rubber, Conductive polymers, $MnCl_2$, $SnCl_2$.

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 are presented[1-24].

In the present paper, a method is presented for obtaining polymer electrolytes from natural rubber. As a factor inducing electrical conductivity of polymer systems, $MnCl_2$ and $SnCl_2$ (manufactured by Chempur®, Poland) were used as well as active carbon (also manufactured by Chempur®, Poland) with a 900 m^2 active surface per one gram of active carbon.

Natural rubber (*Hevea brasiliensis*), which was used for obtaining polymer electrolytes, originated from a Para rubber tree plantation in Ranni, Kerala State, south-western India. Natural rubber was collected and taken down from a Para rubber tree and imported to Poland in June 2006.

EXPERIMENTAL

Preparation of capacitor electrolytes

Synthesis of the natural rubber + $MnCl_2$ or $SnCl_2$ + active carbon system

Stage-1: Dissolution of rubber latex with active carbon addition: Natural rubber is found in the form of rubber latex and oxidises quickly in the air, producing an elastic and stretchy caoutchouc (India-rubber). In order to avoid this process

(since India-rubber dissolves more easily in the form of rubber latex), it was immediately added to toluene (99 % pure). Toluene (manufactured by Spectrum Chemicals, Edayar, Cochin-683 502, India, Code: T 0105) was bought straight before collection of natural rubber in India. Natural rubber latex, preserved this way, was imported to Poland.

To develop a method of natural conductive rubber synthesis, it required in the first stage to precipitate rubber latex from toluene and to dissolve it again in toluene in order to make strictly specific mass recalculations. For precipitating the rubber latex, methanol (98 %, manufactured by Chempur®, Poland) was used. Rubber latex can be dissolved in petrol or benzene, but it best dissolves in toluene. For this purpose, toluene (99.5 %, manufactured by Chempur®, Poland) was used. Proportions of rubber latex dissolution are as follows: 3 g of natural rubber were added to 40 cm^3 of toluene.

Such a rubber solution was left for 12 h, shaking it from time to time. After 12 h, natural rubber was again dissolved in toluene of a known concentration and of white oily consistency. Such a natural rubber solution was supplemented with active carbon (powdery form) in the 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 $MnCl_2$ or $SnCl_2$ possible for adding was determined. This amount was assayed and it equalled to 5 g of $MnCl_2$ or $SnCl_2$. After adding a larger amount than 5 g of $MnCl_2$ or $SnCl_2$, 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.

$MnCl_2$ or $SnCl_2$ in the amount of 5 g were dissolved in 40 cm^3 methanol and added to the natural 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 1 d after removal from the solution. After 1 d, the rubber system is subjected to electrical conductivity testing (Fig. 1).

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: • A.C. 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, 1 Gsa/s.

The systems of conductive polymers were examined on copper plates. These copper plates were earlier cleaned with carbon tetrachloriode and rinsed with hot water. Subsequently, they were subject to 4 h long chemical polishing in a solution composed of: (a) H_3PO_4 (80 %): 500 cm^3; (b) CH_3COOH (icy): 300 cm^3; (c) HNO_3 (60 %): 200 cm^3.

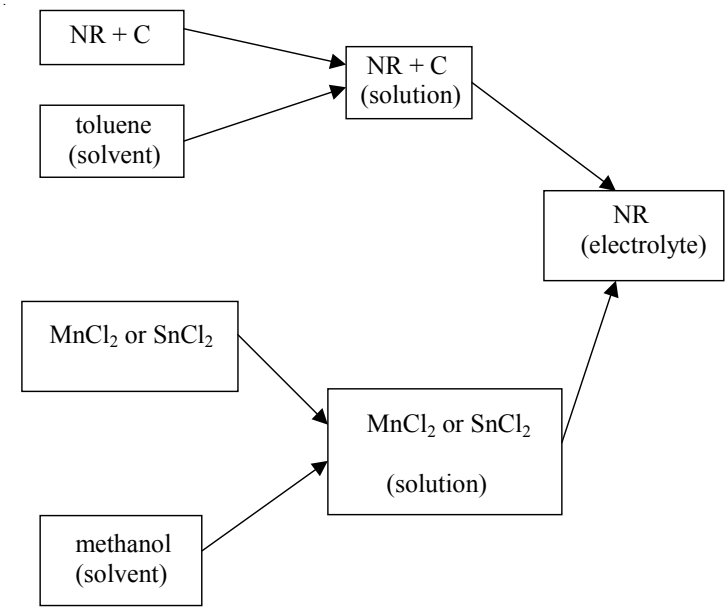

Fig. 1. Preparation of conductive natural rubber (NR)

To two copper plates with an area of 0.88 cm^2 (square centimetres) each prepared this way, the following system was introduced: polymer + $MnCl_2$ (or $SnCl_2$) [MOZE: $CuCl_3$] + active carbon with a thickness of 0.1 cm. Fig. 2 presents a diagram of such a measuring circuit.

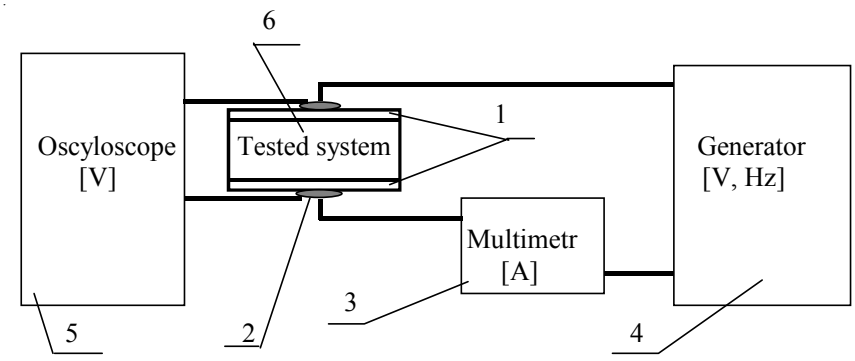

Fig. 2. Measuring diagram for the conductivity of tested polymer system:
1 = copper plates, 2 = conductor and copper plate junction, 3 = multimeter,
4 = alternator, 5 = oscilloscope, 6 = polymeric electrolyte

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

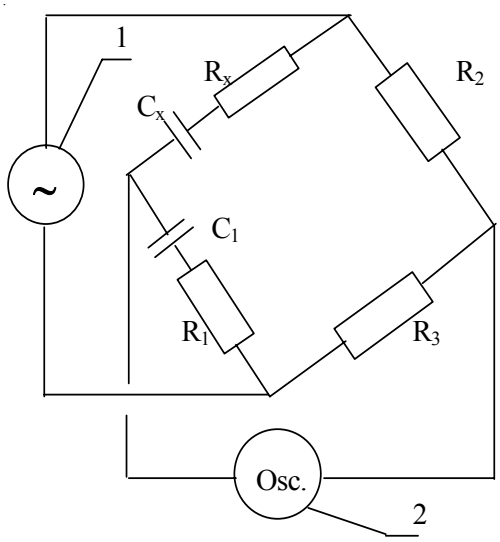

Fig. 3. Electronic A.C. circuit diagram for examining the capacity of polymer systems: 1 = 1.5 Vpp voltage for frequency of 1 kHz produced by Hewlett Packard 33120A functional generator, 2 = Hung Chang-Oscilloscope 3502C (20MHz) oscilloscope setting, $R_{1\text{-}3}$ = resistances set on OD-1-D7a decade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

RESULTS AND DISCUSSION

In the Table-1 shows, 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 TO 2.5 g OF ACTIVE CARBON WITH A CONSTANT VALUE OF $MnCl_2$ OR $SnCl_2$ 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)				
$MnCl_2$	9.0	13.5	16.2	20.6	28.8
$SnCl_2$	4.7	8.1	12.4	15.0	19.4

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 natural rubber with addition of $MnCl_2$ or $SnCl_2$ and active carbon can be used as materials in electronic and electrical industry.

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