

# Receiving and the capacitive profile of the capacitors arrangements on the base of butadiene-styrene rubber with the addition of $\text{CuCl}_2$ or $\text{ZnCl}_2$ and the active carbon

**Tomasz Borowski**

22 m. 12 Mickiewicza Street, woj. zachodniopomorskie  
78-520 Zlocieniec, Poland

e-mail: tomasz.elvis.borowski@wp.pl

## ABSTRACT

In an easy way presented, how to receive cheap capacitive materials with changeable capacitance depending on demand. The examination of capacitive properties has been determined in temperature of 20 °C. Average range of the capacitance oscillated between 1 and 9 F/g. The capacitive arrangements were marked on the arrangements with resistors and the decades capacitors.

## Keywords:

organic capacitors; conductive polymers; SBR;  $\text{CuCl}_2$ ;  $\text{ZnCl}_2$

## 1. INTRODUCTION

Super-capacitors are known from many years. They are mainly used as the materials – “accelerators” in car engines, giving more power. Also, the super-capacitors are widely used in electrical and electronic engineering.

Receiving and the capacitive profile of the organic capacitors for one gram of composite as a capacitor filler have been presented in this article.

Because of good quality and low price, for examination has been used the butadiene-styrene rubber (SBR) as a mixture of 1,4 yew and trance with the composition of : 77% of butadiene for 23% of styrene (the values have been given in percentage of gram-molecule weight), which has been produced by Chemical Plant Dwory S.A. (Joint-stock company) near Oświęcim, Poland.

That caoutchouc has been received in the low-temperature emulsive copolymerization process, no. KER 1507, [1-19].

## 2. EXPERIMENTAL PROCEDURE

### 2.1. Synthesis of the system: SBR + CuCl<sub>2</sub> or ZnCl<sub>2</sub> + active carbon

#### 2.1.1. Stage 1 – dissolution of styrene-butadiene rubber with active carbon addition.

Styrene-butadiene rubber is well-soluble in toluene. Toluene, in the amount of 40 cm<sup>3</sup>, is added to 3 grams of fine-cut SBR. After three days of leaving it at room temperature, the polymer becomes an oily substance. Such a dissolved rubber was supplemented with active carbon (powdery form) in the amount of 0.5g, 1g, 1.5g, 2g, and 2.5g.

#### 2.1.2. Stage 2 – synthesis of polymer electrolyte.

Before obtaining a rubber electrolyte with active carbon addition, a maximum amount of CuCl<sub>2</sub> or ZnCl<sub>2</sub> possible for adding was determined. This amount was assayed and it equaled to 5 grams of CuCl<sub>2</sub> or ZnCl<sub>2</sub>. The tests executed to increase the conductivity by adding bigger quantities CuCl<sub>2</sub> or ZnCl<sub>2</sub> to the caoutchouc demonstrated that the polymer dissolved in toluene is not precipitated as homogenous gel, but is broken into small, inhomogeneous forms of particles. CuCl<sub>2</sub> or ZnCl<sub>2</sub> in the amount of 5 grams dissolved in 40 cm<sup>3</sup> methanol and added to the SBR 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 one day after removal from the solution. After one day, the rubber system is subjected to electrical conductivity testing (Fig. 1).

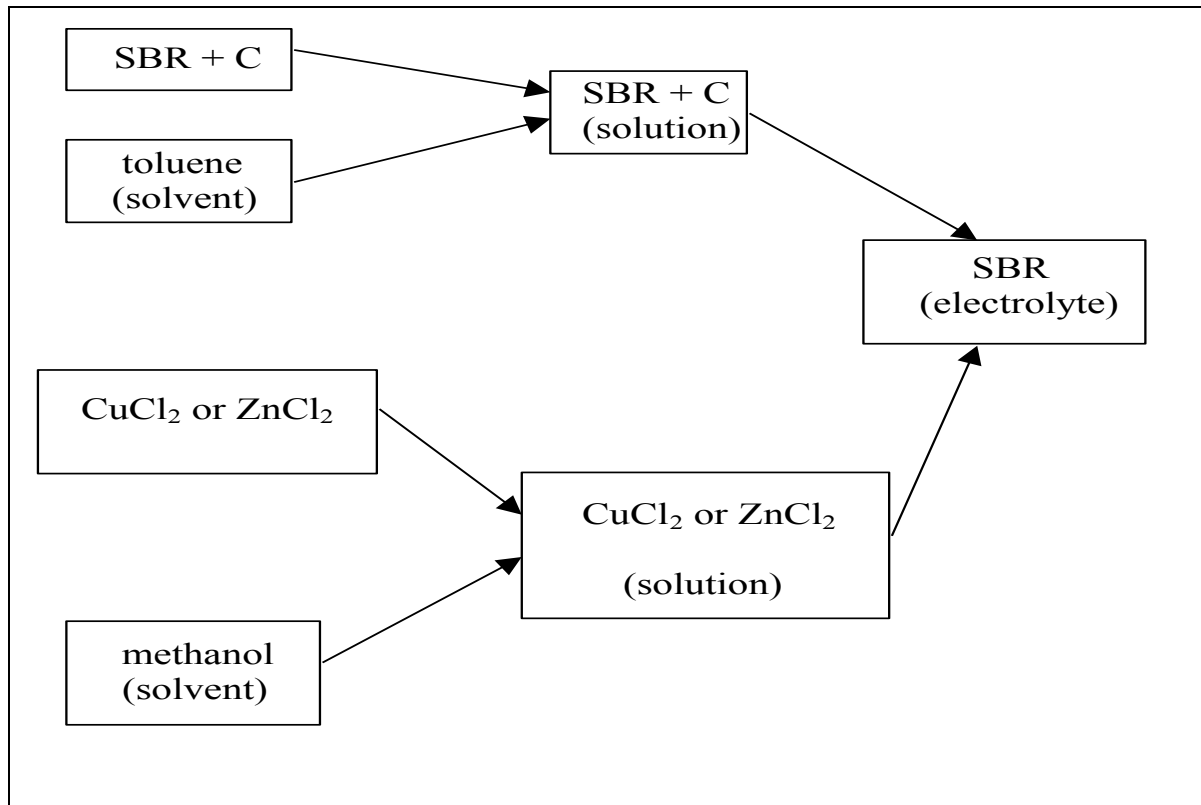


Fig. 1. Preparation of conductive styrene-butadiene rubber (SBR)

### 3. RECEIVING THE CAPACITIVE ELECTROLYTES

#### 3.1. The method of examination of conductivity and the capacitive properties of composite arrangements

In order to mark out the specific conductivity of received arrangements, they have been subjected to examinations with the use of alternating current.

For that, the following apparatus have been used:

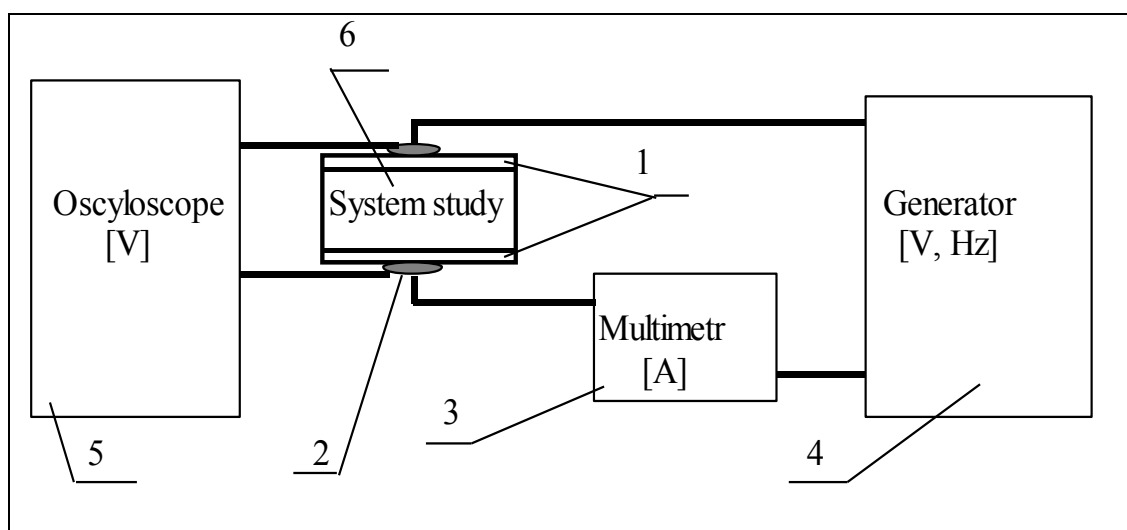
- the generator of alternating current of type: HEWLETT PACKARD 33120A 15MHz FUNCTION/ARBITRARY WAVEFORM Generator
- Multimeter of type AGILENT 3458a 8 1/2 DIGIT MULTIMETER
- Oscilloscope of type HEWLETT PACKARD infinium oscilloscope 500 MHz, 1Gsa/s

Settings of the conductive polymers were examined on copper plates. These copper plates have been earlier cleaned with four-chloride-carbon ( $\text{CCl}_4$ ) and rinsed with hot water.

Next, they have been subjected to four hour long chemical polishing within the solution with the following composition:

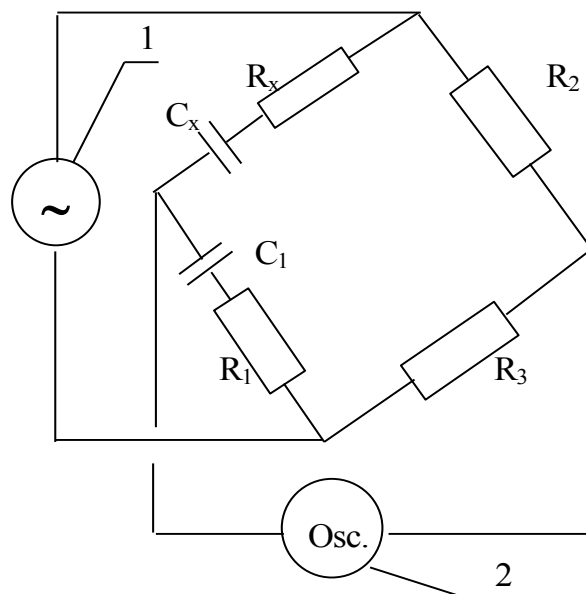
- $\text{H}_3\text{PO}_4$  (80%) 500  $\text{cm}^3$  (cubic centimetres)
- $\text{CH}_3\text{COOH}$  (icy) 300  $\text{cm}^3$
- $\text{HNO}_3$  (60%) 200  $\text{cm}^3$

To such prepared two copper plates with the area of 0.88  $\text{cm}^2$  (square centimetres) each, the following arrangement (setting) has been introduced: polymer +  $\text{CuCl}_2$  ( $\text{ZnCl}_2$ ) + active carbon with the thickness of 0.1 cm. Figure 2 presents the scheme of such measuring arrangement.



**Fig. 2.** Measuring diagram of the conductivity of the polymer system being tested:  
 1 – copper plates, 2 – junction of a conductor with a copper plate, 3 – multimeter,  
 4 – alternator, 5 – oscilloscope, 6 – polymeric electrolyte

Below, has been presented the arrangement scheme for the measurement of capacitors properties of polymers composites. Figure 3, presents typical electronic diagram of such setting.



**Fig 3.** Electronic diagram arrangement of alternating current for examining capacity of polymers arrangements: 1-voltage 1.5 V<sub>pp</sub> for frequency of 1 kHz, produced by functional generator made by Hewlett Packard 33120 A, 2- setting on the oscillograph Hung Chang-Oscilloscope 3502 C (20 MHz), R<sub>1-3</sub> – resistances set-up on decades resistances of type OD-1-D7a, C<sub>1</sub> – set capacitance on the decade capacitor of type CD-5d

#### 4. RESULT AND DISCUSSION

In the following table the capacitive values expressed in Farads have been presented, depending on the amount of active carbon added to the rubber electrolyte.

**Table 1.** The results of the measurement, which are determining the capacity of the composite arrangement for the values from 0.5 to 2.5 grams of the active carbon, with the constant value of CuCl<sub>2</sub> (ZnCl<sub>2</sub>) in the amount of 5 grams.

The chemical relationship	The quantity of the active carbon [g]				
	0.5	1.0	1.5	2.0	2.5
	The capacity of the arrangement [F/g]				
CuCl <sub>2</sub>	0.4	0.8	1.4	2.7	4.1
ZnCl <sub>2</sub>	0.9	2.9	4.7	6.2	9.1

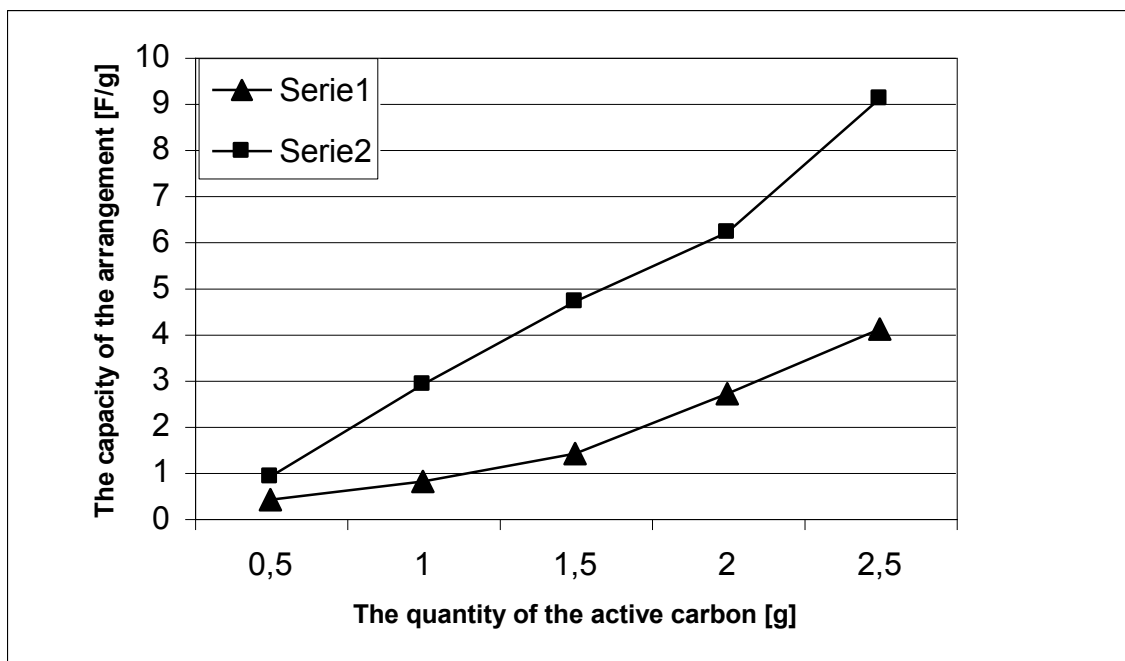


Fig. 3. The chart presents the capacitive dependence as a function of the active carbon amount. Serie 1 – CuCl<sub>2</sub>, Serie 2 – ZnCl<sub>2</sub>

Above, the capacitive profile of the polymer composite has been presented. The active carbon admixture range in regard to polymer arrangement, causes changeable capacitive values. If the added active carbon increases, the capacitive properties increase proportionally, almost in linear way. It can be assumed, that such polymers arrangements with the capacitors properties, are having the predictable capacities, depending on the amount of the active carbon added.

## 5. CONCLUSION

Received, from the butadiene-styrene caoutchouc the capacitive arrangements with the addition of CuCl<sub>2</sub> (ZnCl<sub>2</sub>) and active carbon can be used as materials in electronic and electrotechnical industry.

## REFERENCES

- [1] A. Khorassani, A. R. West, *Solid State Ionics* 7 (1982) 1-8.
- [2] Tomasz Borowski, *Journal of Power Sources* 172 (2007) 988-990.
- [3] Tomasz Borowski, *Materials Letters* 62 (2008) 1382-1384.
- [4] Finn W. Poulsen, *Solid State Ionics* 2 (1981) 53-57.
- [5] J. G. Kamphorst, E. E. Hellstrom, *Solid State Ionics* 1 (1980) 187-1979.

- 
- [6] D. Ostrovskii, L.M. Torell, G.B. Appetecchi and B. Scrosati, *Solid State Ionics* 106 (1998) 19-24.
- [7] M. Deepa, N. Sharma, S.A. Agnihotry, *Solid State Ionics* 152-153 (2002) 253-258.
- [8] M.D. Glasse, R. Idris, R.J. Latham, R.G. Linford, W.S. Schlindwein, *Solid State Ionics* 147 (2002) 289-294.
- [9] R. Idris, M.D. Glasse, R.J. Latham, R.G. Linford, W.S. Schlindwein, *Journal of Power Sources* 94 (2001) 206-211.
- [10] M. Nashiura, M. Kono, N. Namegaya, Y. Matsuda, *Electrochem. Solid State Lett.* 1 (1998) 246-248.
- [11] D. Kim, *Journal of Power Sources* 87 (2000) 78-83.
- [12] Vito de Noto, M. Vittadello, *Solid State Ionics* 147 (2002) 309-316.
- [13] T. Himba, *Solid State Ionics* 9-10 (1983) 1101-1105.
- [14] S.M. Gomes Correia, V. de Zea Bermudez, M.M. Silva, *Solid State Ionics* 156 (2003) 85-93.
- [15] Tomasz Borowski, *Elastomery* 4 (2008) 27-30.
- [16] Tomasz Borowski, *IX International Conference on Frontiers of Polymers and Advanced Materials*, Cracow, (Poland), 8-12 July 2007, p. 328.
- [17] Tomasz Borowski, Tadeusz Hryniewicz, Patent No. PL 202140 B1.
- [18] Tomasz Borowski, Tadeusz Hryniewicz, Patent No. PL 203254 B1.
- [19] Tomasz Borowski, Patent No. PL 209222 B1.