EFFECT OF THE TECHNOLOGICAL FACTORS ON ELECTRIC CONDUCTIVITY OF FILLED SILICONE RUBBERS

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Introduction

The creation of composites with specific physical-mechanical properties, for example, conductive polymer composites, is one of the basic trends in modern polymeric materials technology [1]. Such materials are effectively used in resist heaters, as foreign and domestic experience has shown.

In creating conductive polymer composites, special attention is focused on the study of the electrical characteristics and their alteration by different factors, while the mechanical characteristics are usually not examined. The correlation of the electrical and mechanical characteristics of composites with the type of distribution of the fillers in the matrix has been totally inadequately studied, and this is a significant gap in the methodology of investtigation and creation of composite materials with specific properties.

It is known that vulcanization conditions affects on electroconducting properties of composites [2,3]. It was found that rubbers obtained by high-temperature peroxide vulcanization possess higher ρ values, than similar materials, obtained by additive vulcanization. There is an opinion that the difference in ρ values can be explained by carbon black oxidation by peroxide. However, explanation of this phenolmenon not taking into account the differences in morphology of these two vulcanizates, obtainned by different techniques, apparently, should appear incomplete.

Experimental

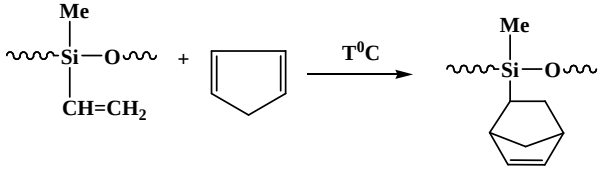
Rubbers were essentially obtained on the basis of 1) polydimethyl(methylvinyl)siloxane – industrial product (with molecular masses: from 4×10^5 up to 7×10^5), possessing 1 : 500 - 1000 ratio of vinyl and methyl groups in the macromolecule and 2) polydimethyl(methylnorbornene)siloxane. The fillers carbon black of types: P803, P357 were used. Thermal splintered graphite has been used in the separate experiments. The amounts of fillers in composites varied in a range 20-60 mas.parts.

The composite materials were obtained by using of three methods of vulcanization: additive, peroxide and radiation polymerization, which are in detail considered below. The tensile test was carried out at room temperature with an Instron–type tensile testing machine. The stretching speed was 10 mm/min and the initial gauge length was 50 mm. The conductance of the samples was carried out by using of 4-contact method.

Results and discussion

For obtaining of electroconductive filled siliconorganic rubbers as a polymer matrix was used industrial product polydimethyl(methylvinyl)siloxane (containing about 0.1% methylvinylsiloxy units) [4] and polydimethyl(methylnorbornene)siloxane (containing about 0.1 % methylnorbornenesiloxy units) [5].

Polydimethyl(methylnorbornene)siloxane was obtained by Diels-Alder reaction of polydimethyl(methylvinyl)siloxane with new distilled conjugated cyclopentadiene, according to the following scheme:



The structure and composition of oligomers, proved by elementary analysis, determination of molecular masses, FTIR, ^{13}C and ^{1}H NMR spectra data. For obtaining of cross-linking sys-

tems we have used different type of vulcanization.

Additive vulcanization. Additive vulcanization in polydimethyl(methylvinyl)siloxane proceeds with the polycondensation mechanism, in which elastomer macromolecules and vulcanizing agent (hardener) participate [3]. Vulcanization of polydimethyl(methylvinyl)siloxane with diethylaminomethyl triethoxysilane hardener (type ADE-3) proceeds with terminal hydroxyl group with elimination of ethanol.

Peroxide vulcanization. Peroxide vulcanization was conducted using dicumyl peroxide which initiated cross-linking processes with participation of vinyl or norbornene groups.

Radiation vulcanization. Radiation vulcanization of polydimethyl(methylvinyl)siloxane proceeds through double bond activation in vinyl group with further π-bond break and formation of free radicals, which may recombine interacting with each other and form cross-links between macromolecules [6].

Technical characteristics of electrically conducting rubbers, obtained by different vulcanization techniques, are shown in Table 1.

Table 1. Technical characteristics of conductive rubbers obtained with use of different vulcanization methods

Vulcanization method	Initiator	Filler type	Filler content, mass parts	ρ, Ohm·m	Homogeneity, %	Strength at break, MPa	Relative elongation, %	Residual elongation,%
Addtive vulcanization	ADE-3	P803	20	12000	108	0.8	101	4.0
		P803	30	2600	98	1.7	246	5.5
		P803	40	11	75	2.1	292	5.7
		P357	40	0.42	76	2.7	240	8.6
		P357	50	0.05	45	3.2	360	7.9
		P357	60	0.02	32	2.8	250	4.3
Peroxide vulcanization	Dicumyl peroxide	P357	40	45	360	3.3	386	16.0
		P357	50	6.4	216	4.4	272	11.5
		P357	60	1.2	92	4.2	266	8.8
Radiation vulcanization	-	P357	40	0.3	2	3.3	292	11
		P357	50	0.08	3	5.1	360	9
		P357	60	0.01	1	4.3	250	10

Conclusions

Vulcanization method and reception factor are the main approach to effective change of material properties (particularly conductivity and strengthening), which allow to creation the conductive composites with desirable properties.

References

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