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ABSTRACTS

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Piezocapacitance Effect of Polyisoprene/High Structure Carbon Black Composites

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INTRODUCTION

Piezoresistance effect of elastomer nanocomposites containing conductive nanoparticles is well known [1,2]. Capacitance (permittivity) changes in polymer nanocomposites, depending on filler concentration, frequency and temperature have also been studied [3,4]. We have not found papers about the piezocapacitive effect of elastomer/conductive nanoparticle structures.

In this study we have attempted to examine the piezocapacitive effect of polyisoprene/high structure carbon (PHCB) composites, and a pronounced effect has been found.

SAMPLES AND EXPERIMENT

In our experiments, samples with different amounts of CB filler were used from previously carried out experiments on direct current [2]. These PHCB samples were manufactured from SWR-3L natural rubber (NR) with the addition of curing ingredients and high structure Degussa™ Printex™ EX-2 carbon black (CB) with an average particle size of 30 nm, surface area of 950 m^2/g. During the process of curing that was carried out on Rondol™ hot press (curing temperature of 150 °C, duration of 15 minutes, pressure of 3 MPa), brass electrodes were tightly attached to composites. The diameter of the obtained samples was 18 mm, and thickness was 1 mm.

Alternating current (AC) measurements were conducted using Agilent E4980A LCR meter and applying mechanical pressure on samples.

RESULTS AND DISCUSSION

The changes in capacitance depending on frequency and applied different values of mechanical pressure for the composite sample containing 4 mass parts of CB (NR-CB04) are shown in Figure 1. It can be seen that pressure reduces capacitance. The effect can be explained in the following way; although electrodes of the sample under pressure get closer and this factor tends to increase capacitance, mechanical interruptions caused by pressure in conductive-capacitive 3D percolation grid cause inverse and much larger capacitance changes, thus, decreasing capacitance.

For NR-CB04, the maximum absolute $\Delta C/C_0$ value (20%) was found at lowest measured frequencies (20–50 Hz). The maximum absolute AC conductivity change for the same sample at lowest frequencies was only slightly larger (24%).

PHCB samples with larger CB filler content under mechanical pressure exhibited smaller $\Delta C/C_0$ values, but the maximum values of $\Delta C/C_0$ were found at higher frequencies.

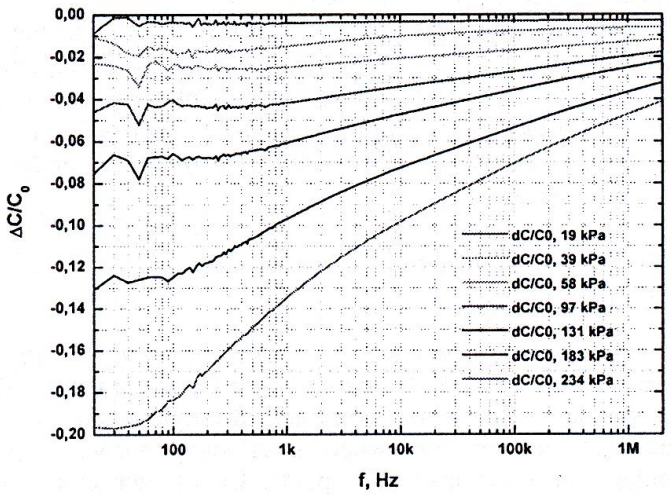

Figure 1. Relative change in capacitance of NR-CB04 composite depending on pressure and frequency

CONCLUSIONS

PHCB composites show a noticeably large piezocapacitive effect. The exact capacitance change mechanism is still to be understood. We believe that the proposed equivalent circuit model in [5] could help to explain the observed effects.

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