CHANGES ELECTRIC PROPERTY COMPOSITE IN DEPENDENCIES ON SIZE ELEMENTS

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Abstract: The object of is to measure and analyze the pemittivity, loss factor, loss index and inner resistivity of composite: elastomer Levapren – Ni powder. The influence of filling factor of Ni powder in the Levapren matrix and the influence of size of Ni particles analyzed.

Keywords: EEICT, template, guide

1. INTRODUCTION

Composite materials with metal fillers in the polymer matrix represent two or multicomponent system whose properties are affected by both the characteristics of the polymer matrix and the properties of the metal filler and the interaction at the interface on the filler – polymer. Type of polymer matrix mainly affects mechanical properties such as strength, ductility, etc., the concentration of the metal filler represented mainly affects the electrical properties of the composite. As the matrix is generally used elastomers, thermoplastics and thermosets, and fillers are carbon black, graphite, ferrite and metals in powder form.

The aim of this work is to determine the properties of the selected dielectric elastomer composite system - nickel powder. Investigated the dielectric properties - dielectric constant and loss factor in the frequency range 101-106 Hz, inner resistivity, and the effect of the nickel content of the conductive filler in the composite on said dielectric properties. Part of the experiment was to determine the possible impact and particle size of the filler metal on the dielectric properties.

2. DEVICE FOR MEASURING DIELECTRIC MATERIALS

2.1. THE BASIC DIVISION OF THE MEASURING DEVICE

The main criterion for measuring in dielectric relaxation spectroscopy is frequency. Therefore, the basic distribution of measuring instruments just based on the frequency range of the meter. Distribution by frequency devices:

- low frequency < 10 MHz,
- high frequency 1 MHz – 40 GHz,
- microwaves 35 GHz – 1100 GHz.

Distribution of devices in terms of the measurement system:

- time domain,
- frequency response,
- automatic bridge
- reflection,
- resonance,
- FTS (Fourier transform spectroscopy).

2.2. MEASURING SYSTEM FOR LOW FREQUENCY

In this typical frequency domain dielectric spectroscopy, the samples are prepared as parallel or plate capacitors. To determine the dielectric constants, such as relative permittivity, loss number and the loss factor, is most commonly used calculation of the geometrical dimensions of the sample.

To measure in the temperature dependency can be used any commercially produced computer-controllable furnace or cryostat device.

2.3. MEASURING SYSTEM FOR HIGH FREQUENCY

In this radio - microwave field are standard dielectric techniques that use BNC - cables. Connection of the measured sample with a measuring device may no longer be at a greater distance is necessary to operate with specially designed coaxial line. Especially in GHz is some "know - how" necessary to obtain reliable results.

2.4. MICROWAVE RESONATORS

- cavity technique

Copper cylindrical cavity which can be used in the range of 9.1 GHz and 9.3 GHz are used in combination with continuous flow on a cryostat; resonance curve is then investigated using a network model. Of changes in the width and the shift in frequency for these samples at the maximum electric field can be calculated conductivity and permittivity. This contactless method is also useful for measuring small sample of particles that are not measurable by standard methods of measurement.

- Fabry - Perot resonator

This open resonator by Damascos Inc., USA, consists of two concave mirrors, the measured samples are inserted midway between the mirrors. The resonance curves in the 10-40 GHz are dielectric constants calculated. The resonator is particularly suitable for low loss dielectric.

2.5. FOURIER DIELECTRIC SPECTROSCOPY

In the area of Fourier transform spectroscopy experiments moving in infrared (FIR), medium - infrared (MIR), near - infrared (NIR), visible, and ultraviolet (UV) region (150 GHz - 1.65 PHZ). This method is used for the measurement of small samples (eg monocrystals) or small sample size of 50μm x 50μm. This area of measurement is in terms of sample preparation, expensive and experience very complex and therefore in this area, very few specialized centers.

3. EXPERIMENTAL PART

For measurement were prepared sets of samples containing a matrix of ethylene-vinylacetate copolymer with 45% by weight proportion of vinylacetate with the trade name Levapren 450, manufactured by Bayer AG. Filler were nickel powders firm Högenäs in three fractions with the following inscription:

- 1320 – with particle size of 45-125 μm,
- 1020 – with particle size of 20-106 μm,
- 1120 – with particle size of 20-71 μm.

All fractions contained by catalog - 95.77% Ni, 2.4% Si, 1.4% B, 0.4% Fe and 0.03% C.

The matrix Lavapren 450 was delivered by the Department of Plastic and rubber CHTF STU Bratislava and nickel powders by the company Wempe s.r.o.

4. PREPARATION OF TEST SAMPLES

Samples of filled elastomers were prepared at the Department of Plastic and rubber CHTF STU Bratislava, which is suitable processing equipment. Volume fraction of nickel in the matrix were chosen on the basis of the consultations mentioned work [1] , taking into account the expected conductivity characteristics and quantity of the powder obtained.

Were prepared following the elastomer composites that include:

nickel powder labeled 1320 , 1120 and 1020:

- 15% by volume proportion of Ni in the matrix,
- 18% by volume proportion of Ni in the matrix,
- 20% by volume proportion of Ni in the matrix,
- 22% by volume proportion of Ni in the matrix,
- 25% by volume proportion of Ni in the matrix,
- 30% by volume proportion of Ni in the matrix,
- 34% by volume proportion of Ni in the matrix.

Nickel powder labeled 1120:

- 42% by volume proportion of Ni in the matrix,
- 50% by volume proportion of Ni in the matrix,
- 55% by volume proportion of Ni in the matrix,
- 60 % by volume proportion of Ni in the matrix,
- 75 % by volume proportion of Ni in the matrix.

Nickel powders were first dried in an electric furnace KCW-100 at 150°C for 30 min with occasional stirring in order to minimize defects in making samples.

Parts by weight of nickel were weighed full contents of the mixing chamber. For mixing of samples was used machine PLASTI-CORDER-BRABENDER used in the rubber industry for the preparation of test samples containing the mixing chamber of 70 cm^3. Prepared mass proportion of the matrix and fillers were gradually homogenized. Homogenization was carried out in two modes - the dosage and mode mixing. The dosing regimen was carried out homogenization at 50 rpm and a temperature of 150°C for mode stirring speed increased to 70 rpm for about 15 min. After homogenization, the mixture was transferred to a steel frame with dimensions 150x150x2 mm and inserted into a press GRT-20 for 10 min at 150°C and a pressure of 20 MPa. The frame is further moved to the press GTR-20 for 8 min at ambient temperature and pressure 20 MPa.

For measurement of the respective films were made by two samples from each of weight matrix and circular dimensions ϕ 55 mm and h = 2 mm, and two samples from each of weight matrix and circular dimensions ϕ 50 mm and h = 2 mm.

5. RESULTS OF MEASUREMENT

Results of measuring resistivity are shown in fig. 1, measuring the relative permittivity and dissipation factor are given in figures 2-4.

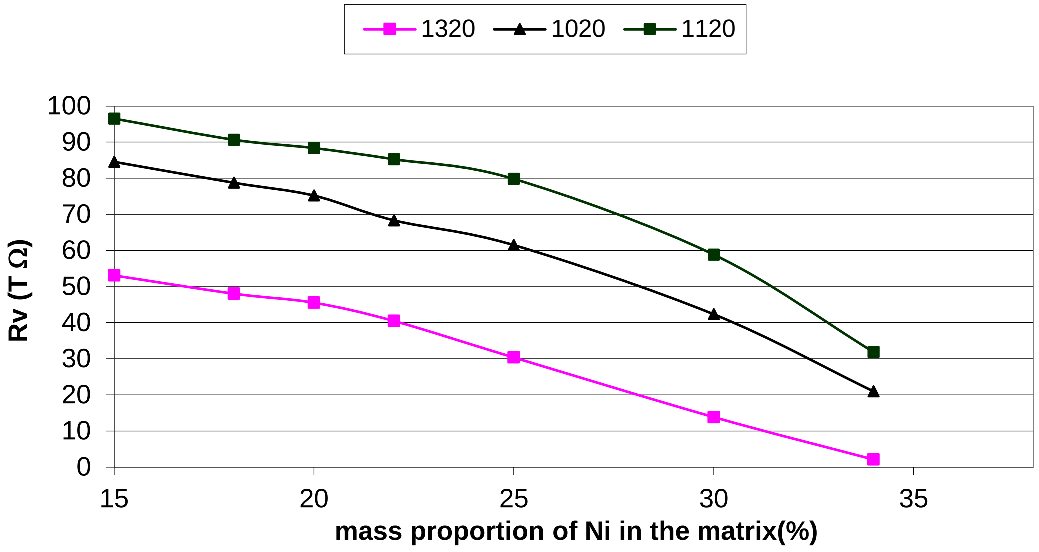

Figure 1: Dependency of resistivity on the weight of Ni in the matrix representation of a filler metal of type 1320, 1020 and 1120

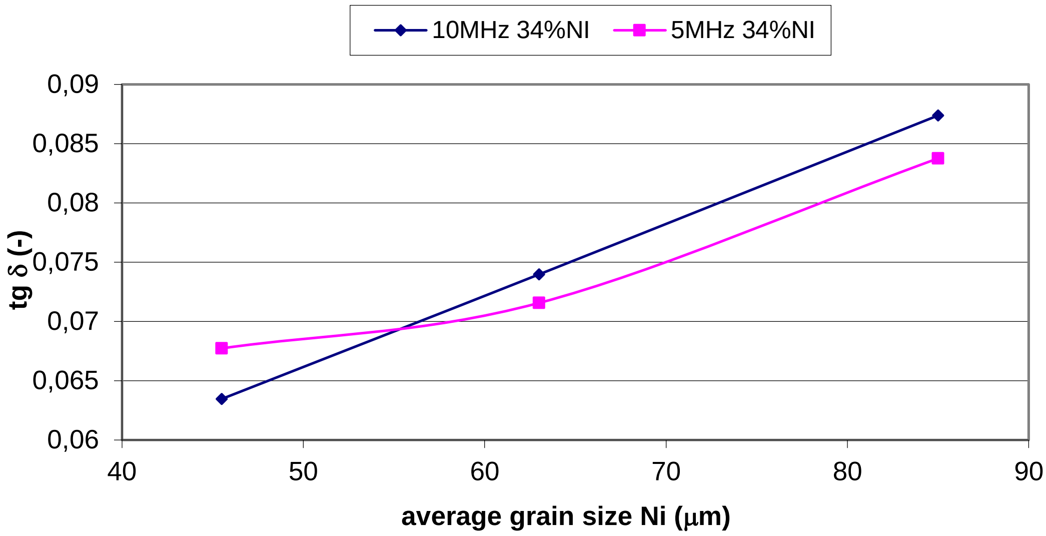

Figure 2: Dependency of dissipation factor on the size of Ni grains in the matrix at frequencies of 5 and 10 MHz

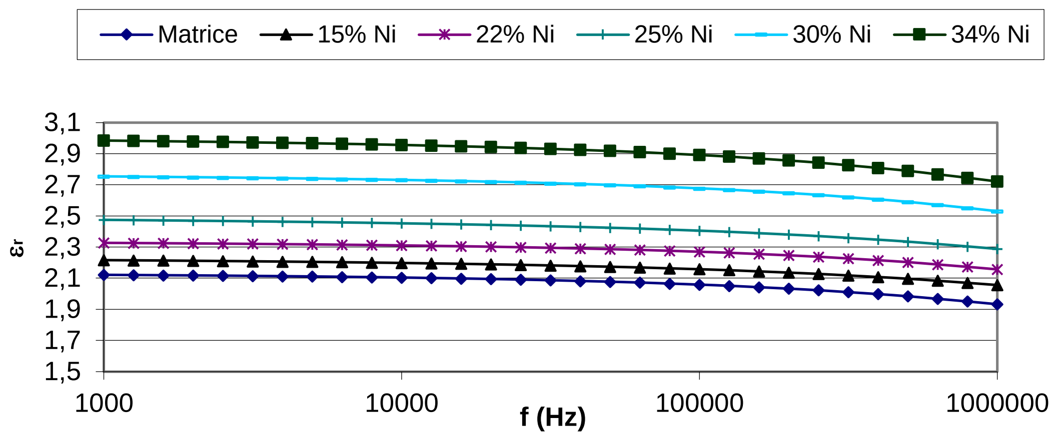

Figure 3: Dependency of the relative permittivity on the frequency of the filler metal type 1320

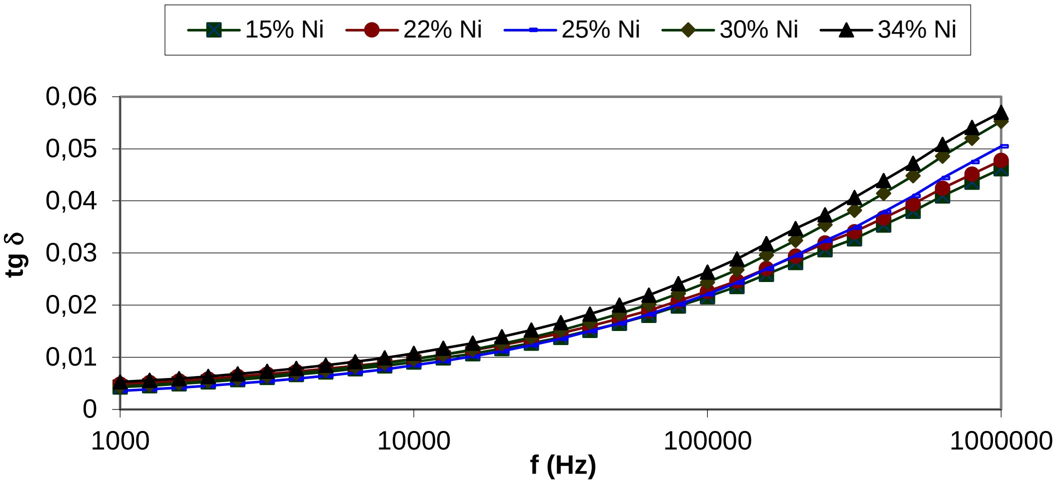

Figure 4: Dependency of dissipation factor at a frequency of filler metal type 1320

6. RESULT

Levapren 450 and conductive composites derived therefrom may be considered as a polar substance. From the measured results, the following facts:

- With the increase of weight of nickel in the matrix increases as expected as the relative permittivity and dissipation factor.
- Increasing of weight nickel reduces the inner resistivity.
- Size of the nickel grains in the matrix has an effect on dielectric properties, the examination of the influence of grain size is continued.

7. REFERENCE

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