Synthesis and characterization of PANI/ABS polymeric varistors

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Abstract – Organic Polymeric Varistors (OPV) have been prepared dispersing PANI powder in ABS solution. The varistor film has been dried and gold electrodes have been deposited in both sides for DC characterization. The breakdown voltage obtained has been around 10,0 V/mm and its non-linear coefficient about 9,0.

Varistors are non-ohmic devices used for protection from over-voltage. Until now, they were prepared only from ceramic compounds. In ceramic varistors, a n-type semiconductor is used, where the semiconductor grain is highly conductive and its grain boundary is insulating. In this work, we present for the first time the usage of polymeric materials to prepare varistors devices. OPV can be used as low breakdown voltage varistors, which increasing interest is caused by its application in electronic devices, as chips and computer processors. The vantage in polymeric varistors instead of ceramic ones is its flexibility and its lower breakdown voltage. Thus in this study it was prepared varistors of PANI and acrylonitrile-butadiene-styrene (ABS) with a high coefficient of non-linearity and low-breakdown voltage.

The PANI synthesis has been made as proposed by MacDiarmid et al [1], and the ABS utilized had 23,62% of acrilonitrile. The varistor's synthesis has been made dispersing the polyaniline (emeraldine salt), in chloroform and adding the solubilized ABS to this solution. The varistor films were dried under infrared light. To characterize them, gold contacts were deposited on both sides of the film, forming a metal-varistor-metal structure. The DC characterization was made ranging the voltage bias from 0 V to 5,0 V, using a Keithley electric source, model 2400.

ABS has been chosen to this work because it's a thermoplastic extremely versatile, once its properties can be easily altered changing its composition. The ABS chosen influences in the varistor flexibility. ABS works as an insulating barrier for PANI particles. A possible explanation for the non-ohmic characteristic found in the synthesized material is the Schottky Barriers [2] formed between the ABS and the PANI. When a voltage is applied, the band gap configuration near the interface of the polymers changes allowing the current flow.

One of the factors that influence the final properties is the PANI dispersion in the ABS. As shown in Figure 1, the PANI is not dispersed homogeneously. As shown in Figure 2, the varistors obtained have a breakdown voltage around 10,0 V/mm for varistors with 20% of PANI and 13,0 V/mm for varistors with 30% PANI, with a coefficient of non-linearity around 3,0 and 9,0, respectively. Comparing the results with ceramic varistors in the literature, OPV devices prepared has a lower breakdown voltage. Doped ZrO varistors prepared by Zhang et al [3] have a breakdown voltage around 30,0 V/mm and our OPV has it around 10,0V/mm. However, the coefficient of non linearity of the ceramic varistor is higher than the OPV prepared, around 30,0 and 9,0, respectively.

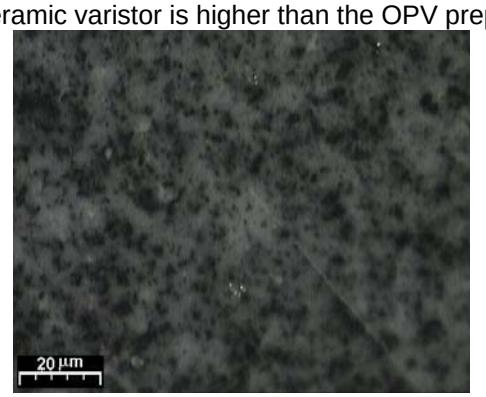

Figure 1: A varistor micrography.

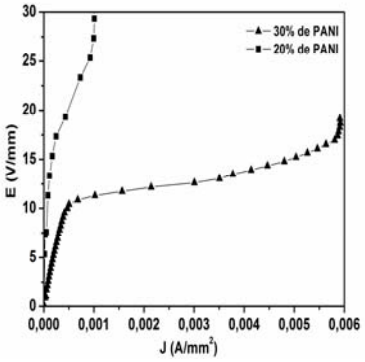

Figure 2: DC analysis of the varistor.

References

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