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Polymer-ceramic Nanocomposites for Embedded Capacitors

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Extended Abstract

Scientific community is doing a great effort on the development of new materials to match the ever increasing demands of miniaturization, cost reduction and high performance of electronic components. Among electronic circuits, passive components occupy a significant volume. And among these ones capacitive components have a major contribution.

So, the finding of materials with large dielectric constant (ε') is one of the ways to achieve miniaturization. Besides, the lowering of dielectric loss is important to improve the performance of electronic components.

Recently, some perovskite type materials, nonferroelectric, like $CaCu_3Ti_4O_{12}$ (CCTO) (Subramanian et al., 2000; Amaral et al., 2008) , were studied and revealed colossal ε' ($>10^4$). Contrarily to the ferroelectric materials (like $BaTiO_3$), CCTO doesn't present any ferroelectric phase transition, so it holds a large ε', almost constant between 100 K and room temperature.

Another way to achieve miniaturization is enhancing the packaging techniques (Jillek, Yung, 2005). Conventionally, capacitors and other passive components are surface-mounted on top of the printed circuit boards (PCBs).

As an alternative option, these passive components are being integrated inside multilayer PCBs, which justifies why they are usually named as embedded passives.

Besides miniaturization, embedding passive components within the board also has the potential to increase performance by shortening conductive paths (reducing the electromagnetic interference, the electrical delay and suppressing electrical parasitic signals), improve reliability by decreasing the number of solder joints, and lower cost.

This work describes the development of new polymeric nanocomposites, using nanopowders based on CCTO as fillers and Kraton as polymeric matrix. The CCTO nanopowders were obtained by sol-gel technique and solid state reaction, followed by high energy ball milling, with a straight control of their morphology (shape, size, distribution). XRD and Raman measurements were used in the structural characterization of the ceramic nanoparticles. A uniform dispersion of the nanoparticles trough the polymeric matrix was guaranteed and the composite was melt blended in a microcompounder at 120 ºC. The dielectric properties of the composite Kraton-CCTO were studied in the frequency range 100 Hz to 10 MHz, for CCTO grains concentrations up to 60% by volume. SEM-EDS analysis of the composites allowed us to study the dispersion of the particles in the composite.

Dynamic mechanical analysis (DMA) was performed to measure mechanical properties as storage modulus, loss modulus, tan delta and glass transition temperature of the composites.

References

Amaral F., Rubinger C., Henry F., Costa L.C., Valente M.A. (2008). Dielectric properties of Polystyrene-CCTO composite, J. Non-Cryst. Sol. 35, 5321-5322.

Jillek W., Yung W.K.C. (2005). Embedded components in printed circuit boards: a processing technology review, Int. J. Adv. Manuf. Technol., 25, 350-360.

Subramanian M.A., Li D., Duan N., Reisner B.A., Sleight A.W. (2000). High Dielectric Constant in ACu3Ti4O12 and ACu3Ti3FeO12 Phases, J. Sol. State Chem. 151, 323-325.