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Electrical and dielectrical properties of $BaTiO_3$ and $Ba_{0.77}Ca_{0.23}TiO_3$ ceramics synthesized by the proteic sol-gel method

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Abstract: $BaTiO_3$ and $Ba_{0.77}Ca_{0.23}TiO_3$ powders were synthesized by the first time by the Proteic Sol-Gel method. In this method, coconut water is employed as polymeric agent instead of the conventional alcoxide precursors. The synthesized samples presented single crystalline phase and after sintering a relative density of 96% was achieved. The ceramics presented a similar dielectric constant behavior with the temperature and the Sol-gel samples presented lower activation energy than Pechini and Literature samples.

Barium titanate ($BaTiO_3$ – BTO) is a ferroelectric material widely applied in the electronics industry both in single crystal and ceramic forms. Because of its very high permissivity (ε =1500-4000) with suitable doping, it has been used extensively as the dielectric in ceramic capacitors with outstanding properties. When calcium doped $BaTiO_3$, the $Ba_{0.77}Ca_{0.23}TiO_3$ (BCT) composition is the only congruently melting compound(1). BCT ceramics have been reported as a promising multi-layer ceramic capacitor (MLCC), whose main advantages are the good dielectric performance on cheap electrode (such as nickel), and the increasing temperature range of the tetragonal phase when compared with pure $BaTiO_3$. The calcium addition also inhibits the formation of the unwanted hexagonal phase of $BaTiO_3$ [1].

In this work $BaTiO_3$ and $Ba_{0.77}Ca_{0.23}TiO_3$ powders were synthesized by the first time by the Proteic Sol-Gel method(2), using as precursor materials barium acetate ($C_4H_6BaO_4$), calcium carbonate ($CaCO_3$), titanium trichlorite ($TiCl_3$) and rare earth nitrates (P.A). In this method, the precursors are mixed with filtrate coconut water and homogenized by stirring until its complete dissolution (at room temperature). The ceramics were sinterized at 1300 °C/2h and a relative density of 96% was achieved.

Figure 1 shows the temperature dependence of dielectric constant of the sintered samples. Ceramics synthesized by the well knew Pechini' method are also used as reference. As can be seen, the curves are similar for both samples. Figure 2 presents the Arrhenius curve of the sintered ceramics. It was observed a reduction of the activation energy in the Sol-gel samples when compared with Pechini (table I) and Literature samples(3). This result can be associated with the impurity from the coconut water.

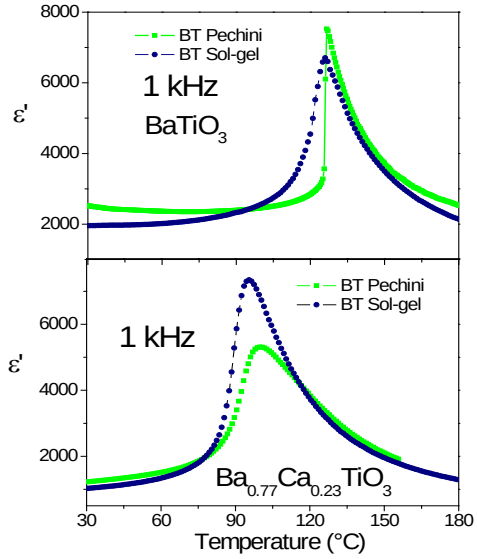

Figure 1 - DTA and TG curves (10°C/min) of the BCT resins

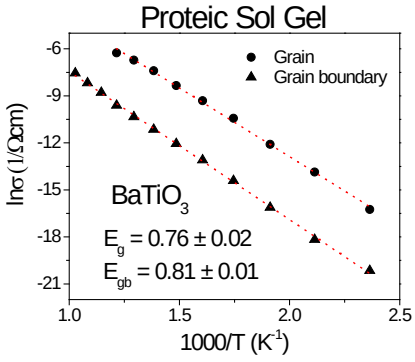

Figure 2 – XRD pattern of the BCT ceramics sintered at 1300 °C/2h

Table I – Activation energy of the studied samples

Method	Activation energy (eV)		
	Sample	**Grain**	**Grain Boundary**
Pechini	**BT**	1.17 ± 0.03	1.35 ± 0.05
	BCT	1.15 ±0.02	1.32 ± 0.02
Proteic sol gel	**BT**	0.76 ± 0.02	0.81 ± 0.01
	BCT	0.96 ± 0.01	0.91 ± 0.03

[1] Silva R. S., Bernardi M. I. B. and Hernandes A. C., J. Sol–Gel Sci. Technol., 42 (2007), 173–179.
[2] M. Macedo, J.M. Sasaki, "Processo de Fabricação de Pós Nanoparticulados", INPI 0203876-5.
[3] X. Guo, C. Pithan, C. Ohly, et al., Appl. Phys. Lett. 86, 082110, (2005).