PAPER REF: 3995

INFLUENCE OF SINTERING TEMPERATURE ON THE STRUCTURAL AND DIELECTRIC PROPERTIES OF BST OBTAINED BY COLLOIDAL PROCESSING

P.V. Antunes[1,2(*)], Susana Olhero[1,3], Ajay Kaushal[3], Jorge Lino[1], J.M.F. Ferreira[3]
[1]INEGI, FEUP, University of Porto, Portugal
[2]Department Mechanical Engineering, University of Coimbra, Portugal
[3]CICECO, University of Aveiro, Portugal
[(*)]*Email:* vale.antunes@ua.pt

ABSTRACT

This work presents the influence of sintering temperatures (1200-1450ºC) of $Ba_{0.6}Sr_{0.4}(TiO_2)$ (BST) ceramic samples on the mechanical and dielectric properties. BST was synthetized by solid state reaction and consolidated by a colloidal approach.

Keywords: BST, colloidal processing, mechanical properties, dielectric constant.

INTRODUCTION

In recent years, efforts have been made towards developing dielectric nonlinear ferroelectric materials due to their potential for substantial miniaturization of microwave components and integration with microelectronic circuits (Ioachim *et al*., 2003). BST finds applications in capacitors, tuneable filters, actuators and sensors for energy storage and conversion, automatic control, acoustic and pressure transducers, detectors and many other electronic devices (Berbecaru *et al*., 2008). Nowadays, dry pressing is the basic fabrication process that provides the BST materials that are the backbone of these kinds of applications in electronics industries (Alexandru *et al*., 2004). However, the inability of dry pressing to destroy particle agglomerates and remove flaws that might exist in the as-received raw material makes it less suitable to consolidate ceramic components with high reliability for advanced applications. The use of aqueous colloidal shaping techniques to consolidate micro BST ferroelectric components may lead to significant improvements in their final properties and expand the potential applications for this material.

In the present work, a colloidal approach was used to obtain BST ceramics and their final properties, including microstructure, density, hardness, flexural strength, and dielectrics were evaluated in function of sintering temperature (from 1200 to 1450ºC). The mechanical and electrical characteristics of these ceramics depend mainly on: powder granulometry, homogeneity of the suspensions, particles packing ability and sintering temperature.

RESULTS AND CONCLUSIONS

Table 1 shows the average bending tests results for BST samples sintered at different temperatures, namely: flexural resistance, static elastic modulus and work-of-fracture (the energy required to fracture the specimen, obtained from the area under the load-displacement curve divided by the specimens' cross-section area). Table 2 presents density, elastic modulus (dynamic) and micro hardness values for the same samples. Standard deviation (**StD**) is presented for all measured properties.

Table 1 - Values for the flexural resistance, work-of-fracture and static elastic modulus for each one of the sintering temperatures of the composite material studied.

Temperature [ºC]	Static elastic mod. [GPa] (StD)	Work-of-fracture [J/m2] (StD)	Flexural resistance [MPa] (StD)
1200	77.13 (8.44)	1.652E-01(0.02)	76.29 (7.75)
1230	143.08 (5.92)	3.661E-01(0.02)	150.61(7.00)
1250	153.86 (13.98)	2.615E-01(0.07)	132.29(13.43)
1300	128.78 (8.62)	2.658E-01(0.05)	124.57(9.50)
1350	129.54 (0.11)	2.524E-01(0.02)	121.79(3.99)
1400	115.01 (0.05)	1.450E-01(0.01)	115.01 (0.05)
1450	151.28(7.60)	3.262E-01(0.05)	152.00 (7.40)

Table 2 - Density, dynamic elastic modulus and microhardness of BST specimens for the temperature range of 1200ºC to 1450ºC.

Temp.[ºC]	Density [%]	Dynamic elastic mod. [GPa]	Microhardness [MPa] (StD)
1200	89.80	94.9	1027.3 (174.3)
1230	94.30	224.0	6135.2 (956.0)
1250	99.67	205.5	8418.9 (294.9)
1300	96.00	176.6	5821.3 (626.0)
1350	87.57	162.6	3832.8 (598.0)
1400	88.34	164.4	3080.3 (253.5)
1450	86.18	181.7	2240.6 (489.0)

From the results obtained it was possible to conclude that sintering temperature influences drastically the mechanical properties. A very good correlation between material density and microhardness was verified. The highest mechanical and dielectric values attained were registered for sintering temperature of 1250ºC.

ACKNOWLEDGMENTS

S.M. Olhero and Ajay Kaushal thanks to the Foundation for Science and Technology of Portugal (FCT) for the financial support under the grant SFRH/BPD/27013/2006 and SFRH/BPD/77598/2011, respectively, and the financial support under the project PTDC/CTM/099489/2008.

REFERENCES

[1]-Ioachim, M. I. Toacsan, M. G. Banciu, L. Nedelcu, C. Plapcianu, H. Alexandrua, C. Berbecarua, D. Ghetua, G. Stoicab, R. Ramerc, “Frequency agile BST materials for microwave applications”, Journal of Optoelectronics and Advanced Materials Vol. 5, No. 5, 2003, p. 1389 - 1393.

[2]-C. Berbecaru, H.V. Alexandru, C. Porosnicu, A. Velea, “Ceramic materials Ba(1-x)SrxTiO3 for electronics - Synthesis and characterization”, Thin Solid Films, 516 (2008) 8210-8214.

[3]-H.V. Alexandru, C. Berbecaru, A. Ioachim, M.I. Toacsen, M.G. Banciu, L. Nedelcu, D. Ghetu, “Oxides ferroelectric (Ba, Sr)TiO3 for microwave devices”, Materials Science and Engineering B 109 (2004) 152-159.