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Texturation of lead-free BaTiO₃-based piezoelectric ceramics

A. Ngueteu-Kamlo¹, F. Levassort², M. Pham Thi³, P. Marchet¹

1 Laboratoire de Science des Procédés Céramiques et de Traitements de Surface, UMR 7315 CNRS, Université de Limoges, Centre Européen de la Céramique, 12, rue Atlantis, F-87068 Limoges Cedex, France.

2 Université François Rabelais de Tours, GREMAN CNRS 734, 10 Boulevard Tonnellé, BP 3223, F-37032 TOURS Cedex 1, France

3 THALES Research & Technology France, Campus Polytechnique, 1, Av. Augustin Fresnel, F-91767 Palaiseau Cedex - France

Contact author: pascal.marchet@unilim.fr

Nowadays, piezoelectric ceramics are integrated in a wide range of devices, in particular in ultrasonic applications (underwater sonar systems, medical imaging, non-destructive testing...). Most of them use Pb(Zr,Ti)O₃ (PZT). However, due to health care and environmental problems, lead content must be reduced in such applications [1]. Recent reviews demonstrated that few lead-free materials families can be considered: the alkaline-niobates (K_{0.5}Na_{0.5}NbO₃), the alkaline-bismuth-titanates (Na_{0.5}Bi_{0.5}TiO₃) and barium titanate based materials (BaTiO₃) [2, 3]. One of the limitations of ceramic materials is their isotropic nature. This is the reason why texturation process has been developed in order to improve their properties in particular electromechanical parameters. The aim of the present study is thus to obtain textured BaTiO₃ based materials by using the templated grain growth process (TGG) and to measure their piezoelectric properties.

Nanosized BaTiO₃ powders were prepared by classical solid state route at relatively low temperature. BaTiO₃ templates of different morphologies were elaborated by a molten salts process. Dispersing agent, binder and plasticizer, the mixture of the templates and matrix particles was then dispersed in the appropriated solvent using non-aqueous formulation. The slurry was then tape-casted on plastic film. After drying, the green sheet was cut, stacked, thermo compressed and then sintered at the appropriated temperature. This process allowed obtaining highly-oriented materials with a texturation degree around 95%

(fig. 1), presenting K_t values around 35-40%, higher than for non-textured BaTiO₃ ceramics.

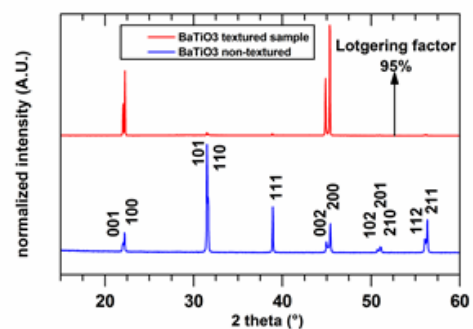


Fig. 1: X-ray diffraction diagram of (tetragonal) textured sample BaTiO₃ and (tetragonal) non-textured BaTiO₃ ceramic as reference.

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[1] Directive 2002/95/EC, Official Journal of the European Union, 13.2.2003

[2] J. Rodel, W. Jo, T.P. Seidert, E-M. Anton, T. Granzow, D. Damjanovic, J. Am. Ceram. Soc. 92, 1153-1177, 2009

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