DIELECTRIC BEHAVIOR OF FLASH SINTERED KNN

Ricardo Serrazina, CICECO-UA
serrazina@ua.pt
Ana M.O.R. Senos, CICECO-UA
Luis Pereira, FCT-NOVA
Paula M. Vilarinho, CICECO-UA

Key Words: FLASH, KNN, Lead-free piezoceramics, Dielectrics.

The market for lead-based piezoceramics, mainly ($Pb_{1-x}Zr_xTiO_3$, PZT) - based materials, is higher than $100 billion per year. Due to lead-toxicity, the demand for lead-free piezoceramics is increasing. Potassium Sodium Niobate solid solutions, namely $K_{0.5}Na_{0.5}NbO_3$, KNN, is currently one of the most promising materials for electromechanical applications. However, monophasic conventionally sintered KNN is hard to obtain, due to alkali evaporation during sintering (T > 1100 ºC, t > 2h). Within this context, there is an increasing interest in sustainable sintering techniques, as FLASH, to decrease both sintering time and temperature, avoiding alkali vaporization. However, FLASH applied to bulk ceramics, frequently produces inhomogeneous specimens.

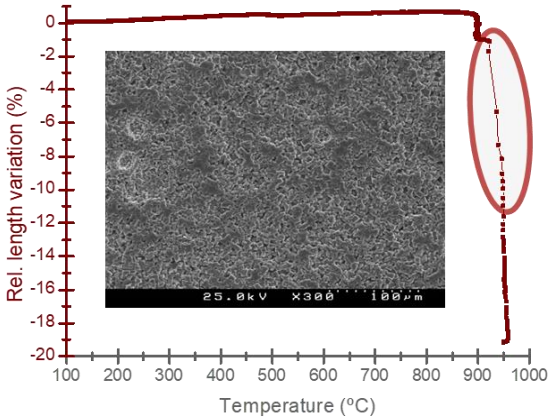

Figure 1 – Variation of length with temperature of FLASH sintered KNN, after a 2 h isothermal step. SEM micrograph showing the uniformly dense microstructure.

In this work, we propose an experimental approach that allows the production of homogeneous, highly dense, KNN. In this method, the use of FLASH sintering contributed to reduce KNN sintering temperature for more than 200 ºC and the cycle time in ~3h. Uniform densification was achieved by using an isothermal step before the application of the electric field. Scanning Electron Microscopy (SEM) and Specific Surface Area (SSA) measurements were performed to characterize the pre-FLASH sintering microstructure.
Interestingly, and for the first time, we show that FLASH sintered KNN behave very closely to conventionally sintered materials, in terms of permittivity as a function of temperature, with a Curie temperature of FLASH sintered KNN very close to 420 ºC. Moreover, despite some leakage currents, FLASH sintered KNN can be polarized and its ferroelectric characteristic determined.

Acknowledgments:

This work is financed by Portugal 2020 through European Regional Development Fund (ERDF), in the frame of Operational Competitiveness and Internationalization Programme (POCI), in the scope of the project “FLASH sintering of lead free functional oxides towards sustainable processing of materials for energy and related applications- FLASH”, POCI-01-0247-FEDER-029078, and in the scope of the project CICECO- Aveiro Institute of Materials, POCI-01-0145-FEDER-007679 (FCT Ref. UID/CTM/50011/2013), cofinanced by national funds through the FCT/MEC