Study of crystallisation, structure and piezoelectric properties of Sr-fresnoite and Sr-Ba fresnoite glass-ceramics.

Authors and affiliations: M.-S. RENOIRT*, M. GONON*
* Faculty of Engineering, Materials Institute, University of Mons, Belgium

Piezoelectric ceramics are used in numerous components (sensors, actuators), present in everybody's life. Most of these piezoelectric ceramics are polycrystalline and ferroelectric. These ceramics need to be poled under a high strength electric field before use. The main drawback of these compounds is that a depolarization takes place over time or under increasing temperature. Although exhibiting much lower electromechanical performances, non-ferroelectric piezoelectric phases (e.g. quartz) are not affected by this downside. However, in that case, macroscopic polar properties must be conferred during processing. This can be the case using the glass-ceramic technology if a preferential crystal orientation is promoted during the crystallisation step.

A PhD thesis performed at UMONS (N. Maury, 2013) has shown that preferential orientation of piezoelectric fresnoite crystals can be obtained by isothermal heat treatment on appropriated glass composition. Such material exhibits surface nucleation and crystallization mechanisms with (00l) lattice plans preferentially orientated parallel to surface. Crystallization further propagates into bulk.

Piezoelectric performances of these glass ceramics remain modest. Two reasons may explain this: i) A loss of preferential orientation in the material bulk; ii)- 180° dipolar moment inversions between crystals.

In the present work, in order to valid these findings, samples -- with the same composition and conditions of preparation as N. Maury used -- are realized and characterized by RX diffraction and piezoelectric measurements. With these two technics, the -180° dipolar moment inversion between the two opposite faces and the presence of a good orientation all along the thickness of the sample is shown.
The correlation between piezoelectric coefficient d_{33} and the lattice parameter in the bulk or into the powder are studied to check if there is some strain in the bulk which influences piezoelectric coefficients.
In a second step, the structure and crystallisation of Sr-fresnoite and Sr-fresnoite substituted with 25 or 50% of barium are compared to demonstrate the influence of substitution on the crystallisation mechanism and piezoelectric properties.