WAXS in Situ Temperature Investigations of Ferroelectric PZN-4.5PT Nanoparticles Thin Films for Structural Transitions

N. C. Y. Fall[1], R. Ndioukane[1], A. K. Diallo[1], D. Kobor[1], M. Touré[1], T. A. Dobbins[2], J. Illavsky[3] and L. Lebrun[4]

1Laboratoire de Chimie et de Physique des Matériaux (LCPM), University Assane Seck of Ziguinchor (UASZ), Quartier Néma 2, BP 523, Ziguinchor, Senegal

2Department of Physics & Astronomy, Provost Fellow (2019), Division of University Research, Rowan University, Oak Hall North 109, 201 Mullica Hill Road Glassboro, NJ 08028-1701

3X-Ray Science Division, Advanced Photon Source, Argonne National Laboratory 9700 S. Cass Avenue, bldg 433A002, Lemont, IL 60439, USA

4Univ Lyon, INSA-Lyon, LGEF, EA682 - 8 rue de la Physique, F-69621, Villeurbanne, France

dkobor@univ-zig.sn

1. Introduction

The Pb(Zn1/3Nb2/3)O3-4.5PbTiO3 (PZN-4.5PT) single crystals showed very large ferroelectric and piezoelectric properties compared to traditional ferroelectric ceramics (BaTiO3 and PZT) used as active material in medical imaging, detection and sonars. However, despite these excellent properties, the greatest difficulty to use PZN-4.5PT single crystals on electronic devices is to achieve them in thin layers form related to the difficulty to make them as ceramic material. To overcome this difficulty, we successfully fabricated thin films by dispersing their nanoparticles in a matrix gel that can maintain at least their bulk properties. After this size reduction at nanoscale and the annealing process following the deposition, phases changes and structural transformations occurred. SEM images show some agglomeration at the surface of the silicon substrate and non-identified microstructural phases which could be at the origin of their excellent properties.

2. Results

In this paper we use the combined USAXS/SAXS/WAXS instrument at 9ID beamline at APS-ANL for in situ characterization of undoped and 1% Mn doped PZN-4.5PT inorganic perovskite nanoparticles thin films deposited on nanostructured silicon to understand the phases transitions and determine the observed microcrystal's structure. The sample was annealed from ambient to 1000 °C. The results revealed structure changes of the nanoparticles thin films which could be explained by the new phase that can be assigned to the $Pb_3(PO_4)_2$ based component. The peak at 31° indicates the presence of the rhombohedral phase perovskites assigned to the nanoparticles. XRD spectra, Raman and EDX mapping are compared to the WAXS results. WAXS characterization permitted to identify many transitions during thermal annealing confirming the perfect crystallization of the film. Two most important peaks were identified at q values around 3.8 and 5.8 A^{-1}.

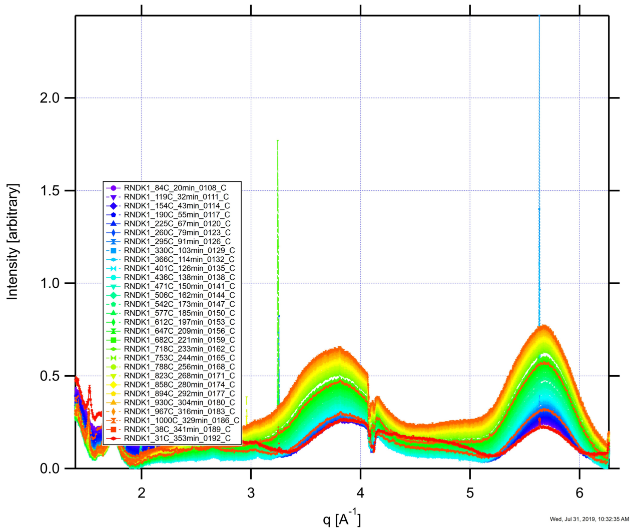

Fig. 1: In situ WAXS curves from ambient to 1000 °C

3. References

[1] R. Ndioukane, M. Touré, D. Kobor, L. Motte, J. Solard and L. Lebrun, J. Mod. Phys., 10 (2019).