Challenges and Advances in the Growth of Thin $LiNbO_3$ Films for Electro-Active Devices

Prof. Ausrine Bartasyte

FEMTO-ST Institute, University Marie & Louis Pasteur, Besançon, France
Centre de Nanosciences et de Nanotechnologies, Université Paris-Saclay, CNRS, Palaiseau, France
Institut Universitaire de France
ausrine.bartasyte@femto-st.fr

Dr. A. Bartasyte is a Full Professor at FEMTO-ST Institute / University Marie & Louis Pasteur, Junior Chair for Innovation at Institut Universitaire de France, and associated researcher at C2N/ University Paris-Saclay. She received her PhD at LMGP, Grenoble INP, conducted postdoctoral research at Oxford University, and completed a sabbatical at Harvard and Penn State Universities. She has over 20 years of expertise in the deposition of epitaxial multifunctional oxides using liquid injection MOCVD and rf puttering. Her current research focuses on Li(K)Nb(Ta)O_3 thin films and single crystals for acoustic, energy harvesting, and photonic applications.

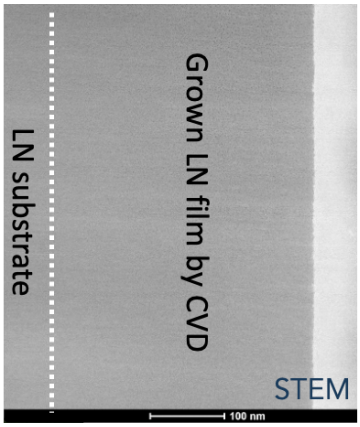

Fig. 1 Cross-sectional STEM image of homoepitaxial LN film grown by DLI-CVD.

Direct thin-film growth of lithium niobate (LN) and lithium tantalate (LT) offers the possibility to achieve tailored Li_2O compositions, including stoichiometric composition that provide superior properties such as enhanced electro-optic and piezoelectric coefficients, lower coercive fields, reduced photorefractive effects, zero birefringence, etc. It also enables controlled doping and the formation of solid solutions (LNT), allowing continuous tuning of material properties between LN and LT. In addition, this approach ensures improved thickness control and homogeneity (<1%), reduced costs through in-house fabrication, and the capability to produce films thinner than 250 nm, thereby overcoming limitations associated with ion-slicing and polishing techniques. However, the growth of high-quality LN/LT thin films has long been considered highly challenging. In this work, direct liquid injection chemical vapor deposition (DLI-CVD) is demonstrated as a promising technique for depositing LN films with controlled and near-stoichiometric Li_2O composition, along with excellent compositional uniformity (±0.05 mol%) across 4-inch wafers, with scalability to 8-inch substrates. The deposited LN films exhibit acoustic performances compatible with filter applications in surface acoustic wave (SAW) and bulk acoustic wave (BAW) devices. To further enable the integration of epitaxial LN–LT films into acoustic and photonic devices requiring single-crystalline layers on standard platforms—particularly those involving silicon substrates and amorphous layers—an homoepitaxial layer transfer process is currently under development (Fig. 1).