Synthesis of $KTa_{1-x}Nb_xO_3$ thin films by chemical and physical routes

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The multiplication of several standards in the field of high frequency devices requires to conceive new design of devices and to develop new materials. In this frame, ferroelectric materials are greatly attractive for many applications such as electrically tunable high frequency devices.

The perovskite-like oxide $KTa_{1-x}Nb_xO_3$ (KTN) is a promising candidate for this type of application due to excellent dielectric permittivity, low loss tangent δ and tunable Curie temperature T_c which can be monitored by the composition x. The synthesis of this material is however a challenge due to the potassium volatility and competition between the ferroelectric perovskite phase and an undesired pyrochlore phase. Moreover, the integration in devices implies the control of high quality thin films (epitaxial growth) on specific substrates suitable for the targeted applications.

Two different routes were investigated to synthesize KTN thin films: a Chemical Solution Deposition (CSD), based on the polymeric precursor process [1] and a physical method, Pulsed Laser Deposition (PLD). Films were deposited onto various substrates suitable for high frequency devices: r-cut sapphire Al_2O_3, $LaAlO_3$ and MgO.

For both routes, the pure perovskite phase is successfully obtained by controlling different parameters such as the initial composition of the precursor solution or the target (K excess of 40-60 %) and the synthesis temperature: 600°C for CSD and 700°C for PLD. The structural studies reveal an epitaxial growth on $LaAlO_3$ and MgO whereas a textured growth is observed on sapphire. Meanwhile, the introduction of a $KNbO_3$ seed layer strongly improves the orientation and crystalline quality of KTN on sapphire [2]. All the films are homogeneous and crack-free with a microstructure strongly influenced by the substrate but also by the method used for deposition.

Finally, the integration of these KTN thin films of high quality with different microstructures in coplanar devices will be discussed.

Keywords: potassium tantalate niobate, thin films, polymeric precursor method, chemical solution deposition, pulsed laser deposition, ferroelectric oxides, epitaxy

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