Oriented Growth of $LiNbO_3$ Thin Films for SAW properties

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Abstract.

There is a global interest in developing Surface Acoustic Wave devices of high frequency capability, high power durability and zero temperature dependence of frequency. Lithium niobate has attracted much attention due to its unusual combination of ferroelectric, piezoelectric and acousto-optic coefficients. $LiNbO_3$ thin films offer an enticing potential for high-frequency broad-band pass SAW device applications when deposited onto silicon and Al_2O_3 substrates.

In order to optimally benefit from the material properties, it is necessary to grow $LiNbO_3$ thin films with a preferred orientation, for this phase with the c-axis normal to the surface of the substrate. For this purpose, an original 2-step growth process has been developed which involves the creation of a high-nucleation density by radio-frequency sputtering in the early stages of the film growth and an enhancement of both the crystallinity and the texture by reactive chemical sputtering (pyrosol). This work summarizes our studies on the growth of $LiNbO_3$/<111>-Si and $LiNbO_3$/<001>-Al_2O_3 heterostructures. Emphasis is given on interface control to promote <001>-oriented crystallization process. Results from textural, microstructural and composition analyses are presented.

By combining both the r.f. sputtering and the pyrosol methods, stoichiometric <001>-oriented heterostructures could be achieved. Depositions performed on <111>-Si templates led to fiber textures, characteristic of oriented polycrystalline materials. <001>-Al_2O_3 substrates allowed the development of hetero-epitaxial layers, built up of two 60°-rotated domains. The volumic ratio of the rotated domain appear to be in a 50 % range, by a direct integration of the pole contributions.

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