Ion Beam Trimming of $LiTaO_3$ and $LiNbO_3$ Compound Wafer

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Modern applications of micro- and nano-electronic devices require complex multilayered structures of various crystalline (semi-)conducting, piezoelectric or isolating materials. In certain occasions, it has turned out useful to create these layers not by means of deposition but rather by composing the layer stack from pre-manufactured wafers of the required materials with a perfect crystalline structure and orientation without defects. Well known since years are silicon on insulator (SOI) wafers, while new compound wafers like lithium niobate (LN) or lithium tantalate (LT) on silicon are recently upcoming new combinations. The LN/LT-compound wafer re-gained industrial interest in the field of wireless communications for meeting system-filtering requirements. The layered wafer structure gives high Q factors, due to its intrinsic better confinement of the acoustic wave and are less sensitive to temperature changes because of the direct bonding to the Silicon substrate.

A good layer uniformity results in higher yield, higher quality, and reduced manufacturing costs. Either smart cutting or bonding, subsequent grinding and final chemical mechanical polishing (CMP) sets the thickness of the piezoelectric layer.

However, oftentimes the specification for the layer thickness homogeneity becomes stricter than those methods can deliver. In these cases, ion beam trimming of the layer drastically improves both, the thickness uniformity (and thus subsequent device yield) as well as the desired target thickness accuracy. By means of the applied trimming technique, the LN/LT layer thickness can be adjusted down to < +/-5 nm off the target value for all the investigated materials. The standard deviation of the thickness topology error decreased significantly with typical improvement factors of 5 to 8, depending on the incoming quality, respectively. Additionality, the surface roughness after the processing is similar to the incoming quality of Ra < 0.3 nm.