3.7 Structural and Electrical Properties of $LiTaO_3$ Thin Films Grown on Silicon by Modified Molecular Beam Epitaxy

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Lithium tantalate ($LiTaO_3$) is one of the most commonly used materials for pyroelectric detectors due to its large pyroelectric coefficient and excellent chemical stability. In our molecular beam epitaxy (MBE) growth process, chemically cleaned wafers underwent a low temperature (200°C) desorption in the load lock and were subsequently thoroughly desorbed for 30 minutes at 900°C under UHV conditions in the transfer system. After the introduction to the deposition chamber and prior to deposition, they were heated to a desired temperature and the fluxes of tantalum, lithium, and oxygen were stabilized at a desired level. A range of different temperatures and flux parameters as well as different substrates have been used for the deposition experiments.

Thin films of $LiTaO_3$ were deposited on Si (111) substrates covered by a thin layer of epitaxial PtSi. Quantitative XPS analysis showed that these $LiTaO_3$ films are stoichiometric. XRD and TEM structural analyses revealed a preferentially oriented polycrystalline structure. Dielectric and ferroelectric properties were measured by contacting the grown films by evaporated gold interdigital electrodes. High temperature permittivity measurements were performed in a wet oxygen atmosphere in order to avoid the loss of ferroelectric phase. The samples showed transition temperatures between 580 and 650°C. Ferroelectric properties were measured by a unique modified Sawyer-Tower technique which allows direct removal of the signal arising from the dielectric loss of the films. No ferroelectric hysteresis was observed at film temperatures less than 400°C, while at higher temperatures well developed hysteresis loops with a coercitive field of 15 kV/cm and a spontaneous polarization of 1$\mu C/cm^2$ were observed. The pyroelectric response of the films shows a high sensitivity of up to 170$\mu A/W$ in the range between 10Hz and 10kHz.

$LiTaO_3$ thin films have been successfully prepared on Si substrates using the MBE technique. The structural and electrical evaluations indicated that the films have the desired physical properties for pyroelectric applications.