3.13 Fabrication and Characterization of a Hybrid Thin Film Pyroelectric Detector Based on KTN

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In order to get the maximum performance from a pyroelectric detector, the detecting structure has to have a small thermal mass and should be well thermally insulated from the surroundings. We satisfied these requirements by building a KTN-based hybrid detector structure on a silicon wafer.

Following the LPE growth of a 50 µm thick KTN film on a 1.5 mm thick KT wafer, the film was polished and provided with an evaporated Ta/Au contact. Tantalum was found to form a good ohmic contact with KTN. In parallel, a silicon wafer was oxidized and coated on the front side with 100 nm of gold. This layer was patterned to match the contacts on the KTN. Gold was chosen as it provides excellent wetting contacts for indium bonding.

Both wafers were bonded in the area of the contacts face to face with a thin layer of indium. In the next step, the KT substrate was mechanically removed, leaving only an approximately 20 µm thick KTN film bonded to the silicon wafer. After the evaporation of top Ta/Au contacts onto the exposed KTN layer, a window, aligned with the KTN film, was opened in the oxide layer on the back side of the silicon wafer. Using the remaining oxide layer as a mask, silicon was anisotropically etched from the back side in a KOH solution, until the front etch-stop oxide layer was reached. The whole processing procedure resulted in practically free-standing, 20 µm thick KTN membranes measuring up to 4x4 mm^2.

After poling of the KTN films above the Curie temperature, with an applied electric field of 1 kV/cm, the pyroelectric response at different frequencies and temperatures was measured. For this purpose we used a chopped HeNe laser beam and a lock-in amplifier. In $KTa_{0.55}Nb_{0.45}O_3$ thin films the maximum pyroelectric response was observed at 339K, which coincided with the expected transition temperature. The measured values corresponded to a pyroelectric coefficient of 5.2 mC/m^2K. The frequency response showed a maximum at 230 Hz which makes this material a good candidate for applications in IR video arrays.