3.8 Growth and Characterization of a New Conducting Substrate for the Liquid Phase Epitaxy of $K_{1-y}Na_yTa_{1-x}Nb_xO_3$ (KNTN) Thin Films

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$KTaO_3$ (KT) is a very good substrate for the liquid phase epitaxy (LPE) of $K_{1-y}Na_yTa_{1-x}Nb_xO_3$ (KNTN) thin films, because with the addition of Na in the KNTN films perfect lattice matching of film and substrate is possible. Nevertheless, the high resistivity of pure KT (about 10^{12} Ωm) does not allow any application or measurement of the voltage perpendicular to the main surfaces of the KNTN films, which is necessary for a poling procedure in order to get large area single-domain thin films.

In order to overcome this deficiency, we have developed a new semiconducting KT substrate by Ba doping. Bulk crystals were grown by the Czochralski method out of a $BaCO_3/KTaO_3/K_2O$ melt. The as-grown crystals were dark blue and electron microprobe analysis (EMPA) confirmed the presence of Ba. Additions of 1000 ppm of Ba into the melt resulted in an resistivity of 10^4 Ωm which is about eight orders of magnitude lower than that observed in the undoped crystals. Color and resistivity remained unchanged also after a high temperature annealing in the oxygen atmosphere. Optical spectroscopy revealed additional absorption at lower photon energies depending on the Ba concentration.The coefficient of this additional absorption is inversely proportional to the third power of the photon energy and can be attributed to ionized-donor scattering.

Dielectric constants measured as a function of frequency and temperature showed a Debye relaxation at frequencies around 1 kHz and a DC conductivity increasing with temperature. Epitaxial KNTN thin films were grown on the produced Ba:KT wafers and characterized structurally and electrically.