Microstructure, Dielectric and Piezoelectric properties of Oxide Films deposited from airflow

Frederic LeCarpentier and Eugene Stytsenko

Industrial Research Limited, PO Box 31-310

Wellington, New Zealand

ABSTRACT

Airflow deposition technique was used to prepare piezoelectric thick films for a comparative study of their microstructures and electrical properties with reference to corresponding bulk ceramics. Thick films were deposited at room temperature using several oxide ceramic compositions based on lead zirconate titanate (PZT), barium titanate, and zinc oxide. Processing at various temperatures showed that the films' microstructures were largely controllable by sintering regimes. The grain size was in the range 0.1 to 20 microns depending on the sintering conditions and the particle size distribution of the precursor powder. Final densities of the films exceeded the densities of bulk samples in spite of reduced sintering temperatures of 700 –900 ^{0}C. Ferroelectric films sintered at low temperature displayed, however, a dielectric and piezoelectric behavior different from bulk ceramics. Permittivity – temperature peaks were broadened and piezoelectric coefficients were lower than for bulk ceramics. Hysteresis loops showed higher coercive fields and lower remnant polarizations. An abnormal dielectric relaxation in the frequency range 0.001 to 100 Hz correlating with the progress of sintering was found. Electron microscopy showed a correspondence between the low frequency dielectric properties and the grain size and density of the film samples. This allowed quick and accurate assessment of the sintering progress by dielectric properties measurements. The applicability of PZT thick films for ultrasonic transducer use was shown.