

Evaluation of All the Material Constants of PMN-28%PT Piezoelectric Single Crystals for Acoustic Transducers

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(Received October 22, 2012; accepted April 8, 2013)

Key words: material constants, PMN-PT, single crystals, finite element analysis, resonator measurement

In this study, all the elastic, piezoelectric, and dielectric constants of lead magnesium niobate-28%lead titanate (PMN-28%PT) single crystals have been determined by the resonance method. In comparison with other PMN-PT crystal compositions characterized so far, PMN-28%PT crystals offer better structural reliability and easy growth controllability. The PMN-28%PT single crystals were grown by the Bridgman method to have a tetragonal symmetry of 4mm, and thus have eleven independent material constants: six elastic constants, two dielectric constants and three piezoelectric constants. The eleven constants were determined through measurement and analysis of only the impedance spectra of six different types of PMN-PT resonators: length extensional (LE), thickness extensional (TE), thickness shear (TS)-mode, and length thickness extensional (LTE) resonators, and two variations of the LTE resonators, $XYt45^\circ$ and $ZXt45^\circ$. The characterization method in this work yields all the material constants of PMN-28%PT crystals through consistent and systematic resonance measurements. The validity of the characterization method and accuracy of the determined material constants are demonstrated through comparison of the experimental impedance spectra with numerically obtained impedance spectra of the resonators having the derived constants.

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