Characterization of Piezoelectric Materials Using Resonant Ultrasound Spectroscopy (2011)

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Abstract

This work deals with the determination of electromechanical properties of piezoelectric materials: ultrasonic wave velocities, coupling coefficients, elastic, dielectric and piezoelectric constants, electrical and mechanical losses. Until now, conventional techniques use several samples for these identifications [ANSI/IEEE Std 176-1987]. Recently, Delaunay et al. proposed an ultrasonic characterisation method allowing the determination of these properties from only one sample. This method, referred to as Resonant Ultrasound Spectroscopy [1], examines the vibration modes of a piezoelectric cube and relates mechanical resonances measured by Laser interferometry to electromechanical properties. This method is here modified to obtain the electromechanical properties from electrical impedance measurements. The direct problem is first solved; the resonance modes of a cube of the material are modelled and both mechanical displacements and electrical impedance are calculated as a function of frequency and electrical boundary conditions. Because the geometry of the sample is fixed (cube shape), this impedance only depends on the material properties. The method is first applied in the case of Pz27 material, the properties of which are known. Electrical impedance measurementson Pz27 are measured and compared to theoretical predictions This validates the electrical modelling of the cube vibrations. In order to determine the properties of unknown materials, the inverse problem is solved by fitting the theorical impedance curves to the experimental ones. By this procedure, the properties of Pz52 and Pz54 from the same supplier are extracted. The results are discussed in terms of ultrasonic transducer performance.

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