MS13-P6 Measuring the magnitude and sign of the effective piezoelectric coefficient by mechanical impact method

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Method of impact action allows determining magnitude and sign of the effective piezoelectric coefficient not only for thin films [1], but for the bulk piezoelectric materials too. Feature of the method is the possibility of its use in technological terms, which allows sorting piezoelectric plates and greatly reduce production costs in the manufacture of piezoelectric devices.

This new express method consists in the application of shock pulse exposure to the sample and removing the piezoelectric response signal using an oscilloscope. Sign of the effective piezoelectric coefficient is determined with the polarity of the signal electric response, and its amplitude and impact force allow calculating the value of the effective piezoelectric coefficient of mechanical impact. Vertical impact is controlled with a calibration system using the value of acceleration in the plane perpendicular to the direction of impact.

In practice, the value of the effective piezoelectric coefficient is required, i.e the superposition of piezoelectric coefficients of the material taken in a definite relation to each other, depending on the orientation of the crystal. Mean values of the effective piezoelectric coefficients most commonly used crystals and the size of their standard deviations were calculated, which are the basic parameters in obtaining reliable experimental values by the method of mechanical impact.

For testing the method, X-cut quartz, Y-cut $LiNbO_3$ and a 127,86˚Y- $LiNbO_3$ plate samples with the well-known theoretical values were taken. Measurements were conducted in a experimental setup several times for each sample.

Dependence of the effective piezoelectric coefficient on the ratio of Li to Nb is theoretically calculated for 127,86˚Y-$LiNbO_3$ plate. Measurement of the effective piezoelectric coefficient and its theoretical dependence on the composition of lithium niobate enables to estimate the ratio of Li to Nb, that is equal to 49.5 mol. % of Li_2O for our specimen. Measurements of the effective piezoelectric coefficients proposed method and its calculation results showed good agreement with the calculated values of measurements according to the literature.

[1] Guo Q., Cao G.Z., Shen I.Y. "Measurements of piezoelectric coefficient d_{33} of Lead Zirconate Titanate thin films Using a Mini Force Hammer." Journal of Vibration and Acoustics 135 (2013): n. pag. Print.

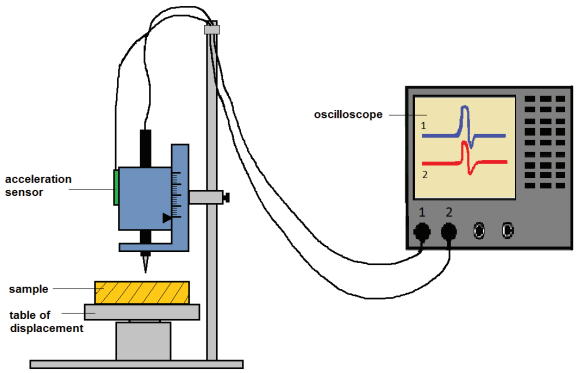

Figure 1. Scheme of setup for measuring the effective piezoelectric coefficient by mechanical impact method

Keywords: effective piezoelectric coefficient, piezoelectricity, impact force, lithium niobate, quartz