Evaluation of Elastic Constants in Piezoelectric Ceramics by Measuring Acoustic Wave Velocities

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Piezoelectric ceramics including lead-free were investigated from viewpoints of relationships between piezoelectricity and elastic constants such as Young's modulus ($Y^E{}_{33}$) and Poisson's ratio (σ). Recently, we developed a method to be convenient to measure acoustic wave velocities suitable for disk samples (dimensions of 10-15 mm diameter and 1.0-1.5 mm thickness) by an ultrasonic thickness gauge (Olympus Co., Model 35DL) with high-frequency (30 MHz and 20 MHz) pulse generation [1, 2]. Figure 1 shows the relationships between planar coupling factors (k_p) vs Young's modulus ($Y_{33}{}^E$) and Poisson's ratio (σ) in alkali niobate (abbreviated to "SZ"), alkali bismuth titanate ("KBT" and "BT") lead-free ceramics compared with "hard PZT" and "soft PZT", and with lead titanate ("PLT" and "PT") ceramics after fully DC poling. It was confirmed that higher k_p values appeared at lower $Y_{33}{}^E$ and higher σ values. The origin of high piezoelectricity was due to the mechanical softness of materials in the direction perpendicular as well as parallel to the poling field. This work was partially supported by a Grant-in-Aid for Scientific Research C (No. 21560340) and a Grant of Strategic Research Foundation Grant-aided Project for Private Universities 2010-2014 (No. S1001032) from the Ministry of Education, Culture, Sports, Science and Technology, Japan.

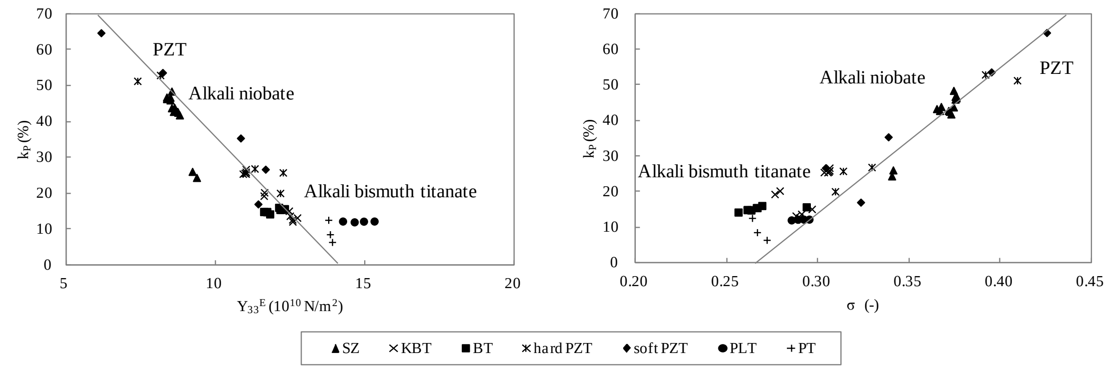

Fig. 1 Relationships between k_p vs $Y_{33}{}^E$ and σ in piezoelectric ceramics.

References

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