Shear piezoelectric coefficients of PZT, LiNbO₃ and PMN-PT at cryogenic temperatures

SYED BUKHARI, MD ISLAM, JOHN BEAMISH, University of Alberta, ARIEL HAZIOT, Ecole Normale Superieure — Piezoelectric transducers are widely used as sensitive detectors of stress and to generate nanometer scale displacements. However, their piezoelectric coefficients often decrease substantially at cryogenic temperatures, limiting their performance in, e.g., low temperature STMs. We have recently used PZT shear transducers to measure the elastic modulus of solid ⁴He at very low strains and to plastically deform the helium at high strains. From our elastic measurements, we inferred a shear piezoelectric coefficient $d_{15} = 1.0 \times 10^{-10} \text{ m/V}$ at temperatures below 1 K. This is about 6 times smaller than the room temperature value for PZT and comparable to $d_{15}$ for single crystal LiNbO₃ transducers ($7 \times 10^{-11} \text{ m/V}$). We have developed a capacitive technique and have directly measured the temperature dependence of $d_{15}$ for ceramic (PZT) and single crystal (LiNbO₃ and PMN-PT) shear transducers. PMN-PT has an extremely large $d_{15}$ at room temperature ($4 \times 10^{-9} \text{ m/V}$) but it decreases rapidly below 100 K. LiNbO₃ has the smallest room temperature $d_{15}$, but it is nearly temperature-independent. At 4 K, the three types of transducers have similar piezoelectric shear coefficients.

¹This research was supported by a grant from NSERC Canada
²Current address: Penn State University