Mechanical Pre-Stressing a Transducer through a Negative DC Bias Field

Stephen C. Butler
Naval Undersea Warfare Center
1176 Howell Street, Newport, RI, 02841 USA
*Stephen C. Butler: stephen.c.butler1@navy.mil

This discussion provides a qualitative study with regards to feasibility of using a negative DC biasing approach to apply a mechanical compressive stress to a transducer's piezoelectric ceramic stack instead using a stress bolt. A typical underwater Tonpilz longitudinal-type transducer is made up of four major parts, a piezoelectric ceramic drive element that is sandwiched between two masses, a tail mass, a radiating head mass and a stress bolt. The stress bolt that passes through the ceramic stack and connects the head mass to the tail mass keeps the transducer parts together and keeps the ceramic element under a constant compressional stress. The compressive stress prevents the ceramic from going into tension and fracturing when driven under high AC drive conditions that exceed its low tensile strength. The typical compressive stresses applied by the stress bolt are 3000 to 6000 psi. When the transducer element lateral dimensions are small, compared with acoustic wavelength, there is little or no room for a stress bolt. An alternative method of applying a compressive preload without the stress bolt is achieved by applying a negative DC electric field across the piezoelectric ceramic stack which in turn causes the piezoelectric ceramic element to contract, resulting in an internal compressive stress. The plausible of this method will be discussed. [Funded by ONR]