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Experimental study of piezoelectret foams as underwater sensors

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This work explores the use of piezoelectret foams (PF) as acoustic sensors for underwater applications. PF material (Emfit Ltd.) provides an intriguing alternative to piezoelectric ceramics and piezopolymers due to their low density, minimal thickness, and potential for easily creating sensors of complex geometries. The foams consist of a continuous polymer containing electrically polarized elliptical voids. Typical density, thickness, and low frequency receive voltatge sensitivity (RVS) values of these foams are 300 kg/m3, 80 μm, and -175 dB re 1V/μPa, respectively. This work presents experimentally obtained RVS of piezoelectret sensors with rigid and pressure release backing. The results show PF sensor RVS is comparable to conventional sonar transducers at low ambient pressures with RVS degradation as ambient pressure increased. The results are compared with theoretical predictions using microelectromechanical mean field theory and equivalent circuit models. Theoretical predictions explain the observed sensitivity degradation due to void closure caused by the applied pressure. To overcome the performance degradation, two pressure tolerant sensor design concepts are proposed and tested. The designs aim to employ PF elements for high ambient pressure applications while leveraging foam density and thickness to create lightweight, low profile sensors.