

# **Piezoelectric Micromachined Ultrasound Transducer (PMUT) Arrays for Integrated Sensing, Actuation and Imaging**

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**Abstract:** Many applications of ultrasound for sensing, actuation and imaging require miniaturized and low power transducers and transducer arrays integrated with electronic systems. Piezoelectric micromachined ultrasound transducers (PMUTs), diaphragm-like thin film flexural transducers typically formed on silicon substrates, are a potential solution for integrated transducer arrays. This paper presents an overview of the current development status of PMUTs and a discussion of their suitability for miniaturized and integrated devices. The thin film piezoelectric materials required to functionalize these devices are discussed, followed by the microfabrication techniques used to create PMUT elements and the constraints the fabrication imposes on device design. Approaches for electrical interconnection and integration with on-chip electronics are discussed. Electrical and acoustic measurements from fabricated PMUT arrays with up to 320 diaphragm elements are presented. The PMUTs are shown to be broadband devices with an operating frequency which is tunable by tailoring the lateral dimensions of the flexural membrane or the thicknesses of the constituent layers. Finally, the outlook for future development of PMUT technology and the potential applications made feasible by integrated PMUT devices are discussed.