Thin-film piezoelectric MEMS

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Abstract: Major challenges have emerged as microelectromechanical systems (MEMS) move to smaller size and increased integration density, while requiring fast response and large motions. Continued scaling to nanoelectromechanical systems (NEMS) requires revolutionary advances in actuators, sensors, and transducers. MEMS and NEMS utilizing piezoelectric thin films provide the required large linear forces with fast actuation at small drive voltages. This, in turn, provides accurate displacements at high integration densities, reduces the voltage burden on the integrated control electronics, and decreases NEMS complexity. These advances are enabled by the rapidly growing field of thin-film piezoelectric MEMS, from the development of AlN films for resonator and filter applications, to their implementation in adaptive radio front ends, to the demonstration of large piezoelectricity in epitaxial Pb(Zr,Ti)O-3 and PbMg1/3Nb2/3O3-PbTiO3 thin films. Applications of low voltage MEMS/NEMS include transducers for ultrasound medical imaging, robotic insects, inkjet printing, mechanically based logic, and energy harvesting. As described in this article, advances in the field are being driven by and are prompting advances in heterostructure design and theoretical investigations.

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