Giant Piezoelectricity on Si for Hyperactive MEMS

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Abstract: Microelectromechanical systems (MEMS) incorporating active piezoelectric layers offer integrated actuation, sensing, and transduction. The broad implementation of such active MEMS has long been constrained by the inability to integrate materials with giant piezoelectric response, such as Pb(Mg(1/3)Nb(2/3))O(3)-PbTiO(3) (PMN-PT). We synthesized high-quality PMN-PT epitaxial thin films on vicinal (001) Si wafers with the use of an epitaxial (001) SrTiO(3) template layer with superior piezoelectric coefficients (e(31,f) = -27 +/- 3 coulombs per square meter) and figures of merit for piezoelectric energy-harvesting systems. We have incorporated these heterostructures into microcantilevers that are actuated with extremely low drive voltage due to thin-film piezoelectric properties that rival bulk PMN-PT single crystals. These epitaxial heterostructures exhibit very large electromechanical coupling for ultrasound medical imaging, microfluidic control, mechanical sensing, and energy harvesting.

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