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Lead magnesium niobate-lead titanate single crystal thick films on silicon substrate for high-frequency micromachined ultrasonic transducers

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Some new clinical applications requiring ultrasonic frequencies higher than 30 MHz are emerging, such as ophthalmological and dermatological imaging and intravascular imaging with probes mounted on catheter tips. High frequency ultrasonic transducer (HFUT) has thus been a growing research area in recent years. Most of the HFUTs reported are using piezoelectric PZT ceramic thin plates, ZnO films or PVDF films as the transducer materials. The PMN-PT ((1-x)Pb(Mg1/3Nb2/3)O3-xPbTiO3) single crystal, although possessing the highest piezoelectric coefficients, has seldom been used for this purpose because it is difficult to lap down the brittle single crystals to thin plates and handle them in conventional way of transducer fabrication. In this work, a novel high-frequency ultrasonic transducer structure is realized by using PMN-PT-on-silicon technology and silicon micromachining. A hybrid processing method involving wafer bonding, mechanical lapping and wet chemical thinning is successfully developed. PMN-PT thick films with thickness ranging from several to tens of microns have been demonstrated and they have properties comparable to those of PMN-PT bulk samples. A prototype high frequency ultrasonic transducer is being fabricated and characterized.
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