Lateral Scaling of $Pb(Mg_{1/3}Nb_{2/3})O$-3-$PbTiO_3$ Thin Films for Piezoelectric Logic Applications

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Source: JOURNAL OF APPLIED PHYSICS, Volume: 115, Issue: 23, Article Number: 234106, DOI: 10.1063/1.4882025, Published: JUN 21 2014

Abstract: The dielectric and piezoelectric behavior of 70Pb(Mg1/3Nb2/3)O-3-30PbTiO(3) (70PMN-30PT) thin films was studied as a function of lateral scaling. Dense PMN-PT films 300-360 nm in thickness were prepared by chemical solution deposition using a 2-methoxyethanol solvent. These phase pure and strongly {001} oriented films exhibited dielectric constants exceeding 1400 and loss tangents of approximately 0.01. The films showed slim hysteresis loops with remanent polarizations of about 8 mu C/cm(2) and breakdown fields over 1500 kV/cm. Fully clamped films exhibited large signal strains of 1%, with a d(33,f) coefficient of 90 pm/V. PMN-PT films were patterned down to 200 nm in spatial scale with nearly vertical sidewalls via reactive ion etching. Upon lateral scaling, which produced partially declamped films, there was an increase in both small and large signal dielectric properties, including a doubling of the relative permittivity in structures with width-to-thickness aspect ratios of 0.7. In addition, declamping resulted in a counterclockwise rotation of the hysteresis loops, increasing the remanent polarization to 13.5 mu C/cm(2). Rayleigh analysis, Preisach modeling, and the relative permittivity as a function of temperature were also measured and further indicated changes in the domain wall mobility and intrinsic response of the laterally scaled PMN-PT. (C) 2014 AIP Publishing LLC.