Ferroelectric Thin Films for Microelectronic and MEMS Applications

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We report a new fatigue mechanism on oxygen stability in the octahedra of ferroelectric perovskites. From the comparative studies of $SrBi_2Ta_2O_9$ and $Bi_4Ti_3O_{12}$, it is found that chemical bond strength between Bi and O atoms in the octahedra is critical for polarization reversal characteristics. La-substituted $Bi_4T_3O_{12}$ exhibits an excellent fatigue endurance property. Furthermore, it shows a good retention, resistance to hydrogen deterioration, and low-temperature processing temperature, indicating that this material is suitable for high-density ferroelectric random access memory applications. Owing to newly developed scanning probe microscopy, it is possible to study domain switching of ferroelectric thin films at nanometer scale. Retention and imprint behaviors have been studied by a normal and a reverse-poling scheme. Micromachining of silicon and related materials envisions new microstructures and devices. By combination of ferroelectric thin films and microelectromechanical systems (MEMS), we are able to fabricate a variety of piezoelectric cantilevers, which are promising for high speed scanning probes, large density storage, and optical switch micromirrors.