Science and Technology of Advanced Materials

Characterization of Bi and Fe co-doped PZT capacitors for FeRAM

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Issue Volume 11, Number 4

Citation Jeffrey S Cross *et al* 2010 *Sci. Technol. Adv. Mater.* **11** 044402
doi: 10.1088/1468-6996/11/4/044402

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Abstract Ferroelectric random access memory (FeRAM) has been in mass production for over 15 years. Higher polarization ferroelectric materials are needed for future devices which can operate above about 100 °C. With this goal in mind, co-doping of thin $Pb(Zr_{40},Ti_{60})O_3$ (PZT) films with 1 at.% Bi and 1 at.% Fe was examined in order to enhance the ferroelectric properties as well as characterize the doped material. The XRD patterns of PZT-5% $BiFeO_3$ (BF) and PZT 140-nm thick films showed (111) orientation on (111) platinized Si wafers and a 30 °C increase in the tetragonal to cubic phase transition temperature, often called the Curie temperature, from 350 to 380 °C with co-doping, indicating that Bi and Fe are substituting into the PZT lattice. Raman spectra revealed decreased band intensity with Bi and Fe co-doping of PZT compared to PZT. Polarization hysteresis loops show similar values of remanent polarization, but square-shaped voltage pulse-measured net polarization values of PZT-BF were higher and showed higher endurance to repeated cycling up to 10^{10} cycles. It is proposed that Bi and Fe are both in the +3 oxidation state and substituting into the perovskite A and B sites, respectively. Substitution of Bi and Fe into the PZT lattice likely creates defect dipoles, which increase the net polarization when measured by the short voltage pulse positive-up-negative-down (PUND) method.

PACS
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77.80.Bh Phase transitions and Curie point
61.72.S- Impurities in crystals
77.55.+f Dielectric thin films
78.30.Hv Other nonmetallic inorganics

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Dates
Issue 4 (August 2010)
Received 10 八月 2010 , accepted for publication 2 九月 2010
Published 6 十月 2010

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