DEPOSITION OF NICKEL STRONTIUM AND NIOBIUM DOPED PZT THIN FILMS BY RF MAGNETRON SPUTTERING

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Objectives

- Synthesis and characterization of nickel, strontium and niobium doped PZT ceramic materials.
- Grown of doped PZT thin films with chemical composition \((\text{Pb}_{0.98}\text{Sr}_{0.02})(\text{Ni}_{0.06}\text{Nb}_{0.05}\text{Zr}_{0.49}\text{Ti}_{0.40})\text{O}_3\) by RF sputtering method.
- Structural, morphological and electrical characterization of doped PZT thin films.

Target preparation

Mixing 3h in a planetary ball mill using balls of 10 mm diameter and a ball/powder weighted ratio of 2/1. Dried and double calcined at 850\textdegree C and 900\textdegree C respectively with an intermediate milling of 1 h and a final wet milling of 10 h. Powders were compacted as discs of 55 mm diameter and 7 mm thick. The pressed samples were sintered at 1150-1350\textdegree C with a dwell time of 4 h. The sintered samples were processed as discs with 50 mm diameters and 5 mm thick.

Thin films preparation

Thin films growth:

- TiO\textsubscript{2}(10nm)/Ti(2nm) adhesion structure deposited on SiO\textsubscript{2}/Si substrate by reactive rf-magnetron sputtering at 10mTorr O\textsubscript{2} pressure, 600\textdegree C substrate temperature, 50W.
- Pt thin films were deposited onto TiO\textsubscript{2}/Ti/SiO\textsubscript{2}/Si substrate at 30W, 12mTorr Ar pressure, 600\textdegree C, 200nm.
- 200nm doped PZT deposited by rf-magnetron sputtering, off-axis method, onto Pt/TiO\textsubscript{2}/Ti/SiO\textsubscript{2}/Si substrate at 100W, 15mTorr O\textsubscript{2} pressure, 600\textdegree C substrate temperature.

Characterization

- XRD spectra of oriented (111) PZT thin film deposited on TiO\textsubscript{2}/Pt/TiO\textsubscript{2}/Ti/SiO\textsubscript{2}/Si substrate.
- The patterns show the perovskite structure. Few nanometer thick of TiO\textsubscript{2} layer represents a very efficient seed layer for the nucleation of doped PZT(111).
- The film clearly exhibit dense microstructures with relatively fine grains. The average grain size is typically 100 nm.
- Scanning electron microscopy (SEM) of as deposited PZT thin film.
- The polarization versus electric field (P-E) hysteresis loop.

Conclusions

- Pt grown on TiO\textsubscript{2}/Ti/SiO\textsubscript{2}/Si substrate grow almost perfectly in (111) orientation (98 % texture index).
- PZT films deposited by RF sputtering method on Pt(111) by means of a 2nm thick TiO\textsubscript{2} seed layer show a preferred (111) orientation.
- Doped PZT films show good electrical properties: dielectric constant = 720, \(Pr=22 \mu\text{C/cm}^2\), coercive field = 48kV/cm.