Sensors and Materials, Vol. 18, No. 6 (2006) 313–327
MYU Tokyo

S & M 0652

1–10 μm PZT Films Grown by Modified Sol-Gel Method

Yi-Chu Hsu*

Department of Mechanical Engineering, Southern Taiwan University of Technology, Tainan 710, Taiwan

(Received March 20, 2006; accepted September 1, 2006)

Key words: PZT thick films, piezoelectricity MEMS, microsystems, PZT microfabrications

Lead zirconate titanate (PZT), a piezoelectric material, has a wide variety of applications in the fields of capacitors, memories, sensors and actuators owing to its excellent piezoelectric effects. There are limits to PZT films: cracking, electric leakage, small vibration displacement and sensing signals. The objective of this work is to fabricate and characterize crack-free, reliable-sensitivity, high-actuation PZT films for microsensors and microactuators. Two techniques were applied to improve conventional sol-gel processing: precursor concentration modulation and rapid thermal annealing. This research demonstrates that the former could increase both grain size and film thickness, whereas the latter could prevent film cracking. By these methods, the thickness of each coating layer is approximately 0.6 μm, and the PZT films attain a 10 μm thickness by a sixteen-coating process. The structure, surface morphology and physical properties of the PZT films were characterized by X-ray diffraction (XRD), scanning electron microscopy (SEM), atomic force microscopy (AFM), and electrical property and dynamic performance measurements. The results showed that the films were dense and crack-free, and had grain sizes between 10 and 20 μm. Also, the thicker films attained larger grain sizes. The average roughness was 2.2 nm within a surface area of 5×5 μm. At 1 kHz, the dielectric constant was approximately 160. The remnant polarization and coercive field of the PZT ferroelectric capacitors were approximately 3.63 μC/cm^2 and 64.4 kV/cm, respectively. Actuation and sensing tests were developed to measure dynamic performance. The frequencies of the first two modes in the experiments were also compared with the theoretical results obtained by considering the Euler-Bernoulli beam theory. This comparison demonstrates that the experimental results are similar to the theoretical data with an error of 5.19% at the first resonance.

*Corresponding author, e-mail address: yichu@mail.stut.edu.tw