Control of Crystallographic Texture and Surface Morphology of Pt/TiO_2 Templates for Enhanced PZT Thin Film Texture

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Optimized processing conditions for $Pt/TiO_2/SiO_2/Si$ templating electrodes were investigated. These electrodes are used to obtain [111] textured thin film lead zirconate titanate ($Pb[Zr_xTi_{1-x}]O_3$ $0 \leq x \leq 1$) (PZT). Titanium deposited by dc magnetron sputtering yields [0001] texture on a thermally oxidized Si wafer. It was found that by optimizing deposition time, pressure, power, and the chamber pre-conditioning,
the Ti texture could be maximized while maintaining low surface roughness. When oxidized, titanium yields [100]-oriented rutile. This seed layer has as low as a 4.6% lattice mismatch with [111] Pt; thus, it is possible to achieve strongly oriented [111] Pt. The quality of the orientation and surface roughness of the TiO_2 and the Ti directly affect the achievable Pt texture and surface morphology. A transition between optimal crystallographic texture and the smoothest templating surface occurs at approximately 30 nm of original Ti thickness (45 nm TiO_2). This corresponds to 0.5 nm (2 nm for TiO_2) rms roughness as determined by atomic force microscopy and a full-width at half-maximum (FWHM) of the rocking curve 0002 (200) peak of 5.5° (3.1° for TiO_2). A $Pb[Zr_{0.52}Ti_{0.48}]O_3$ layer was deposited and shown to template from the textured Pt electrode, with a maximum [111] Lotgering factor of 87% and a minimum 111 FWHM of 2.4° at approximately 30 nm of original Ti.