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Orientational control of CeO_2 films on sapphire substrates grown by magnetron sputtering

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Abstract

The effect of deposition temperature and post-annealing on the crystallographic orientation of cerium dioxide (CeO_2) films on sapphire (α-Al_2O_3) substrates were investigated. CeO_2 films, with thickness of 17 nm, were grown on c-plane and r-plane sapphire substrates by radiofrequency (rf) magnetron sputtering. Deposition temperatures between 150 and 500 °C were used with a sintered CeO_2 target in an Ar-O_2 gas mixture. The post-annealing treatment was performed in air at various temperatures ranging from 400 to 1000 °C. The films were characterized by X-ray diffraction, atomic force microscopy, and Rutherford backscattering spectroscopy. X-ray diffraction studies revealed that the orientation of the CeO_2 films changed from (001) to mixed (001)/(111) and then to (111), with increasing deposition temperatures on both the c-plane and r-plane sapphire substrates. Post-annealing at 1000 °C improved the degree of crystallinity of the films, and formed rectangular grains. The results suggest that control of the deposition and post-annealing temperatures provides orientation-controlled CeO_2 films on c- and r-plane sapphire substrates.