Ferroelectric Gate ZnO Thin Film Transistor with an MgO Buffer Layer

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We report on the transistor operation with nonvolatile memory function in ferroelectric gate thin film transistors (TFTs) using Al doped ZnO (Al: ZnO) as a channel material with an MgO buffer layer. $PbZrTiO_3$ thin films have been grown by rf magnetron sputtering as a gate insulator on MgO buffered Al: ZnO thin films. Epitaxial growth of MgO thin films on (0001) Al-doped ZnO (Al: ZnO) as buffer layer have been investigated systematically by X-ray diffraction and atomic force microscopy, along with the current-voltage characteristics. Grown by oxygen plasma assisted pulsed laser deposition, MgO thin films show a distinguished behavior that the preferred MgO orientation changes from (111) to (001) in the films as the growth temperature increases. Two completely different in-plane epitaxial relationships were also determined from X-ray diffraction as: [110]MgO//$[11\bar{2}0]$Al: ZnO and [110]MgO//$[1\bar{1}00]$Al: ZnO for (001) MgO with 60° rotated triplet domains, and [110]MgO//$[11\bar{2}0]$Al: ZnO for (111) MgO with 180° rotated twin. The pronounced temperature dependence indicates a reconciliation of the nucleation driving forces among surface, interfacial and strain energy for heteroepitaxy of cubic MgO on hexagonal Al: ZnO. The related interfacial atomic registry is considered to be of important in the formation of unusual (001) MgO on hexagonal crystals. MgO buffer layers with different orientations provide an excellent template to realize the complex oxide integration on ZnO for the application of the ferroelectric nonvolatile memory.