

High performance thin film transistors with N doped ZnO active layer prepared by atomic layer deposition

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Recently, ZnO based thin film transistor is attracting great interests for transparent and flexible displays. Atomic layer deposition (ALD) can be a good deposition technique for display applications since it can produce films with good uniformity over large area at relatively low growth temperature. However, the ALD of ZnO from diethyl Zn as a precursor and water or ozone for reactant generally results in intrinsically high carrier concentration ($> 10^{17} /\text{cm}^3$). This is a significant drawback for the application to TFT channel material, since large off current is expected. In this research, we developed an efficient way to control the carrier concentration in the ALD ZnO films. Nitrogen doping was achieved in situ during ZnO ALD by using NH_4OH as reactants. By nitrogen doping, grain size of ZnO films were reduced and, more importantly, the carrier concentrations were reduced to $< 10^{15} /\text{cm}^3$. Inverted staggered type TFTs with ALD Al_2O_3 as a gate insulator were fabricated at low process temperatures lower than 150°C on glass substrate. Very good device properties were achieved; $\mu_{\text{sat}} = 7 \text{ cm}^2/\text{Vs}$, and $I_{\text{off}} < 3 \times 10^{-12} \text{ A}$ and $I_{\text{on}} / I_{\text{off}} > 10^8$. Also, the hysteresis and subthreshold swing of the TFTs were low, about 0.5 V and $0.7 \text{ V}/\text{dec}$, respectively. ZnO:N TFT with higher saturation mobility ($\sim 20 \text{ cm}^2/\text{Vs}$) was also fabricated on plastic substrate.

Keywords: ZnO, atomic layer deposition, Transparent Thin Film Transistor,

The Dielectric Properties of Epitaxially Strained Perovskites: First-Principles Study

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The effect of in-plane epitaxial strain on the dielectric permittivity and polarization of four perovskite oxides (ABO_3): BaTiO_3 (BTO), CaTiO_3 (CTO), PbTiO_3 (PTO), SrTiO_3 (STO) is investigated by Density-Functional Theory (DFT) based on pseudopotentials and a plane-wave basis. The behaviors of these materials with epitaxial strain were explained by A-site effect which has two-folded nature - electronic and volume effects. We found that the difference in phase diagrams with misfit strain of the materials has its origin in the different degrees of hybridization between A-site-p and O-2s orbitals. The volume effect, which is caused by the various A-atom effective radii, leads to the difference in the phase transition mechanisms of these perovskite oxides. The phase transition mechanism, either purely displacive in CTO and STO or mixed with order-disorder in BTO and PTO, determines the dielectric behavior of the strained perovskites near the phase transition.

Keywords: Dielectric properties