(Supporting Information)

Effect of Ti Scavenging Layer on Ferroelectricity of $Hf_xZr_{1-x}O_2$ Thin Films Fabricated by Atomic Layer Deposition Using Hf/Zr Cocktail Precursor

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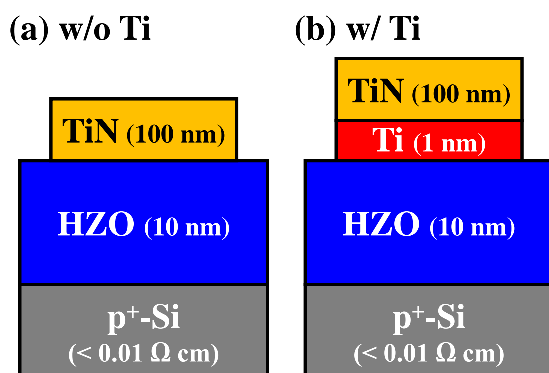

Fig. 1 Schematic illustrations of metal–ferroelectric–semiconductor (MFS) capacitors with and without a Ti scavenging layer. A post metallization annealing (PMA) was performed at 300 or 400°C for 1 min in N_2 ambient. The Hf/Zr ratios in HZO films were estimated to be 0.43/0.57 evaluated by X-ray photoelectron spectroscopy.

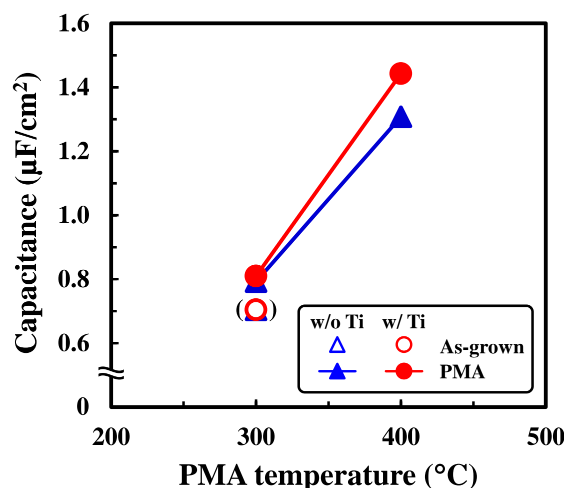

Fig. 2 Capacitance (C) of MFS capacitors with and without a Ti layer as a function of the PMA temperature. The MFS capacitors after PMA at 300°C showed almost the same C of 0.8 μF/cm^2 regardless of the presence of a Ti layer. After the PMA at 400°C, the MFS capacitors with a Ti layer exhibited slightly higher C of 1.5 μF/cm^2 than that (1.3 μF/cm^2) without a Ti layer.

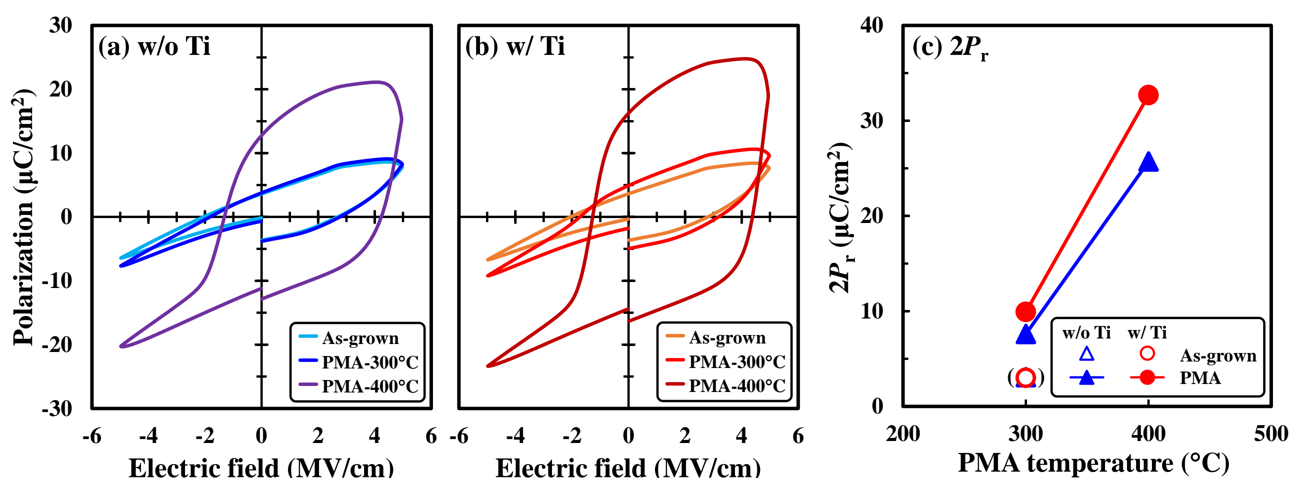

Fig. 3 Polarization–electric field (P–E) hysteresis curves of MFS capacitors (a) without and (b) with a Ti layer. (c) Remanent polarization ($2P_r = P_r^+ - P_r^-$) of MFS capacitors with and without a Ti layer as a function of the PMA temperature. The higher $2P_r$ value (33 μC/cm^2) of the MFS capacitor with a Ti layer was achieved compared to that (26 μC/cm^2) without a Ti layer after the PMA at 400°C.