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A study of MOS characteristics of reoxidized HfO_2 thin film for gate oxide applications

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We investigated the change of the microstructure which depend on the thickness of Hf films deposited by DC magnetron sputtering on Si substrate for gate dielectric application. Also, we estimated the electrical property and the microstructure of the interlayer between the thin HfO_2 films and Pt and Al gate electrode. The Hf films reoxidized by the RTP(rapid thermal processing) were analyzed by spectroscopic ellipsometry, AFM, XRD, XPS, and HR-TEM. We observed small grains of the HfO_2 film due to the local crystallization of the as-deposited Hf film ~90Å by HR-TEM. The thickness of the interfacial layer between hafnium oxide and Si substrate was about 8Å. After RTP treatment at 800℃ in N_2 ambient, the thickness of interfacial layer was equal to that of as-deposited film. For 500Å thick as-deposited Hf film, the HfO_2 layer at the surface was observed about 55Å by HR-TEM. The HfO_2 layer increased to be 90Å at 800℃ in N_2 ambient. Especially, the HfO_2 grains were shown not only at the surface of the Hf film but also at the silicide(Hf_5Si_4) grain boundaries. And the buckling of the silicide film on the Si substrate was locally observed due to the stress generated during the silicide and hafnium dioxide formation. XRD peaks indicated the formation of silicide after RTP treatment over 700℃. We evaluated C-V and I-V of the MOSCAP structures in the Pt/Hf(~100Å)/Si and Al/Hf(~100Å)/Si , and it demonstrated that the capacitance and the leakage current level of the MOS structures were changed upon the temperature of RTP treatments.