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Structural and electrical characterization of CeO_2/HfO_2 as a gate dielectric deposited by r.f magnetron sputter

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The aggressive downscaling thickness of SiO_2, which was used as conventional gate dielectric of metal oxide semiconductor (MOS) device, caused excessive leakage current as the device scale decreased. Because physically limited thickness of gate dielectric. Thin gate dielectric film caused high direct tunneling currents, the use of SiO_2 thinner than 2.0 nm maybe boundary of future MOS devices. High dielectric constant gate oxides such as Ta_2O_5, TiO_2, HfO_2, ZrO_2 and CeO_2 with higher dielectric constant than SiO_2 have been studied to overcome the scaling limit of SiO_2.

HfO_2 and CeO_2 were the most candidate material for gate dielectric. HfO_2 has high dielectric constant(~25) and stable for thermal effect also CeO_2 has high dielectric constant (~26) and good epitaxy on Si. CeO_2 and HfO_2 deposited by r.f magnetron sputter with Ar gas. The film thickness was 5 nm which was measured by ellipsometry. After deposited, CeO_2/HfO_2 film was annealed by rapid thermal process during 5 minute with N_2 gas at 650 ℃ to 850℃. To evaluate the electrical properties of CeO_2/HfO_2 film, palladium electrode was deposited by evaporator. CeO_2/HfO_2 film was investigated by X-ray diffraction. High frequency capacitance was performed by using a boonton 7200 at 1 Mhz. The EOT and dielectric constant were calculated by capacitance. Current-voltage (I-V) curves were measured by HP 4140B. CeO_2/HfO_2 film shows that leakage current was suppressed and has high dielectric constant. In accordance with increasing temperature, flat band voltage was fixed and hysteresis width was decreased

In this result indicate that CeO_2/HfO_2 were proposed to be a possible ate dielectric material in MOS of next generation.