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Electric Characteristics of HfO_2 deposited by Atomic Layer Deposition

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According to the transistor scaling, thickness of gate oxide layer in metal-oxide-semiconductor field effect transistor (MOSFET) devices is scaled down. Established materials for the gate oxide are coming up to its physical limits in terms of leakage current and reliability across a Si. Generally, SiO_2 film has been used for the gate dielectric in MOSFET. However, SiO_2 is no longer applicable because of the excess leakage current due to direct tunneling and reliability problems. For the reason, high dielectric constant k (high-k) materials have gained considerable attention as a possible alternative.
In this work, we investigated the physical and electrical properties of HfO_2 films. HfO_2 film was deposited on the Si substrate by atomic layer deposition (ALD). Gate dielectric was annealed by rapid thermal process (RTP) in N_2 ambient for 5 min. Annealing temperature is as-deposited, 500, 600℃.

According to increase annealing temperature, capacitance values of HfO_2 are increased and flat band voltage characteristics are improved. Measured information by x-ray diffraction confirmed increasing crystallization. The dielectric constants of HfO_2 were calculated to be 14.3, 22.2, 26.27 at as-deposited, 500, 600℃, respectively. Results indicated that annealing sample in 600℃ is best characteristics and increasing annealing temperature improves electric characteristics.