The investigation of surface treatments prior to Al_2O_3 deposition

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Abstract

The aggressive scaling of semiconductor device has led silicon dioxide gate dielectric to meet the physical limitation. The direct tunneling current occurs as gate oxide thickness thinner than 30A°. When the leakage current is more than $1A/cm^2$, high-k materials are investigated to replace silicon dioxide. The high-k materials show thicker physical thickness to achieve leakage current reduction at the same effective silicon dioxide thickness.

There are many interfacial states as high-k materials directly contact silicon. Some high-k materials possible react with silicon or interlayer formation during subsequent high temperature process. The phenomenon must be avoided. Therefore we want to grow a thin SiO_2 or SiO_2-like interfacial layer between silicon and high-k materials. The SiO_2-like layer demonstrates fewer interface states and hysteresis reduction. The

ultrathin oxide grown by ozone water shows that density, self-limited growth, less suboxide, layer by layer growth, and superior film quality in literature. The various surface treatments such as without treatment, nitridation, RTO, and ozone water are compared and studied.

In the thesis, we demonstrate that a thin oxide grown by ozone water treatment prior Al_2O_3 deposition and post Al_2O_3 deposition annealing at 900°C are the better choice which possessed characteristics of fewer interface states, leakage current and hysteresis reduction, and higher capacitance value.