

The characteristics of the lanthanum hafnium oxide (LHO) deposited by ECR atomic layer deposition

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High-k materials have been widely studied as an alternative gate dielectric film in the next generation of CMOS devices. Among several candidates, lanthanum hafnium oxide (LHO) is one of the promising gate dielectric because of its high dielectric constant, high crystalline temperature, and good metal oxide semiconductor capacitor characteristics.[1] Also we investigate one of the potential candidates for gate electrode, ruthenium electrode deposited by atomic layer deposition. In this work, electron cyclotron atomic layer deposition (ECRALD) was used to deposit LHO film using $\text{La}(\text{EtCp})_3$ (trisethylcyclopentadienyl lanthanum) as lanthanum precursor and TEMAHf (tetrakisethylmethylamino hafnium) as a hafnium precursor and O_2 plasma as a reactant gas. Ruthenium electrode were grown by RF-direct ALD using $\text{Ru}(\text{EtCp})_2$ as a precursor and NH_3 gas with plasma. Ru/LHO/Si stack MOSCAP was fabricated by using lift off method. In order to investigate the structural and electrical properties, we used transmission electron microscopy (TEM), and current-voltage (J-V) and capacitance-voltage (C-V) measurements. TEM analyses reveal that Ru/LHO/Si structure and small grain of crystalline phase of the film. From current-voltage (I-V) measurement of the LHO films, extremely low gate oxide leakage currents were observed. The capacitance-voltage (C-V) characteristics were analyzed at high frequency (1 100 kHz) with a sweep voltage.

Keywords: Lanthanum hafnium oxide, ruthenium gate electrode, electron cyclotron resonance, atomic layer deposition, high-k dielectric.

[1] B. Mereu, A Dimoulas, G. Velliantis, G. Apostolopoulos, R. Scholz, and M. Alexe. Appl. Phys. A 80, 253-257 (2005)