NT-P033

In-situ Synchrotron Radiation Photoemission Spectroscopy Study of Atomic Layer Deposition of Ta_2O_5 film on Si Substrate with Ta(NtBu)(dmamp)$_2$Me and H_2O

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The interfacial state between Ta_2O_5 and a Si substrate during the growth of Ta_2O_5 films by atomic layer deposition (ALD) was investigated using in-situ synchrotron radiation photoemission spectroscopy (SRPES). A newly synthesized liquid precursor Ta(N^{t}Bu) (dmamp)$_2$Me was used as the metal precursor, with Ar as a purging gas and H_2O as the oxidant source. After each half reaction cycle, samples were analyzed using in-situ SRPES under ultrahigh vacuum at room temperature. SRPES analysis revealed that Ta suboxide and Si dioxide were formed at the initial stages of Ta_2O_5 growth. However, the Ta suboxide states almostdisappeared as the ALD cycles progressed. Consequently, the Ta^{5+} state, which corresponds with the stoichiometric Ta_2O_5, only appeared after 4.0 cycles. Additionally, tantalum silicate was not detected at the interfacial states between Ta_2O_5 and Si. The measured valence band offset between Ta_2O_5 and the Si substrate was 3.22 eV after 3.0 cycles.

Keywords: Tantalum pentoxide, In-situ atomic layer deposition, In-situ synchrotron radiation photoemission spectroscopy