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MOCVD법으로 증착한 TaO_xN_y의 전기적 성질에 대한 연구 (Electrical Properities of MOCVD-TaO_xN_y as a storage capacitor material for next generation devices)

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Ta_2O_5 and (Ba, Sr)TiO_3 (BST) have been studied as high dielectric materials for dynamic random-access memory (DRAM). TaO_xN_y has excellent process compatibilities with Ta_2O_5, for TaO_xN_y can be deposited by using the same source gas as Ta_2O_5 and NH_3 in the same equipments. Thus, TaO_xN_y attracts many interests as a high dielectric material in giga-bit DRAM technologies. Stoichiometric TaON has a monoclinic crystal structure with a = 0.4966 nm, b = 0.5034 nm, c = 0.5185 nm and β = 99.65° , but the precise relative permittivity of TaON is not known until now. In this study, we have investigated the relative permittivity and leakage current density of TaO_xN_y films.

TaO_xN_y films were deposited by low pressure chemical vapor deposition (LPCVD) by using pentaethoxy-tantalum ($Ta(OC_2H_5)_5$) and NH_3. NH_3 flow rate was varied from 0 sccm to 250 sccm with 50 sccm intervals. The deposition temperature was 500℃, and the process pressure was 1 Torr. Electrical properties of TaO_xN_y film deposited at the NH_3 flow rate of 150 sccm were investigated using a metal-insulator-semiconductor (MIS) capacitor structure. Phosphorus-doped poly-Si/SiO_2/Si(100) was used as substrates. The substrates were treated by rapid thermal nitridation(RTN) at 900℃ for 90 s using NH_3. The thickness of TaO_xN_y films was about 200 nm. After the film deposition, it was annealed in N_2 ambient at 700℃ for 30 min. The top electrode was prepared by the reactive sputtering of TiN using a metal shadow mask.

As NH_3 flow rate is increased, phase is changed from Ta_2O_5 to TaO_xN_y. The relative permittivities of as-deposited and N_2 annealed TaO_xN_y films deposited at 150 sccm NH_3 are 51 and 146. Leakage current density of as-deposited TaO_xN_y film is over $\sim 10^{-5}$ A/cm^2 at 1.0 MV/cm. After N_2 annealing, leakage current density is increased over $\sim 10^{-4}$ A/cm^2 at 1.0 MV/cm.