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Physical characteristics of HfSiON films using a direct N plasma

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Hf silicate thin films have emerged as an attractive material among high dielectric films because of their compatibility with various gate materials owing to their good thermal stability when in contact with the gate. Moreover, Hf silicate has an improved crystallization temperature and superior thermal stability, when in contact with a Si substrate and a poly-Si gate electrode. In order to improve the thermal stability of high-k gate dielectrics, the incorporation of nitrogen into high-k metal oxide is a powerful technique, because the incorporated N can overcome the insufficient resistance to the crystallization and phase separation.

In this study, we focused on the electronic structure and thermal stability of nitrided $xHfO_2(100-x)SiO_2$ (HfSiO) (x=30%, 55%, and 70%) films on Si using a direct nitrogen plasma treatment. We investigated the change in chemical state related to the thermal stability of $xHfO_2(100-x)SiO_2$ with N incorporated as a function of film composition and postnitridation annealing(PNA) using x-ray photoelectron spectroscopy (XPS), and near edge x-ray absorption fine structure (NEXAFS). The composition in the depth direction was also assessed by medium energy ion scattering (MEIS).

N 1*s* spectra of nitrided Hf silicate films indicate that complex chemical states are generated. In particular, energy states with a high binding energy are stable, even after a postnitridation annealing. The quantity of N incorporated into the film is not dependent on the mole fraction of HfO_2 in the film, while the thermal stability of the N in the film is significantly influenced by the fraction of HfO_2 present. The thermal stability of the N in the film critically affects the composition and thickness of the film: i.e., after the postnitridation annealing, the thickness of the silicate film and the quantity of Hf and N are decreased, as the result of the dissociation of unstable Hf-N bonds.

[Reference]

1. G. D. Wilk, R. M. Wallace, and J. M. Anthony, J. Appl. Phys. 87, 484 (2000)
2. G. Lucovsky and G. B. Raynor, Appl. Phys. Lett. 77, 2912 (2000)
3. H. Kim and P. C. McIntyre, J. Appl. Phys. 92, 5094 (2002)
4. M. R. Visokay, J. J. Chambers, A. L. P. Rotondaro, A. Shanware, and L. Colombo, Appl. Phys. Lett. 80, 3183 (2002)