Effect of deposition temperature on the crystallinity and polarization of Ga-doped HfO_2 films by atomic layer deposition.

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Ferroelectric random access memory(FRAM) is considered as one of next gengration memoy devices due to its merits such as low power consumption and fast operation speed.[1] Recently, HfO_2 thin films with non-centrosymmetric orthorhombic phase of the space group of $P_{ca}2_1$ attracted intensive attention because of their ferroelectric property. Also, effects of doping, stress, and substrate were studied to enhance the ferroelectricity of HfO_2 films.[2] It was reported that the ferroelectric behavior of HfO_2 was affected by conditions such as deposition and post annealing temperatures in addition to alloying elements.[2]

In this study, Ga-doped HfO_2 (Ga-HfO_2) films were deposited at various temperatures, ranging from 300℃ to 340℃. Ga-HfO_2 films were grown on bottom electrodes of TiN by atomic layer deposition with Tetrakis(ethylmethylamino)-hafnium(TEMA-Hf), Trimethyl-gallium (TMG) as precursors and ozone as the oxidant. Then, top electrodes of 15nm-thick TiN were deposited by sputtering. And the post annealing was conducted by rapid thermal annealing (RTA) in N_2 atmosphere at 600 ℃ during 20s.

Chemical composition and bonding of Ga-HfO_2 films were investigated by X-ray photoelectron spectroscopy (XPS). Structural properties were examined by Grazing Incidence X-ray diffraction (GI-XRD). The ferroelectric behaviors of Ga-HfO_2 films were measurened by P-V, PUND methods with electric pulses of 3.3 MV/cm at 50 kHz and the endurance of ferroelectric switching, in addition.

Ga concentration and the non-lattice oxygen in Ga-HfO_2 film were estimated to be 5.9 % and 17. 2 %, respectively. GI-XRD shows an increased intensty in nano-crystalline peak with increasing deposition tempreature. But the remanent polarization of Ga-HfO_2 film was decreased with increasing deposition tempreature.

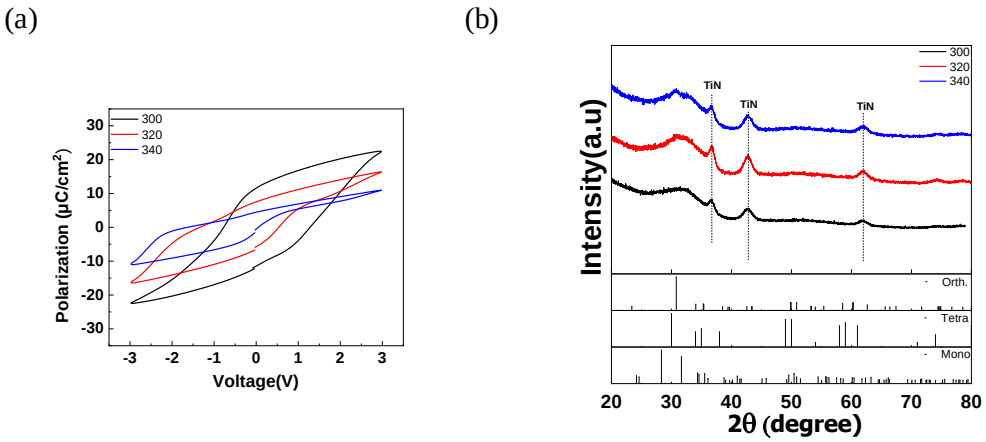

Fig 1. (a) P-V measurement (b) As grown Ga-HfO_2 GI-XRD spectra

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References
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