Ferroelectric Stability of $HfZrO_2$ Probed by In-Situ X-ray Techniques

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Abstract

In this work, the amorphous $HfZrO_2$ (HZO) thin films (5 nm) were crystallized by rapid temperature annealing (RTA) upon TiN capping for characterizations. Synchrotron-based x-ray diffraction (XRD) was employed to confirm the formation of non-centrosymmetric orthorhombic phase with RTA particularly along the horizontal crystallographic direction. Using high-resolution x-ray photon spectroscopy (XPS), we found the existence of oxygen vacancies and nitrogen diffusion at TiN/HZO interface. The in-situ x-ray absorption spectroscopy (XAS) revealed the HZO's local structural information during electrical stressing. It showed the decrease of coordination number of Hf atom with applying stress voltage at HZO, and this was attributed to redistribution of oxygen vacancies at the TiN/HZO. The information sheds light on the ferroelectric stability of ultra-thin HZO for the realization of low power nanoelectronics.

Keywords – Ferroelectric, $HfZrO_2$, Wake-up effect, In-situ EXAFS.