Phase Homogeneity of $HfZrO_2$ Probed by X-Ray nanobeam mapping

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Abstract

In recent years, driven by microelectronic scaling and the industrial striving, finding a suitable ''high-k'' replacement for integrated gate and capacitor dielectrics is the mainstream of field- effect transistor research in semiconductor technology. Extensive research has been conducted on HfO_2 and ZrO_2 based thin films. [1][2] It is generally accepted that the ferro-electricity within these materials originates from the formation of non-centrosymmetric $Pca2_1$ orthorhombic phase (o-phase), which is not a stable phase under the usual temperature and pressure conditions.

In this work, the $HfZrO_2$ thin film was prepared by atomic layer deposition (ALD), and then rapid thermal annealing (RTA) was conducted. With different percentages of Hf and Zr, the electric-field dependent polarization property changes from para-electricity to ferro-electricity. X-ray diffraction (XRD) data suggest that the different electrical properties was caused by the composition of three different phases, monoclinic, orthorhombic, and tetragonal. In order to understanding the homogeneity and composition of each phase, we choose several energy points on Hf L3 X-ray Absorption Near-Edge, doing two-dimensional mapping. By applying linear combination fitting with pure-phase Hf L3 edge models, and using constrained-least square method, the percentage of phase can be derived. Thus, the homogeneity of $HfZrO_2$ can be observed.

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References

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