

MAGNETOELECTRIC PROPERTIES OF ATOMIC LAYER DEPOSITED $\text{ZrO}_2\text{-HfO}_2$ THIN FILMS

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ZrO_2 and HfO_2 have been materials of interest due to their several potential applications, for example in microelectronics as a memory material [1]. In this study, $\text{ZrO}_2\text{-HfO}_2$ films were grown by atomic layer deposition (ALD) on planar Si(100) and TiN substrates by alternately applying certain amounts of constituent binary oxide growth cycles. ZrCl_4 and HfCl_4 were used as zirconium and hafnium precursors, respectively. The oxidizer was H_2O .

Films with various compositions were grown, cation ratio Hf/Zr varied from 0.21 to 10 at. %, as measured by X-ray fluorescence spectrometer. Some films were grown as solid solutions and some as nanolaminates. The film thicknesses, measured by spectroscopic ellipsometry, varied between 9 and 22 nm. Fig. 1 shows that a nanolaminate, where 10 nm of HfO_2 is deposited on Si(100) and 8 nm of ZrO_2 is deposited on top of HfO_2 , is ferromagnetic. The same sample deposited on a TiN substrate was subjected to a Sawyer-Tower measurement and exhibited a certain charge polarization.

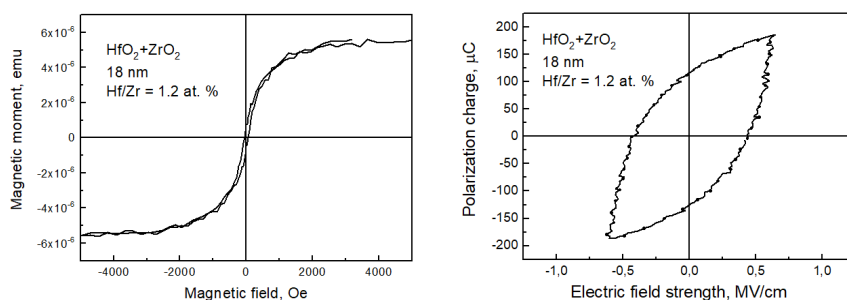


Fig.1 Magnetic moment in a $\text{HfO}_2\text{-ZrO}_2$ nanolaminate on Si(100) substrate with respect to external magnetic field, measured by vibrating sample magnetometer, on the left panel. Polarization charge – applied electric field curve for the same sample on TiN on the right panel.

[1] Leskelä, M., Niinistö, J., Ritala, M., Atomic Layer Deposition. In Comprehensive Materials Processing; Cameron, D., Ed.; Elsevier Ltd., 2014; Vol. 4, pp 101–123