Probing the oxygen vacancy related defect states in HfO$_2$ gate dielectric using DLTS$^1$ ARVIND KUMAR, SANDIP MONDAL, KSRK RAO, Indian Inst of Science — Large numbers of theoretical works are present to understand the oxygen vacancy related traps (V$_{O}$) in technologically relevant HfO$_2$. Most of these calculations are based on the atomistic models and typically ideal, hence, cannot provide the realistic device parameters. Here, we applied the Deep Level Transient Spectroscopy (DLTS); a sensitive tool; to study the deep level defects presents in high-k HfO$_2$. DLTS signal is originating from the segregated oxygen vacancy at the interface, tunneling/hopping between bulk and interface traps and communication of interface defects with respective bands. We observed four prominent deep levels; the estimated activation energies are Ec - 1.22, Ec - 1.36, Ec - 1.76 and Ec - 2.03 eV, below the HfO$_2$ conduction band. These trap states are related to V$_{O}$ in different charge states as suggested theoretically. We also measured the capture cross-sections ($\sigma$) of these states and found it is quite low ($\sim 10^{-18} - 10^{-21}$ cm$^2$), which indicate a negligible influence on the device performance. This study will be helpful to disclose the numerous fascinating facts witnessed in HfO$_2$.

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