HfO_2 and Lanthanide-doped HfO_2 MIM Capacitors for RF/Mixed IC Applications

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We demonstrate high quality HfO_2-metal-insulator-metal (MIM) capacitors with a high capacitance of 4.7 fF/cm^2 and a leakage current density of less than 10^{-8} A/cm^2, meeting ITRS requirement for analog capacitor applications. In addition, we demonstrate that doping HfO_2 with Lanthanide (Tb) at an optimum concentration improves both voltage linearity and leakage current density of HfO_2 MIM capacitor, allowing further reduction of insulator thickness and achieving a density of 13.3 $fF/\mu m^2$ with leakage current meeting requirements for RF bypass capacitor applications.