Strong Correlation between Dielectric Reliability and Charge Trapping in SiO_2 / Al_2O_3 Gate Stacks with TiN Electrodes

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Abstract

Polarity-dependent charge trapping and defect generation have been observed in SiO_2 / Al_2O_3 gate stacks with TiN electrodes. For the substrate injection case, electron trapping in the bulk of the Al_2O_3 films dominates, whereas hole trapping near the Si substrate is observed for gate injection. This asymmetry in defect creation causes an asymmetry in oxide reliability. For gate injection, reliability is limited by the thin SiO_2 interfacial layer, yielding low beta values, independent of the Al_2O_3 thickness. For substrate injection, reliability is limited by electron trap generation in the bulk of the Al_2O_3 film, yielding a strong thickness dependence of the beta values, as expected from the percolation model and as observed in SiO_2 layers of similar thickness.