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Role of Metal Nanocrystals on the Breakdown Statistics of Flash Memory High-κ Stacks

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ABSTRACT

We present a statistical perspective of the dielectric breakdown characteristics of flash memory devices constituting Au nanocrystallites (NCs) embedded in HfO_2 successfully by using a defect generation and clustering model. The significant clustering and apparent high breakdown voltage in the NC sample are well-explained with the present of non-uniform spatial electric field patterns in the vicinity of the NCs. Simulation results for NC-embedded high-κ dielectrics reveal some regions with suppressed and some with enhanced electric field in the dielectric film, with the field magnitude depending on the accumulated charge (Q_i) in the NC and the size of NC. From the breakdown tests, a positive correlation between the Weibull slope (β) and the ramp rate (*RR*) is observed, which is attributed to oxide thinning effect. In addition, temperature dependent current-voltage (*I-V*) characteristics clearly reveal that the change in E-field in the NC embedded stacks influences the voltage transition point for different conduction mechanisms to occur.

INDEX TERMS – Breakdown, Clustering model, Flash memory, High-κ dielectrics， Metal nanocrystal, Percolation.

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