Materials Science & Engineering Thesis Defense

Analyze of Total Ionizing Dose (TID) Effect in MOS/MNOS Capacitors

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Abstract

Metal-Oxide-Semiconductor (MOS) are essential to the modern VLSI devices. In the past decades, a wealth of literature has been created to understand the impact of the radiation induced charges on the devices, i.e., creation of electron-hole pairs in the oxide layer which is the most sensitive part of MOS structure to the radiation effect. In this work, both MOS and MNOS devices were fabricated at ASU NanoFab to study the total ionizing dose effect using capacitance-voltage (C-V) electrical characterization and electron holography observation.

C-V measurements revealed the C-V curves shifted to the left after irradiation (with positive bias applied) because of the net positive charges trapped at the oxide layer for the oxide only sample. On the other hand, for nitride/oxide samples with positive biased during irradiation, the C-V curve shifted to the right due to the net negative charges trapped at oxide layer. It was also observed that the C-V curve has less shift in voltage for MNOS than MOS device after irradiation.

To quantify the number of charges induced after irradiation, charge separation techniques were performed. These techniques allow for the extraction of oxide trap concentrations (NOT) across oxide layer. It was found that MNOS structure has less NOT build up after irradiation is likely due to the charge compensation at the oxide/nitride layer for the MNOS sample.

Off-axis electron holography was performed to observe the electrostatics potential and map the charge distribution across the MOSCAP samples. Compared with both pre- and post- irradiated samples, a larger potential drop at the Si/SiO2 was noticed in post-irradiation samples, which indicates the presence of greater amounts of positive charges that build up the Si/SiO¬2 interface after the TID exposure. TCAD modeling was used to extract the density of charges accumulated near the SiO2 / Si and SiO2 / Metal interface by matching the simulation results to the potential data from holography. The increase of near interface positive charges in post-irradiated samples is consistent with the C-V results and causes the flattening of the potential in the oxide observed with holography.

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Zoom Link: https://asu.zoom.us/j/85928638752?pwd=T1VNYVdOTzlCQXdXOU9tQzdsTVd5UT09