

Gamma and Ion radiation tolerance, charge trapping, and defect dynamics studies of ALD-grown a thin film of HfO₂ based MOSCAPs

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The radiation response, long-term performance, and reliability of HfO₂-based gate dielectric materials play a critical role in metal oxide semiconductor (MOS) technology for space device applications. Al/HfO₂/Si atomic layer-deposited devices were irradiated by gamma and swift heavy ions. One set of samples was irradiated with gamma dose varying from 25 to 100 krad. An increase in the leakage current and charge trapping has been observed. The density of oxide traps was found to increase with an increase in the gamma dose while the interface trap density has been found to decrease. Another set of samples was irradiated by 120 MeV Au ions by using a Pelletron accelerator, IUAC, New Delhi. Ion irradiated samples have been used to study the induced annealing/creation of defects and intermixing effects in HfO₂/Si-based devices. The formation of an interfacial layer of HfSiO at a fluence of at $5 \times 10^{13} \text{ cm}^{-2}$ is revealed by X-ray reflectivity analysis. The densities of interface- and oxide-trapped charges are found to decrease up to a critical fluence of $1 \times 10^{12} \text{ cm}^{-2}$ and then increase with further increase in fluence to $5 \times 10^{13} \text{ cm}^{-2}$. The presence of the interlayer, due to the swift heavy ion-induced intermixing, has been confirmed by X-ray photoelectron spectroscopy measurements. Various current conduction mechanisms in both substrate and gate injection cases were used to understand the basic mechanisms of direct, Fowler–Nordheim, and Poole–Frenkel tunneling, as well as Schottky emission in these devices. These studies elucidated the radiation tolerance and charge-trapping behavior of Al/HfO₂/Si nMOS capacitors. Ion beam annealing effects, irradiation induced damage and intermixing of constituent elements across the interface will be discussed in detail during the conference presentation.

Biography

Anand pathak is currently working as a professor of Physics University of Hyderabad and he has an experience of 35 years. He worked as Honorary Professor of Physics Since Oct 2017 onwards at University of Hyderabad and worked as NASI Sr Scientist for Platinum Jubilee Fellow Since first Feb 2020 onwards. He was a Guest Scientist at foreign Institutions. His aptitude on Condensed Matter Physics and he was a Member and Editorial Board in reputed Journals and also worked as chairman and Director for conferences. He completed his Ph.D in Indian Institute of Technology Kanpur in 1971. His research interests are Condensed Matter Physics, Atomic Collisions in Solids, Ion Solid Interactions, Ion Beam Studies of Nano-Materials.