National Institute of Technology Rourkela

Defence Seminar

Seminar Title	: Modulation of electrical properties of RF sputtered tantalum oxide based thin films for high-k dielectric applications
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Venue	: MC-217, Dept. of Physics and Astronomy
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Abstract	: Integrated circuit (IC) technology plays a vital role for the down-scaling of microelectronic components as the use of portable electronic devices is increasing in every sector. The incorporation of CMOS-compatible advanced materials and the development of fabrication technology has drawn considerable attention to meet the current demand of producing miniaturized microelectronic components like MOSFETs and resistive memory devices. Dielectric thin films are important building blocks of microelectronic devices, and therefore research on the development of high-k dielectric thin films has drawn research interest. Transition metal oxide films can be used as high-k gate dielectrics for both field effect transistors and resistive memory devices. However, the high dielectric constant, low oxide charge density, interface charge density, and leakage current are the basic requirements for a high-k dielectric film. In this research work, high-k dielectric Ta_2O_5 thin films were deposited on p-Si substrate by RF reactive sputtering. During the deposition, the sputtering parameters were varied to get an optimized deposition condition. Post-deposition, annealing, and rapid thermal annealing were carried out to annihilate any defects present in the film and to improve its structural and morphological properties. To further improve the electrical properties of the Ta_2O_5 thin film, Zr and Hf dopants of various concentrations are doped in the film using co-sputtering techniques. In addition, the dopant oxide like ZrO_2 and HfO_2 stack layer with Ta_2O_5 was fabricated with different thickness configurations to enhance the Ta_2O_5 film properties. The modulation of structural, morphological, and electrical properties of the undoped, doped, and stack-layered Ta_2O_5 thin film was studied using XRD, AFM, FESEM, XPS, capacitance-voltage, and current-voltage measurement techniques. The resistive switching behavior of the Ta_2O_5 thin film was investigated by fabricating a MIM structure and found to be improved in doped and stack-layer Ta_2O_5 films.