National Institute of Technology Rourkela

Synopsis 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-126, Dept. of Physics and Astronomy
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Abstract

: Integrated circuit (IC) technology plays a vital role in the downscaling of microelectronic components for portable electronic devices. The incorporation of CMOS-compatible advanced materials and the development of fabrication technology have drawn considerable attention to meet the current demand for producing miniaturized microelectronic components like MOSFETs and resistive memory devices. 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 (Q_{ox}), interface charge density (D_{it}), 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 by varying sputtering parameters. RF power of 150 W, sputtering pressure of 1.0×10^{-2} mbar, Ar:O_2 gas flow ratio of 3:2 and substrate temperature of 300 °C are found to be the optimized sputtering condition. Post-deposition conventional annealing and rapid thermal annealing were carried out to improve the electrical properties of sputtered film. Thereafter, Zr and Hf dopants of various concentrations are doped in the Ta_2O_5 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. A high dielectric constant of 28.5 with minimum $Q_{ox,}$ (3.0×10^{11} cm$^{\&minus2}$) and D_{it} (4.2×10^{11} eV^{-1}cm^{-2}) are found for the Hf doped Ta_2O_5 thin film. 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. An I_{SET}/I_{RESET} ratio of 873 is estimated for the HfO_2/Ta_2O_5 stack layer.