Abstract 6 – Paper ID: 115

Analog Resistive Switching in Nickel Ferrite Thin Film Fabricated via Sol-Gel Spin Coating Technique

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Abstract

Nickel ferrite ($NiFe_2O_4$) thin films were deposited on platinized silicon [$Pt/TiO_2/SiO_2/Si$] substrate to investigate their resistive switching characteristics for potential non-volatile memory applications. The $Pt/TiO_2/SiO_2/Si$ substrate was spin coated with 2 layers of $NiFe_2O_4$ and was annealed at 700°C for 1 hour for crystallization of the amorphous film. X-Ray Diffraction spectroscopy confirms that the film so obtained shows preferred orientation along (311) plane indexed using ICDD card no. 010-0325. Metal-Insulator-Metal (MIM) structure was developed by applying gold dots of 60 nm thick over the film by using thermal evaporation technique. The platinum will act as bottom electrode and the gold dots will act as top electrode. The resistive switching behaviour was measured by using Keysight B2901A SMU precision system. The film exhibits a well-defined analog resistive switching behaviour, characterized by reproducible SET and RESET processes under opposite voltage polarities from 0 V $\rightarrow$ +2 V $\rightarrow$ 0 V $\rightarrow$ −2 V $\rightarrow$ 0 V. Current-Voltage (I–V) measurements reveal a stable transition between high-resistance (HRS) and low-resistance (LRS) states with a good switching ratio and at a low operating voltage of 0.5 V. Endurance tests demonstrate consistent switching over multiple cycles and long-term stability of resistance states. Structural and interfacial analyses suggest that the switching mechanism is governed by the creation and rupture of oxygen-vacancy-mediated conductive filaments within the ferrite layer, influenced by the Schottky-like contact at the $Pt/NiFe_2O_4/Au$ interface. These results highlight the suitability of nickel ferrite thin films on platinized silicon as promising candidates for applications in resistive random-access memory (ReRAM) devices, magneto-resistive memristors, smart sensors, etc.

Keywords: Nickel ferrite, resistive switching, sol-gel, spin coating, thin films, oxygen vacancy

ISBN: 978-81-989164-2-6; DOI: 10.21467/abstracts.8.1