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Reversible transitions among four modes of nonpolar resistive switching characteristics in nano-crystalline zinc ferrite magnetic thin films

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Abstract

Nano-crystalline zinc ferrite ($ZnFe_2O_4$) magnetic thin film was prepared on $Pt/Ti/SiO_2/Si$ substrate by chemical solution deposition method though spin coating technique. Reproducible nonpolar resistive switching (RS) characteristics in $Pt/ZnFe_2O_4/Pt$ devices are reported. By changing the magnitude and polarity of the applied electric bias, reversible transitions among all the four nonpolar RS modes can be realized. For each switching mode, I-V characteristics were measured in the temperature range of 200 K to 340 K. Temperature dependent I-V characteristics of high resistance state (HRS) have been found to support the conduction mechanism across the metal/insulator/metal (MIM) systems to be Schottky emission. Associated parameters such as activation energy and effective height of Schottky barrier at zero biasing (ϕ_o) have been evaluated at different temperature and electric field. In addition, the increase in resistance of low resistance state (LRS) with temperature revealed that the conduction through $ZnFe_2O_4$ in LRS is metallic. Based on the temperature-dependent characteristics, the reversible switching among the four modes of nonpolar RS via formation and rupture of the conducting filaments has been attributed to the joint effect of field-induced migration of oxygen vacancies and metallic Zn atoms.