World Academy of Science, Engineering and Technology
International Journal of Electronics and Communication Engineering
Vol:12, No:11, 2018

Oxide Based Memristor and Its Potential Application in Analog-Digital Electronics

Authors : P. Michael Preetam Raj, Souri Banerjee, Souvik Kundu

Abstract : Oxide based memristors were fabricated in order to establish its potential applications in analog/digital electronics. $BaTiO_3$-$BiFeO_3$ (BT-BFO) was employed as an active material, whereas platinum (Pt) and Nb-doped $SrTiO_3$ (Nb:STO) were served as a top and bottom electrodes, respectively. Piezoelectric force microscopy (PFM) was utilized to present the ferroelectricity and repeatable polarization inversion in the BT-BFO, demonstrating its effectiveness for resistive switching. The fabricated memristors exhibited excellent electrical characteristics, such as hysteresis current-voltage (I-V), high on/off ratio, high retention time, cyclic endurance, and low operating voltages. The band-alignment between the active material BT-BFO and the substrate Nb:STO was experimentally investigated using X-Ray photoelectron spectroscopy, and it attributed to staggered heterojunction alignment. An energy band diagram was proposed in order to understand the electrical transport in BT-BFO/Nb:STO heterojunction. It was identified that the I-V curves of these memristors have several discontinuities. Curve fitting technique was utilized to analyse the I-V characteristic, and the obtained I-V equations were found to be parabolic. Utilizing this analysis, a non-linear BT-BFO memristors equivalent circuit model was developed. Interestingly, the obtained equivalent circuit of the BT-BFO memristors mimics the identical electrical performance, those obtained in the fabricated devices. Based on the developed equivalent circuit, a finite state machine (FSM) design was proposed. Efforts were devoted to fabricate the same FSM, and the results were well matched with those in the simulated FSM devices. Its multilevel noise filtering and immunity to external noise characteristics were also studied. Further, the feature of variable negative resistance was established by controlling the current through the memristor.

Keywords : band alignment, finite state machine, polarization inversion, resistive switching
Conference Title : ICN 2018 : International Conference on Nanoelectronics
Conference Location : Rome, Italy
Conference Dates : November 12-13, 2018