World Academy of Science, Engineering and Technology
International Journal of Electronics and Communication Engineering
Vol:11, No:03, 2017

A 1T1R Nonvolatile Memory with Al/TiO_2/Au and Sol-Gel Processed Barium Zirconate Nickelate Gate in Pentacene Thin Film Transistor

Authors : Ke-Jing Lee, Cheng-Jung Lee, Yu-Chi Chang, Li-Wen Wang, Yeong-Her Wang

Abstract : To avoid the cross-talk issue of only resistive random access memory (RRAM) cell, one transistor and one resistor (1T1R) architecture with a TiO_2-based RRAM cell connected with solution barium zirconate nickelate (BZN) organic thin film transistor (OTFT) device is successfully demonstrated. The OTFT were fabricated on a glass substrate. Aluminum (Al) as the gate electrode was deposited via a radio-frequency (RF) magnetron sputtering system. The barium acetate, zirconium n-propoxide, and nickel II acetylacetone were synthesized by using the sol-gel method. After the BZN solution was completely prepared using the sol-gel process, it was spin-coated onto the Al/glass substrate as the gate dielectric. The BZN layer was baked at 100 °C for 10 minutes under ambient air conditions. The pentacene thin film was thermally evaporated on the BZN layer at a deposition rate of 0.08 to 0.15 nm/s. Finally, gold (Au) electrode was deposited using an RF magnetron sputtering system and defined through shadow masks as both the source and drain. The channel length and width of the transistors were 150 and 1500 μm, respectively. As for the manufacture of 1T1R configuration, the RRAM device was fabricated directly on drain electrodes of TFT device. A simple metal/insulator/metal structure, which consisting of Al/TiO_2/Au structures, was fabricated. First, Au was deposited to be a bottom electrode of RRAM device by RF magnetron sputtering system. Then, the TiO_2 layer was deposited on Au electrode by sputtering. Finally, Al was deposited as the top electrode. The electrical performance of the BZN OTFT was studied, showing superior transfer characteristics with the low threshold voltage of −1.1 V, good saturation mobility of 5 cm^2/V s, and low subthreshold swing of 400 mV/decade. The integration of the BZN OTFT and TiO_2 RRAM devices was finally completed to form 1T1R configuration with low power consumption of 1.3 μW, the low operation current of 0.5 μA, and reliable data retention. Based on the I-V characteristics, the different polarities of bipolar switching are found to be determined by the compliance current with the different distribution of the internal oxygen vacancies used in the RRAM and 1T1R devices. Also, this phenomenon can be well explained by the proposed mechanism model. It is promising to make the 1T1R possible for practical applications of low-power active matrix flat-panel displays.

Keywords : one transistor and one resistor (1T1R), organic thin-film transistor (OTFT), resistive random access memory (RRAM), sol-gel
Conference Title : ICOE 2017 : International Conference on Organic Electronics
Conference Location : Singapore, Singapore
Conference Dates : March 29-30, 2017

Open Science Index, Electronics and Communication Engineering Vol:11, No:03, 2017 publications.waset.org/abstracts/65265.pdf