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A Survey on Spintronic Devices: Magnetic Tunnel Junctions

Joyanto Roy Choudhary*, Sumitesh Majumder and T K Maiti

Department of Electronics and Communication Engineering, Meghnad Saha Institute of Technology, India

***Corresponding Author:** Joyanto Roy Choudhary, Department of Electronics and Communication Engineering, Meghnad Saha Institute of Technology, India.

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Abstract

We have presented here magnetic tunnel junction (MTJ) model based universal NAND and NOR logic gates and studied the proposed universal gates by both experimental and simulation methods. Experimental results substantiates with both the simulated and theoretical results.

Introduction

Magnetic Tunnel Junction (MTJ) device is presently a very promising device because of its mesmerizing physics, their non-volatility, reconfigurable capability, fast-switching speed, small-dimension, CMOS compatibility, and also its different applications areas like spintronics logic devices and circuits, magnetic storage devices, magnetic sensors and communication etc. Recently, researchers have been established the MTJ based different logic gates [1-6] and in these developed logic gates, MTJs have used as main devices for logical computations and intrinsically enable logic-in-memory architectures with no need for extra hardware. In a logic mode the MTJs act as the basic elements for computations and in a memory mode they are used for non-volatile storage purposes. This enables for the expanding of non-volatile electronics from memory to logical computing applications without any sensing amplifiers and intermediate circuitry as compared to the hybrid CMOS based non-volatile logic circuits. MTJ is a spintronic device which gives a spin orientation in two opposite direction - one parallel and another anti-parallel (shown in Fig.1) i.e. MTJ behaves as a resistor with two resistance characteristics (high and low) depending on the direction of magnetization in the two ferromagnetic layers. Electrically this resembles with diode behavior with high current in the forward direction and low current in the reverse direction.

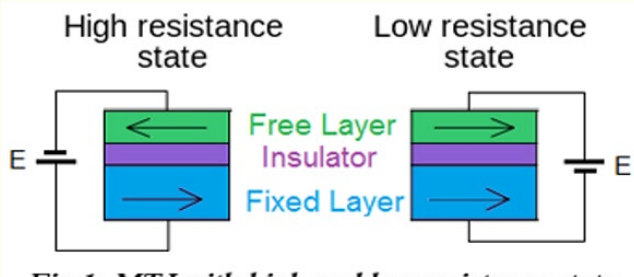

Fig.1: MTJ with high and low resistance state

Here we have exploited the above-mentioned properties to realize the universal NAND and NOR logic gates [7] with a simple behavioral model of MTJ device (shown in Fig. 2) which has been represented as two identical diodes with a low resistance (RP) during parallel magnetization and high resistance (RAP) during anti-parallel magnetization.

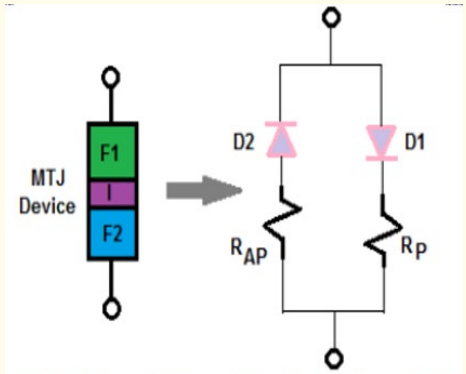

Fig.2: Magnetic Tunnel Junction device model

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