Centre for Nonlinear Dynamics
School of Physics
Bharathidasan University
Tiruchirappalli - 620 024

Abstract

Effect of Interlayer Coupling and Biasing on Spin Transfer Torque Switching in Ferromagnetic Nanopillars

by **D. Aravinthan**

Spin transfer torque induced magnetization switching has recently attracted much interest due to its potential applications in magnetic random access memory (MRAM), fast programmable logic, high-density magnetic storage devices, magnetic sensors and in high frequency devices for telecommunications. Magnetic storage devices and magnetic sensors based on Giant Magnetoresistance (GMR) and Tunnelling Magnetoresistance (TMR) effects require high quality multilayers constructed out of ultrathin ferromagnetic and non-magnetic films. The performance of these devices strongly depend on the morphological and structural properties of the films and their physical characteristics. Among them, the crucial factor is the interlayer coupling between the two ferromagnetic layers separated by a non-magnetic spacer. Various interlayer coupling mechanisms have been reported. Among them, pinhole coupling, orange peel coupling, biquadratic coupling and RKKY coupling are important ones. These interlayer couplings play an important role in the understanding of magnetization switching mechanism and GMR of spin valves and TMR of magnetic tunnel junction structures. We have done a systematic and in-depth study about the effect of interlayer coupling that arises due to the interface roughness namely orange peeling coupling and biquadratic coupling on spin transfer torque magnetization switching in trilayer and pentalayer nanopillar structures. Our study started with an investigation on the impact of orange peel coupling on the magnetization switching in the trilayer nanopillar structure. Then, we studied the effect of biquadratic coupling on magnetization switching in trilayer structure. Further, the study was extended to pentalayer nanopillar structure and we studied the effect of both orange peeling coupling and biquadratic coupling on spin transfer torque magnetization switching. In order to have a better understanding of the effect orange peel coupling, we also studied the influence of free layer thickness and spacer layer thickness on the switching time in the case of both trilayer and pentalayer structures. Likewise, to understand the effect of biquadratic coupling, we have investigated the influence of spacer layer thickness and roughness on the switching time in the case of trilayer and pentalayer nanopillar structures. Further, we have investigated the effect of biasing on spin transfer torque magnetization switching in the pentalayer structure, in order to reduce the switching time and critical current density required to initiate the magnetization switching.