Experimental Challenges in New Material Schemes for Magnetic Tunnel Junctions

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We have experimentally investigated a range of perpendicular magnetic anisotropy (PMA) material systems in an effort to reduce switching current densities and increase thermal stability for MgO-based magnetic tunnel junctions (MTJ's). These PMA schemes include Co-based multilayers, crystalline alloys (hcp, fcc, $L1_0$), and amorphous rare-earth transition-metal (RE-TM) alloys. The advantages and disadvantages of each approach will be discussed. Fabrication and transport properties of pMTJ's with varying degrees of PMA will be discussed. A new approach to increased thermal stability and reduced switching current densities is the inducing of partial perpendicular anisotropy (PPA) by capping the CoFeB free layer for in-plane MTJ's. The effect of capping layers on the PPA and damping of the CoFeB will be discussed as a function of capping materials, CoFeB thickness and composition, and annealing conditions, with exciting new results of high PPA and low damping reported for vanadium caps.