Perpendicular Magnetic Tunnel Junctions based on Thin CoFeB Free Layer and Co-based Multilayer SAF Pinned Layers

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We have previously reported on fully perpendicular Co/Pd multilayer (ML)- based CoFeB/MgO/CoFeB magnetic tunnel junctions (MTJ's)[1, 2]. However, Co/Pd ML-based MTJ's have rarely exhibited TMR ratios greater than about 10%. This has been attributed to the inability to pull a sufficiently thick CoFeB layer perpendicular on top of MgO, as well as the incomplete bcc templating of CoFeB from MgO owing to the adjacent fcc Co/Pd ML's[3]. Recent results[3-7] have generated great interest in MTJ's with pinned perpendicular synthetic antiferromagnets (SAF), of the form AP1/Ru/AP2 where AP1 and AP2 are Co -based multilayers. We report on fully perpendicular MTJ's with a thin CoFeB free layer and a Co/Pd(Pt) ML-based SAF pinned layer. For Co/Pd ML SAF's, strong antiferromagnetic coupling was seen at tRu of 1.1nm, with a coupling strength of 0.017 mJ/m2. For Co/Pt ML SAF's the optimum antiferromagnetic coupling was found at slightly higher Ru thickness of 1.3 nm, with a coupling strength of 0.013 mJ/m2. Improved MTJ properties are expected from using a thin Ta-seeded CoFeB bottom free layer, along with a thin, amorphous Ta layer used to transition from bcc CoFeB to fcc Co/Pd(Pt) for the top pinned layer[6]. These M-H loops show extremely good agreement with our micromagnetic simulations. Current-in-plane tunneling measurements indicated TMR values of nearly 40% for fully perpendicular stacks annealed at 200 ^{o}C for 2 hours.

References:

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