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Giant TMR effect and spin momentum transfer in MgO-based magnetic tunnel junctions[1]

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First-principle theories predicted an extremely high magnetoresistance (MR) ratio over 1000% in fully epitaxial Fe(001)/MgO(001)/Fe(001) MTJs [1]. This giant tunneling magnetoresistance (TMR) effect originates from a coherent spin-dependent tunneling of highly spin-polarized Δ_1 electronic states. We have fabricated fully epitaxial $Fe_{1-x}Co_x$(001)/MgO(001)/Fe(001) MTJs [2,3] and CoFeB/MgO(001)/CoFeB MTJs [4] and achieved giant MR ratios above 200% at room temperature. A low resistance-area (RA) product indispensable for magnetic sensor application has also been achieved in CoFeB/MgO(001)/CoFeB MTJs [5]. Because of the high spin polarization of tunneling electrons, the MgO-based MTJs have an advantage in spin transfer phenomena, too. Current-induced magnetization reversal due to spin transfer torque has been demonstrated using CoFeB/MgO(001)/CoFeB MTJs [6]. The MTJ was also found to act as a microwave detector [7]. When an ac current with a microwave frequency is applied to the MTJ, a dc offset voltage is generated. This phenomenon, named as spin-torque diode effect, originates from spin momentum transfer, ferromagnetic resonance and the giant TMR effect. The giant TMR effect and spin momentum transfer in MgO-based MTJs are the key for next-generation spintronic devices. References [1] W. H. Butler *et al.*, Phys. Rev. B **63**, 054416 (2001). [2] S. Yuasa *et al.*, Nature Mater. **3**, 868 (2004). [3] S. Yuasa *et al.*, Appl. Phys. Lett. **87**, 222508 (2005). [4] D. D. Djayaprawira *et al.*, Appl. Phys. Lett. **86**, 092502 (2005). [5] K. Tsunekawa et al., Appl. Phys. Lett. **87**, 072503 (2005). [6] H. Kubota *et al.*, Jpn. J. Appl. Phys. **44**, L1237 (2005). [7] A. A. Tulapurkar *et al.*, Nature **438**, 339 (2005).

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