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Electric field assisted switching in magnetic tunnel junctions[1]
WEIGANG WANG, MINGEN LI, STEPHEN HAGEMEN, C. L. CHIEN, Johns Hopkins University — It is of great interest to acquire large effects of electric field on magnetic properties, partly driven by the premise that voltage-controlled magnetization reversal would be far more energy efficient and be compatible with the ubiquitous voltage-controlled semiconductor devices. Normally the effect of electric field in metallic systems is negligible because the electric field can only penetrate into the materials by a few monolayers due to screening by the free electrons. Here we report the pronounced effects of electric field in magnetic tunnel junctions (MTJs) with very thin CoFeB electrodes, where the magnetic anisotropy originates solely from the CoFeB/MgO interfaces. The MTJs have the key structure of Co40Fe40B20(1.2-1.3nm)/MgO(1.2-2nm)/Co40Fe40B20(1.6nm) and the tunneling magnetoresistance in all junctions is in excess of 100%. Due to the redistribution of electrons among the different 3d orbitals of Fe and Co, the perpendicular magnetic anisotropy of the CoFeB electrodes can be significantly modified by an applied electric field. As a result, the coercivity, the magnetic configuration, and the tunneling magnetoresistance of the MTJs can be manipulated by voltage pulses, such that the high and low resistance states of the MTJ can be reversibly controlled by voltages less than 1.5 V in magnitude and with much smaller current densities.

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Weigang Wang
Johns Hopkins University

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