Nonlinear control of damping constant by electric field in ultrathin ferromagnetic films

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The performances of many spintronics devices are governed by the damping constant and magnetic anisotropies of constituent materials. The spin-orbit coupling (SOC) has been found to be the origin of these material parameters. Therefore, electric field control of latter parameter is in high demand for developing energy efficient nanoscale spintronics devices. Although, electric field control of interfacial magnetic anisotropies is well studied and understood, the damping constant, on the other hand, has conventionally been controlled by current induced spin-orbit torque. Here, we have taken an alternative approach to control damping constant by electric field. We have performed ferromagnetic resonance measurement by spin pumping and inverse spin Hall effect technique to investigate variation of damping constant with electric field in CoFeB/MgO heterostructures. Interestingly, we have found nonlinear variation of damping coinstant with electric field, especially, for ultrathin CoFeB films. With the help of theoretical argument we explicitly show that the presence of Rashba SOC at ferromagnet/insulator interface and the electric field dependence of Rashba coefficient may account for the observed nonlinear behavior. Furthermore, we show that the engineering of underlying and oxide materials properties, i.e., bulk SOC, Rashba SOC, to tune the spin angular momentum relaxation pathways could possibly increase the device functionality significantly.

References:

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