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Electric-field induced magnetization reversal using multiferroics

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Controlling magnetism using solely electric fields is interesting not only from a fundamental standpoint, but presents great potential for ultimately low energy consumption logic and memory. The evidence of the electrically controllable antiferromagnetic ordering in the multiferroic magnetoelectric bismuth ferrite (BiFeO3) drew an increasing interest in the pursuit for new emerging devices. To use such functionality for device applications, deterministic control not only of antiferromagnetism, but also ferromagnetism is essential. To achieve this goal, a ferromagnet/multiferroic heterostructure has been proposed based on the combination of magnetoelectric coupling in BiFeO3 and exchange coupling between magnetic materials and offers a new pathway for the electrical control of magnetism. By combination of a piezoresponse force microscopy, photoemission electron microscopy and anisotropic magnetoresistance measurements, we demonstrated the non-volatile reversal of a CoFe layer magnetization induced solely by the application of an electric field at room temperature. This 180 degree rotation of the magnetization of the ferromagnetic layer is mediated by a strong interfacial coupling. The correlation between the ferroelectric state in the multiferroic layer and the CoFe ferromagnetic domain architecture is evidenced. The projection of this strong magnetoelectric coupling in an out-of-plane configuration, allowing the reduction by an order of magnitude of voltage required, will be discussed. Our results show the high potential of magnetoelectric-based heterostructures for future low energy consumption data storage devices.