Magnetoresistance in a Tunnel Junction with an Antiferromagnet Electrode

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A spin valve is a microelectronic device in which high- and low-resistance states are realized by using both the charge and spin of carriers. Spin-valve structures used in modern hard-drive read heads and magnetic random access memories comprise two ferromagnetic electrodes whose relative magnetization orientations can be switched between parallel and antiparallel configurations, yielding the desired giant or tunneling magnetoresistance effect. Here, we demonstrate a large magnetoresistance effect in a tunnel junction with an AFM electrode of IrMn and a nonmagnetic counter electrode [1]. Antiferromagnets (AFM's) have been used in spintronics devices so far only to pin the magnetization direction of a ferromagnetic electrode through the exchange-bias effect. Spintronics devices whose transport is governed by AFM's have been theoretically proposed, but remain a great challenge for experimental realization. In our device, the tunneling resistance depends on the magnetization direction of the IrMn electrode, so-called tunneling anisotropic magnetoresistance (TAMR) effect, which is based on the spin-orbit coupling. This is quite different from the conventional spin-valves where the resistance depends on the relative magnetization directions of two ferromagnetic electrodes. The magnetization direction of the AFM IrMn layer was manipulated with a relatively small magnetic field of 50mT by the exchange spring effect of coupled soft NiFe. In addition, We employ this device to study the behavior of exchage coupling between an antiferromagnetic IrMn and a ferromagnetic NiFe. Experiments performed by common laboratory tools for magnetization and electrical transport measurements allow us to directly link the broadening of the NiFe hysteresis loop and its shift (exchange bias) to the rotation and pinning of antiferromagnetic moments in IrMn [2].

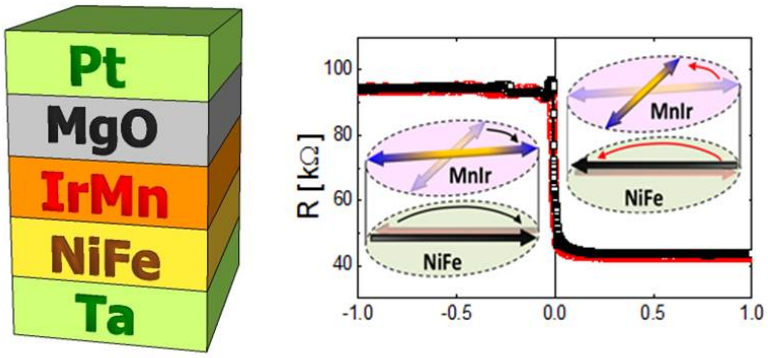

Fig1. Schematics of a tunnel junction with an antiferromagnetic IrMn electrode and its Magnetoresistance

Reference

[1] B. G. Park et al, Nature Materials 10, 347 (2011)
[2] X. Marti, B. G. Park, et al, Phys. Rev. Lett 108, 017201 (2012)