SC01

Inverse Magnetoresistance in the Simple Spin Valve System $Fe_{1-x}Cr_x$/Cu/Co

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Inverse giant magnetoresistance (GMR) can be observed in multilayers with alternating two ferromagnetic layers F1 and F2 possessing opposite spin scattering asymmetries [1-4]. In this work, the dependence of inverse GMR on Cr doping concentration of FeCr alloy in simple spin valves, FeCr/Cu/Co, was systematically investigated.

In our study, 4 series of samples, two for different FeCr layer thicknesses, $Fe_{0.65}Cr_{0.35}$(t)/Cu4/Co12 and Co12/Cu4/$Fe_{0.65}Cr_{0.35}$(t), and another two for different Cr concentrations, $Fe_{1-x}Cr_x$9/Cu4/Co12 and Co12/Cu4/$Fe_{1-x}Cr_x$, were prepared. Fe9/Cu4/Co12, which has a normal GMR, serves as a reference sample. The layer thicknesses in all samples are given in nm.

Cr impurities present in Fe alters the spin dependent scattering in the Fe layer, leading to an inversion of the bulk spin scattering asymmetry coefficient β, i.e. $\beta_{FeCr} < 0$ while $\beta_{Fe} > 0$. The inverse CIP-GMR observed in the trilayer spin valves FeCr/Cu/Co varies with the concentrations of Cr and FeCr thickness. The highest magnitude of IGMR, 0.45 %, can be found in the sample with 35 at. % of Cr.

The detailed inverse GMR dependence on the Cr concentration and the FeCr layer thickness reveals a competition between interface scattering which gives a normal GMR [4] and the bulk scattering which is responsible for the observed inverse GMR.

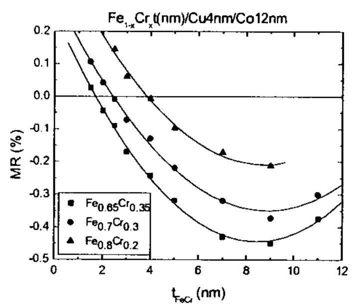

Fig. 1. Variation of the magnetoresistance in $Fe_{1-x}Cr_x$t nm/Cu4 nm/Co12 nm spin valves as function of the thickness t of the FeCr layer, for three different concentrations (x) of Cr.

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SC02

Spin Filtering in a Two-Dimensional Electron Gas Under Local Fringe Field

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Generation of a spin polarized current in a semiconductor by spin injection from a ferromagnetic metal has met serious obstacles and will probably need tremendous efforts to overcome. For an efficient spin injection, the interface between ferromagnetic metal and semiconductor seems play a crucial role. However, treatment of the interface requires technological challenges. To avoid such difficulties, we consider an alternative route to obtain a spin polarized current. We employ Zeeman splittingin a semiconductor with high g-factor. The fringe field of the ferromagnet leads to a perpendicular nonhomogeneous magnetic field in a two-dimensional electron gas. Electrons passing through a region of thefringe field become spin-polarized. The spin polarized current obtained by such way can be also filtered by a magnetic barrier generated by another fringe field [1].

In this experiment, the spin filtering device consists of a 3-μm-wide electron gas channel made of InAs heterostructures and two ferromagnetic films (See Fig. 1). The ferromagnetic film and the electron gas channel were separated by undoped InAs layer so that the role of the ferromagnetic films was only to provide a local fringe field. By applyingan external magnetic field along the channel we aligned the magnetization of the ferromagnetic films to desired directions. When magnetizations of two ferromagnetic films are parallel (antiparallel), spin polarized current meets positive (negative) magnetic barrier [2], leading to a low (high) electrical conductance. Figure 2 shows resistance of the device as a function of magnetic field at T= 4.5 K. Around ±200 Oe magnetizations of two ferromagnetic films become antiparallel, and hence a low resistance occurs. The spin filtering effect diminishes as thermal energy suppresses Zeeman splitting.

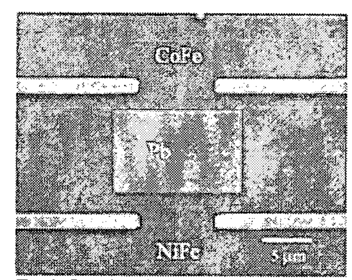

Fig. 1. Scanning electron micrograph of a spin filtering device.

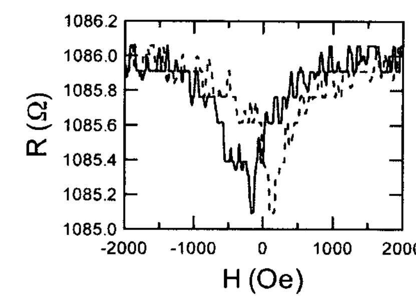

Fig. 2. Spin filtering effect at T= 4.5 K.

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