TD07

Interlayer coupling in Co_2MnSi – based epitaxial layered structures

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To enhance magnetoresistance and spin injection efficiency, using high spin polarization materials instead of transition ferromagnetic elements in spintronic nanostructuresis one of promising subjects in recent years. A very recent report shows a largely enhanced tunneling magnetoresistance (TMR) ratio (570% at 4.2K) by using full-Heuslar type ferromagnets Co_2MnSi as electrodes [1]. Our previous work shows that the large spin polarization leads to an enhancement of the resistance change-area product in current-perpendicular-to-plane giant magnetoresistance for $Co_2MnSi/Cr/Co_2MnSi$ trilayers [2]. However, that work focusesonly on the transport properties. The properties of interlayer exchange coupling between Co_2MnSi across Cr spacer remains unknown. In this study, the magnetic properties of epitaxial full-Heuslar Co_2MnSi alloy with different Cr spacer thickness have been investigated systematically.

Co_2MnSi (20 nm)/Cr (x nm)/Co_2MnSi (7 nm) trilayers with x= 0.3 - 7.2 nm weregrown on a Cr (5 nm)/Au (30 nm)/Cr (10 nm) buffer layer on a MgO (001) substrate by an ultra-high vacuum sputtering method. The buffer layers were annealed at 3000°C for 1 hour to achieve high crystalline quality and flatness. The bottom 20 nm-thick Co_2MnSi layer was deposited at RT and subsequently annealed at 3000°C for 1 hour. The spacer Cr and the top 7 nm-thick Co_2MnSi were deposited at RT to avoid the interdiffusion between Co_2MnSi and Cr layers.

The values of saturationmagnetization for top and bottom Co2MnSi are larger than 800 emu/cc, which is comparable to the bulk value 1050 emu/cc, showing an evidence for the high quality Co2MnSi layer. The element (Cr) filtered images exhibit smooth interfaces with $L2_1$ or B2 structure. Non-ferromagnetic type hystersis loops have been clearly observed in samples with x in the range of 0.6 - 3.0 nm and 3.6 - 6.6 nm. However, the non-ferromagnetic type coupling disappears for the samples with x around 3.3 nm or larger than 6.9 nm. The shape of hysteresis loops shows oscillatorybehavior versus x. The numerical calculation confirms that a 90° coupling plays a dominant role in this series samples. $|J_2|$ shows oscillatory behavior versus x while the contribution of bilinear coupling J_1 remains zero. The strength of J_2 decreases rapidly which is different with the conventional theoretical predictions. These observations are noticeably different from the coupling behavior observed in Fe/Cr/Fe systems in this interlayer thickness range. The results for other spacers (Au, V, Ru, etc.) will also be shown and compared to those for Cr in the presentation.

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TD08

Inhomogeneous spin accumulation in Py/Au/Py spin valve

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Effective spin injection to nonmagnetic material gives rise to spin accumulation at anti-parallel magnetic configuration of two FM electrodes, which can be detected in the non local measurement. If injection (detection) occurs homogeneously across the entire width of the sample and the sample film is very thin, then the baseline resistance in the nonlocal measurement is zero. Indeed, all of the fabricated spin valve devices ever reported have shown non-zero base resistance. [1~3] In addition, injected spin current usually produce inhomogeneous spin accumulation which appears to a different magnitude of voltage drop depending on the position of voltage probes on the detector.[2] It is meaningful to investigate the relation between the magnitude of potential drop represented by $\triangle R$ and different voltage probe configuration in nonlocal measurement.

In the study, we performed nonlocal measurement with different voltage and current probe configurations on the lateral Py/Au/Py spin valve devices in order to address the cause of non zero base resistance as well as a large difference of non local signal depending on the location of injecting or detecting probes.

Since there is no net current between electrodes in the non local spin valve (NLSV), the voltage represented by resistance ($\triangle R$) is only sensitive to the chemical potential originating from spin accumulation in Au channel. We measured NLSV signals in two different probe configurations. Voltage probe between 4 and 5 is called "A" configuration and contacting 5 and 6 is "B" configuration when the current flows from 1 to 2. in Fig. 1. We have done the same measurement over 10 samples with different Au channel gap and width in total and obtained the consistent result that "B" configuration is always lower than "A" in the magnitude of $\triangle R$ depending on the channel length as well as gap between injector and detector. We believe this is mainly attributed to both factors: first, the point contact forms between the injector and Au channel producing inhomogeneous spin injection, and second, effective spin travel length starting from the point contact affects observed $\triangle R$ in two measurement configurations of "A" and B". In conclusion, inhomogeneous spin accumulation initiating from the point contact induces the different distribution of spin accumulation flowing into a detector.

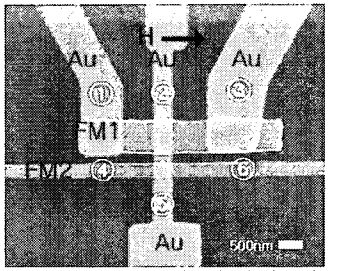

Fig. 1. SEM image of the lateral Py/Au/Py spin valve device

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