DA03

Spin Transport Across the Ferromagnetic Metal/Semiconductor Interface

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Spin-polarised current transport across ferromagnetic (FM) metal/semiconductor (SC) structures is a key ingredient for the realisation of spintronic devices. Our group has extensively studied such processes by utilising optical spin orientation in GaAs to create a population of spin polarised electrons which subsequently undergo 'spin filtering' at the FM/SC interface, i.e., their transmission probabilities depend on their spin orientation relative to the magnetisation in the FM layer [1, 2]. We present here an overview of our work to date and show how photoexcitation can be used as a powerful tool for a variety of studies of the critical parameters that control spin transport across these interfaces. Studies on heterostructures with different FM materials and tunnel barriers (Schottky, AlGaAs and AlOx) have revealed that electron tunnelling is the dominant spin dependent transport process across the interface [1, 3]. Co/GaAs was seen to have a high sensitivity on the interface preparation procedure with measurable spin transport only present in samples grown on well-prepared substrates [4]. In order to probe in more detail the effect of various interface parameters on spin transport, we designed an *in-situ* version of our technique. *In-situ* temperature dependent measurements on Fe/n-GaAs structures showed that the dominant spin transport contribution is due to hot photoexcited electrons tunnelling at the interface. A detailed study of Fe/AlOx barrier/GaAs samples with varying AlOx layer thickness revealed a spin filtering efficiency increasing with barrier width. Our combined measurements emphasize the critical importance of both the FM/SC interface and the tunnel barrier for achieving efficient spin transport.

Recently, in a new approach, the photoexcitation experiment was used to investigate the effect of the polarised electron population on ferromagnetic resonance (FMR). Light-induced exchange coupling and spin accumulation excited in GaAs was observed by FMR in Fe/GaAs Schottky contacts. The FMR spectra offer a way of quantifying the efficiency of spin transport across these interfaces.

This work is supported by EPSRC. T.T. would like to thank JSPS for a Postodoctoral Fellowship.

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DA04

Development of Silicon-Based Spintronic Materials and Devices

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To utilize spintronic materials in silicon technologies, we are now focusing our efforts on the following three research issues. We will show the recent achievements in the conference.

(1) Synthesis of a silicon carbide (SiC)-based ferromagnet: A good possibility that the material shows the ferromagnetic behavior was theoretically predicted in a previous report. For the 4H-SiC host, we obtained the result that the majority of Mn atoms were incorporated into the interstitial site in the host lattice and no ferromagnetic behavior was detected [1]. When employing the 3C poly-type, on the other hand, the possibility that a Si atom in the 3C-SiC lattice was substituted with Mn atom was experimentally confirmed.

(2) Fabrication of $Fe_3Si/CaF_2/ Fe_3Si$ heterostructures: We succeeded in the optimization of the growth condition to obtain a very flat Fe_3Si surface by employing the low temperature MBE growth followed by the post-anneal process at 250 ^oC, although the roughness of the Fe_3Si surface was not able to be suppressed before this research project was started. This result enabled us to fabricate the magnetic tunnel junction (MTJ) having an epitaxial heterostructure of $Fe_3Si/CaF_2/Fe_3Si$ on Si [2].

(3) Nonvolatile change of Schottky barrier between Pt and TiO_x: TiO_x is one of the promising spintronic materials and a candidate of high-k dielectric in silicon technologies. The initial current-voltage characteristics of the Pt/TiO_x junction show rectifying behavior originated from the Schottky junction formed between TiOx and the Pt electrode [3]. This Schottky-junction behavior can be switched to Ohmic one by applying the voltage pulse across the interface, and the switching effect is non-volatile.

The works of (1) and (2) were supported partly by a Grant-in-Aid for Scientific Research in Priority Area, Creation and Control of Spin Current, MEXT, Japan.

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