16p-P4-7

Spin injection with FM/InAs direct contact and InP Shottky barrier

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Abstract

We investigate spin injection from FM into SC in dependence of Schottky and an MgO tunnel barrier thickness. MgO tunnelling barrier has been considered to have suitable characteristics for high efficient spin injection due to the lack of a direct interfacial connection between FM and SCs. In this case conductivity mismatch can be overcome [1]. Band structure calculations in FM/MgO/SC predict, that the injected spin polarization can even exceed the FM´s internal Spin polarization under the condition of a certain barrier thickness [2]. Beyond this barrier thickness spin injection will exponentially decrease due to the electrical insulating characteristic of MgO. We now focus on the behaviour with zero barrier thickness, the direct contact between FM and InAs. It has been predicted by Schmidt at al., that spin injection efficiency in this regime is almost zero, due to the conductivity mismatch of FM and SC. On the other Hand first principle calculations, which have been carried out for a direct contact between Fe/InAs, predict a spin injection efficiency of up to 99% [3]. For spin injection measurement we use inverted HEMT´s on InP (001) substrate with an InGaAs/InAs quantum well and an additional InP layer above, to enhance the etching process by selective H_3PO_4 etching and Ar^+ milling. The mobility and carrier density have been determined to 120000 [cm^2/Vs] and 2×10^{12} [cm^{-2}] respectively. Spin valve measurements were carried out on three kinds of samples to determine the spin injection efficiency, NiFe/InP(3nm)/InGaAs(7.5nm)/InAs Shottky contact and with NiFe/MgO(2nm)/InAs tunnelling barrier. The contact resistance of our NiFe/InP/InGaAs/InAs interface has been determined to 5×10^{-6} [Ωcm^2] with linear I-V characteristics. In this case we were not able to detect clear MR ratio. In comparison to this we were able to measure a spin signal through the NiFe/MgO/InAs tunnel contact, with a contact resistance of 7×10^{-6} [Ωcm^2],as reported before. We here assume, that Spin injection using InP Shottky barrier is not possible. In this conference we will discuss the barrier roll for spin injection including FM/InAs direct contact sample.

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[2] W.H. Butler, Phys.Rev.B,63,054416 (2001)
[3] M.Zwierzycki,Phys.Rev.B,67,092401(2003)