

InAs 이차원 전자계로의 스핀주입

(Electrical spin injection and accumulation in InAs based two dimensional electron gas)

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To realize a spin based field effect transistor (FET), researchers have focused on electrical injection and detection of spin polarized carriers in two dimensional electron gas (2DEG). While electrical spin injection to metal films has been already observed[1-3], the electrical spin injection and detection in semiconductors have been hindered by conductance mismatch at the interface between the ferromagnetic film and the semiconductor. We have overcome the difficulties of spin injection by developing a well-controlled interface treatment, and have found the evidence of spin injection and accumulation in InAs based 2DEG. The injection of spin-polarized electrons has induced interesting effects associated with spin accumulation. We have studied the electrical injection and detection of spin transport in a lateral permalloy(Py)/InAs 2DEG/permalloy(Py) spin valve device with transparent interfaces. Ferromagnetic metal electrodes with different aspect ratio ($3\ \mu\text{m} \times 25\ \mu\text{m}$, $0.5\ \mu\text{m} \times 40\ \mu\text{m}$) being separated by 500 nm were fabricated on $3\ \mu\text{m}$ or $5\ \mu\text{m}$ wide InAs channel. Our multi-terminal geometry allows us to experimentally study non-local spin valve effect as well as local spin valve effect. In the non-local spin valve measurement we are able to completely isolate the spin valve signal from other spurious effects and observe clear spin accumulation signals. Based on the spin accumulation signal depending on the channel length, we have evaluated the spin relaxation length in InAs.

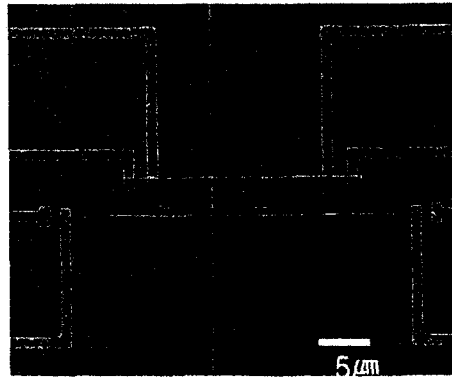


Fig. 1. Scanning electron micrograph of a spin injection device.

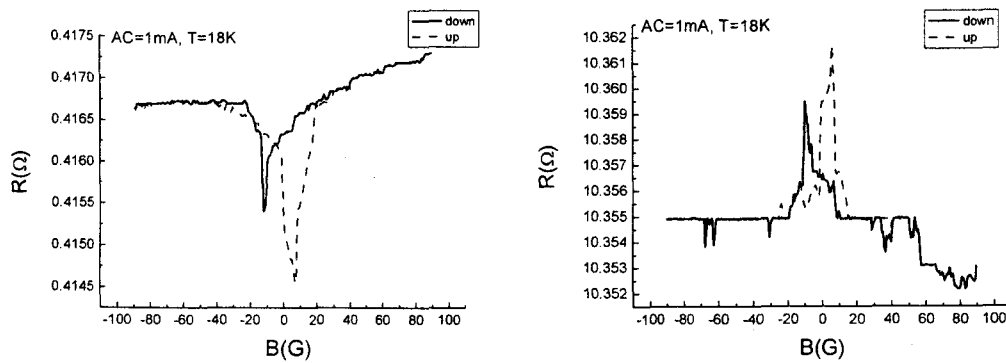


Fig. 2. The spin valve effect at $T=18\text{K}$ in the non-local geometry (left) and the local geometry (right) for Py/InAs 2DEG/Py spin valve device.

References

- [1] F. J. Jedema, M. S. Nijboer, A. T. Filip, and B. J. van Wees, Phys. Rev. B 67, 085319 (2003)
- [2] F. J. Jedema, A. T. Filip, and B. J. van Wees, Nature 410, 345(2001)
- [3] M. Johnson, Phys. Rev. Lett. 70, 2142 (1993)