DA01

Spintronics with Electrons Trapped in Acoustic Waves

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The capture of single electrons in the minima of surface acoustic waves was first demonstrated over twelve years ago [1]. The experimental devices consisted of a single split-gate structure patterned on the surface of a GaAs-AlGaAs heterostructure. The experiments measured the acoustoelectric current passing through the constriction produced under these gates as a function of the potential applied to them. The quantized current observed indicated that on average each minimum contained a single electron. In the intervening years, experiments and devices have become considerably more complex, achieving coherent single-electron control and manipulation. The most recent experiments have shown the capture and manipulation of single electrons with acoustic-wave pulses [2,3,4], studied the tunneling of single electrons from dynamic quantum dots [5,6] and made the first observations of coherent charge oscillations of a single electron [7]. This talk will review these experiments and give a detailed view of the future of this field and how through the use of such technologies as 'race-track' memory, the spin torque effect and other spintronics technologies and effects it will lead to a scalable and practical basic technology for the fabrication of a variety spintronic quantum technologies [8,9,10].

REFERENCES

[1] Shilton JM, et al. JOURNAL OF PHYSICS-CONDENSED MATTER **8** L531 (1996).
[2] Kataoka M, et al. JOURNAL OF APPLIED PHYSICS **100** 063710 (2006).
[3] Kataoka M, et al. PHYSICAL REVIEW LETTERS **98** 046801 (2007).
[4] Kataoka M, et al. PHYSICA E-LOW-DIMENSIONAL SYSTEMS & NANOSTRUCTURES **40** 1596 (2008).
[5] Astley MR, et al. PHYSICAL REVIEW LETTERS **99** 156802 (2007).
[6] Astley MR, et al. PHYSICA E-LOW-DIMENSIONAL SYSTEMS & NANOSTRUCTURES **40** 1136 (2008).
[7] Kataoka M, et al. PHYSICA E-LOW-DIMENSIONAL SYSTEMS & NANOSTRUCTURES **40** 1017 (2008).
[8] Barnes CHW, et al. PHYSICAL REVIEW B **62** 8410 (2000).
[9] Barnes CHW. PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY OF LONDON SERIES A-MATHEMATICAL PHYSICAL AND ENGINEERING SCIENCES **36**1 1487 (2003).
[10]Barnes CHW and Pepper M. Problems of Condensed Matter Physics: Quantum Coherence Phenomena in Electron-hole and Coupled Matter-light Systems (International Series of Monographs on Physics) (Hardcover) by Alexei L. Ivanov (Editor), Sergei G. Tikhodeev (Editor).

DA02

Observation of Spin Transport in an InAs-based Quantum well Layer at Room Temperature

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Spin transport at room temperature are the most crucial aspects for realizing a spin field-effect transistor (spin-FET). In a spin-FET, the spin-polarized current injected from a ferromagnetic electrode delivers through a semiconductor channel to reach the other ferromagnetic electrode. Controlling spin-orbit interaction is also essential part for the development of spin field effect transistor. In this study, InAs based two-dimensional electron gas (2DEG) layer was utilized for a spin channel. For achieving the higher spin injection efficiency, the interface resistance was controlled. Figure 1 shows the results of local and non-local spin valve results. From the local spin valve geometry, we found that the magnetoresistance of the local spin-valve measurement slowly reduces with increasing temperature, but $\Delta R/R$ remains near 1% at room temperature. For the non-local geometry, where the pure spin characteristic can be obtained, the clear signals are detected up to room temperature as shown in Fig.1. The electrically observed spin diffusion length and spin relaxation time at room temperature are 1.3 μm and 10 ps respectively [1]. Another issue is controlling spin-orbit interaction parameter by adjusting gate voltage. In order to determine the spin-orbit interaction parameter, we observed the Shubnikov-de Haas (SdH) oscillation. The results show that the spin-orbit interaction parameter decreases with increasing gate voltage but the gate voltage dependence indicates nonlinear relationship. When the minus gate voltage is applied, the slope of quantum well bottom becomes noticeably steeper. In the case of applying plus gate voltage, the slope of quantum well tends to flat but the change is very small. This non-linear behavior is due to the location of carrier supply layer. We found that for an efficient operation of spin-FET, selecting the proper gate voltage range is also very important.

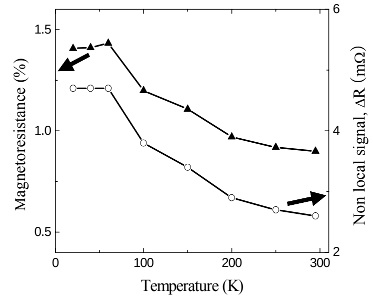

Fig. 1. Temperature dependence of spin valve signal.

This work was supported by the KIST Institutional Program.

REFERENCES

[1] H. C. Koo, H. Yi, J.-B. Ko, J. Chang, S.-H. Han, D. Jung, S.-G. Huh, J. Eom: Appl. Phys. Lett. 90, 022101 (2007).