Peculiar Rashba spins on semiconductor surfaces

Kazuyuki Sakamoto

Department of Nanomaterials Science, Chiba University, Chiba 263-8522, Japan

Rashba effect [1] is a novel exotic low-dimensional solid-state property that produces a spin-polarized two-dimensional electron gas from a combined effect of spin-orbit interaction and structural inversion asymmetry even for nonmagnetic materials, and it is the key factor for operating a spin field-effect transistor [2] that is one of the most prominent semiconductor spintronics devices. In an ordinary Rashba system, the Fermi surface shows isotropic vortical spin structures with spin polarization vectors lying in the surface plane, which lead to a high-probability of electron backscattering and thus lower the efficiency of the electron spin current. Here I present Rashba system with peculiar spin structures in which the Rashba spins would be scattered in particular directions only. By using direct and inverse spin- and angle-resolved photoelectron spectroscopies, we have measured the Rashba spin bands of an electron-doped Tl/Si(111)-(1x1) surface and a Tl/Si(110)-(1x1) surface. In the former system, spin-polarized electron valleys with peculiar Rashba spins pointing along the surface normal direction were observed at the K and K' points of the surface Brillouin zone. The opposite spin direction at these points indicates that the valleys [3] are polarized and thus the backscattering of electron spin with a non-magnetic impurity is considerably suppressed in this system. Regarding the latter system, we observed an extraordinary quasi-one dimensional Rashba splitting that would also improve the efficiency of the spin current originating from its peculiar spin structure. We will also discuss the origins of these peculiar spin structures based on the symmetries of the surfaces. Furthermore, since the present system is formed on silicon substrates, the present results would provide not only a scientific interest but also a significant step toward the readily realization of silicon spintronics devices with high-efficiency.

REFERENCES

1. Y. A. Bychkov and E. I. Rashba, JETP Lett. **39**, 78-81 (1984).
2. S. Datta and B. Das, Appl. Phys. Lett. **56**, 665-667 (1990).
3. S. Goswami, K. A. Slinker, M. Friesen, L. M. McGuire, J. L. Truitt, C. Tahan, L. J. Klein, J. O. Chu, P. M. Mooney, D. W. van der Weide, R. Joynt, S. N. Coppersmith and M. A. Eriksson, Nature Phys. **3**, 41-45 (2007).