Detection of spin precession angles in various crystalline directions and its application for complementary spin logic devices

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In a semiconductor channel spin-orbit interaction field is divided into two terms, Rashba and Dresselhaus fields. The Rashba field is induced by the structural inversion symmetry and is the Dresselhaus field results from bulk inversion asymmetry. These two effects are phenomenologically inseparable so extraction of individual field is not simple. The Rashba field is always perpendicular to the wavevector but the orientation of the Dresselhaus field depends on the crystal orientation of channel [1]. Thus, these two spin-orbit interaction parameters can be separately extracted by measuring the Shubnikov-de Haas oscillations for the various crystalline orientations. The spin field effect transistor (spin-FET), proposed by Datta and Das [2], the demonstration is one of the major concern in the field of spin transport devices because in can be utilized for switching and logic devices. Using InAs quantum well system, gate control of conductance oscillation was experimentally presented [3]. Due to the different alignment between Rashba and Dresselhaus fields (B_R and B_D), the spin precession behavior depends on the crystal direction in a spin-FET structure. For example, the total field can be expressed as $B_R + B_D$ for the [110] direction and as $B_R - B_D$ for the [1-10] direction. When the channel length is 1 μm, the precession angle is 550° for the [110] direction and 460° for the [1-10] direction, respectively. Using the two spin transistors with different crystal directions, which play roles of *n*- and *p*-type transistors in conventional charge transistors, we propose a complementary logic device.

References

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