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Presentation Title

Wire orientation dependence of electron spin relaxation in modulation-doped GaAs/AlGaAs wires

Abstract

An effective magnetic field arising from spin-orbit interaction (SOI) causes electron spin relaxation [1]. However, when the two types of SOI (Rashba SOI and Dresselhaus SOI) are equal in magnitude, the effective magnetic field is aligned along the same direction, leading to persistent spin helix (PSH) state. In this case, spin information can be propagated over a long distance [2,3]. In particular, the effective field is cancelled in wires along the [110] direction ($\alpha = \beta$), where α and β are the Rashba and Dresselhaus parameters, and thus electron spin relaxation is suppressed [4]. In this work, we investigated the wire dependence of electron spins ensemble dynamics in wire fabricated a modulation-doped GaAs/AlGaAs quantum well using time resolved Kerr rotation technique. measurement.

The sample we studied here was a 20-nm thick GaAs QW capped by a 35 nm thick AlGaAs, a 20 nm thick n-AlGaAs, and a 5 nm thick GaAs. We fabricated arrays of 1 μm-wide quasi-1D wires using electron beam lithography and wet etching. And we measured electron spin dynamics in each wire by TRKR technique. In the result, it was observed that the spin dephasing time in [110] oriented wires is above 1 ns, and that is much longer than that in [-110] oriented wires at magnetic field 1 T and temperature 5 K. This strong anisotropy of spin dephasing time suggests that the effective field of SOI along [110] orientation is cancelled. And therefore Rashba and Dresselhaus SOI are close in magnitude.

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