Dresselhaus Spin-Orbit Coefficient Evaluated from Weak Antilocalization in a Gated InSb/AlInSb Quantum Well

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InSb, a narrow-gap III-V semiconductor has garnered significant attention in the fields of electronics, optoelectronics, and spintronics, primarily due to its strong spin-orbit interaction. In addition, InSb nanowire/superconductor hybrid structures are being studied intensively as a potential platform for topological quantum computing, leveraging the spin-orbit interaction. Recently, InSb-based one-dimensional systems have attracted attention because of the finding of Majorana particles based on superconductor/InSb hybrid junctions. In each of these fields, precision control of spin-orbit interaction becomes essential. However, there is controversy regarding the strength of the Dresselhaus spin-orbit coefficient in the InSb between theoretical [1] and experimental [2] results. In this study, we evaluated the Dresselhaus spin-orbit coefficient in a gated InSb/AlInSb quantum well using quantum interference effects.

The InSb/AlInSb quantum well structure was fabricated by molecular beam epitaxy on a (001)-oriented GaAs substrate. Initially, we confirmed the carrier density modulation by applying the gate bias voltage through Shubnikov-de Haas measurements, where we observed the systematic change of oscillation periods with the gate voltage. Next, quantum interference effects were measured at $T = 20$ mK. Figure 1(a) shows the magnetic field (B) dependence of conductivity ($\Delta\sigma$) with different carrier densities. As shown in the figure, we observed clear signals of weak antilocalization around the zero magnetic field regions. We also conducted the simulation based on Sawada model [3] to evaluate the Dresselhaus spin-orbit coefficient in the InSb/AlInSb quantum well. Figure 1(b) shows the simulated results which reproduced the gate modulation of the WAL signal well. This confirms the validity of the Dresselhaus coefficients evaluated in this method.

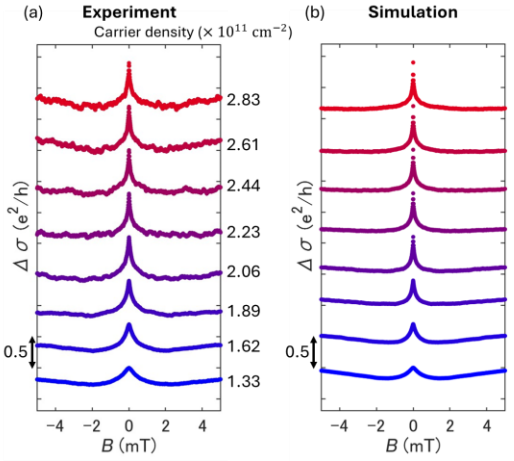

Fig.1 Comparison of experimental and simulated magneto-conductance in InSb/AlInSb quantum well.

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References

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