Magneto-transport properties in layered semiconductor GaSe thin films

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1. Introduction

Two-dimensional (2D) layered materials have attracted much attention since the discovery of graphene [1]. GaSe is one of the layered semiconductors which has a large direct bandgap about 2.0 eV [2], which is useful for a thin film photodetector [3]. However, transport properties of GaSe have not been investigated in detail. In this research, we measured magneto-conductance of GaSe thin films at low temperatures and analyzed the data in order to evaluate strength of spin-orbit interaction (SOI).

2. Experimental methods

We fabricated multi-layered GaSe thin films by micromechanical cleavage method and transcribed it on 300 nm SiO_2 / *n*-doped Si substrate. GaSe thickness was evaluated by atomic force microscope and Raman spectroscopy (RAMANtouch, Nanophoton). For the electrical transport measurements, we fabricated about 10-nm-thick GaSe film devices. The 100-nm-thick silver was deposited on GaSe films by resistance heating deposition method to form Ohmic contacts. Magneto-resistance and carrier density were measured by four-terminal resistance and Hall-effect measurements using lock-in amplifiers, respectively. To evaluate spin-orbit interaction, we employed Iordanskii, Lyanda-Geller and Pikus (ILP) theory [4].

3. Result and discussion

Results of magneto-conductance in GaSe thin films are shown in Fig. 1, which clearly shows weak anti-localization. Since these results are well fitted by ILP theory, it is suggested that the D'yakonov-Perel spin-relaxation mechanism is dominant in GaSe thin films. In addition, we obtained phase coherence length l_ψ, spin-orbit scattering length l_{SO} and Rashba SOI α of GaSe. From the WAL analysis, l_ψ and l_{SO} of GaSe at 1.4K are about 142 nm and 15.2 nm, respectively. Also, Rashba SOI parameter α was determined to be about 5.0×10^{-12} eVm. This SOI parameter is almost the same as InGaAs quantum wells and relatively high from considering the large bandgap of GaSe.

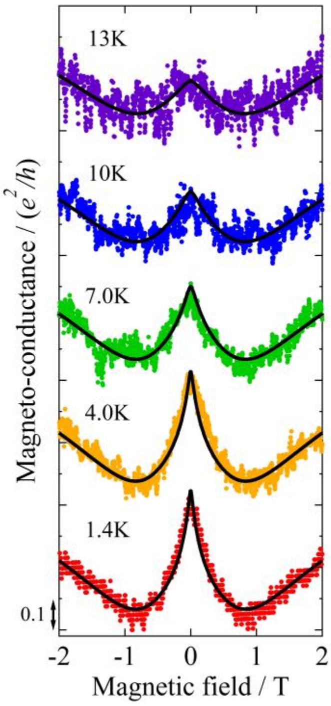

Fig.1 Magneto-conductance in GaSe with ILP fitting (black solid lines)

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