Simulation of Anisotropic Magnetoresistance Effect at Finite Temperature in GaAs/GaMnAs Superlattice Structure

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Ferromagnetic semiconductor GaMnAs which is a group III-V semiconductor doped with a magnetic element of Mn is an important research subject in the spintronics field because of its ferromagnetism. However, its ferromagnetic transition mechanism and electronic state are still under discussion. In a superlattice (SL) structures [1] consisting of GaMnAs and GaAs layers, an experimental result has been reported: the anisotropy of electric conduction varies depending on the film thickness of the GaMnAs layer in the SL, however its origin is unclear. In order to elucidate them, simulation of anisotropic magnetoresistance (AMR) which is based on electric state calculation by k・p perturbation method and semi-classical Boltzmann transport theory has been explored. Comparing with experimental results and simulation, they discussed the validity of the model [2]. In the present research, we extended the previous study [1] and performed the simulation of the AMR at finite temperature. In the 14 ML-GaAs / *d* ML-$Ga_{0.95}Mn_{0.05}As$ SLs, we calculated the film thickness *d* dependence and temperature dependence of the AMR (Fig. 1). Here, the energy dependence of the relaxation time is ignored and the scattering is assumed to be isotropic. Although the AMR obtained by present simulation seems to fluctuate depending on *d*, consistency of present calculations and the experimental results are not good enough. In the presentation, we will also talk about the simulations taking account of energy dependent relaxation and impurity band.

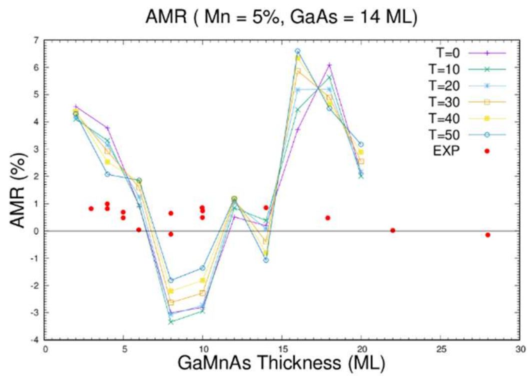

Fig. 1. The calculated film thickness *d* dependence and temperature dependence of the AMR in 14ML-GaAs / *d* ML-$Ga_{0.95}Mn_{0.05}As$ SLs. The experimental data [2] (EXP) is measured at 5 K.

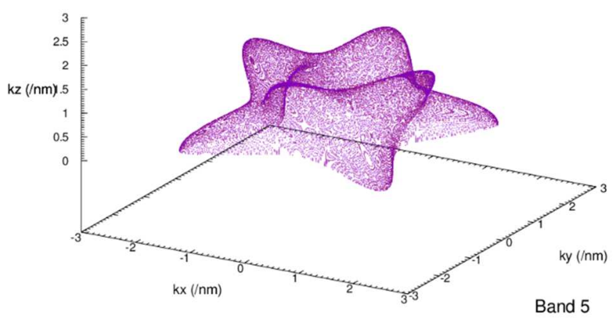

Fig. 2. The Fermi surface of the $Ga_{0.95}Mn_{0.05}As$-Bulk. Strong anisotropy is seen in ⟨110⟩ or ⟨101⟩ directions. When using a theory which assumes a spherical Fermi surface, several modification may be necessary.

Reference

[1] D. Nozaki et al., Tokyo Tech, Dept. Phys. Master Thesis (2013)

[2] D. Nozaki et al., JPS Conf. Proc. 2. 010302 (2014)