Field-Angular Dependence of Interlayer Off-Diagonal Magneto-Resistance in Quasi Two-Dimensional Layered Conductors

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In low-dimensional layered conductors, such as high temperature superconductors and organic conductors, a mechanism of an interlayer conduction under a magnetic field has been a central issue of investigations since the so-called angular magneto-resistance effects were discovered. Here, the angular magneto-resistance effects are oscillatory patterns and peak or dip structures in the interlayer resistance R_{zz} appearing when a direction of a magnetic field with a fixed strength is rotated. Many studies have elucidated behaviors of R_{zz} under the field, and now these angular effects are almost perfectly understood as phenomena reflecting Fermi surface topological structures by the Boltzmann theory. Methods to obtain information on Fermi surface by measuring the angular effects are established. Especially, the angular dependent magneto-resistance oscillation (AMRO) in quasi two-dimensional layered conductors is the important angular effect because AMRO enables a direct mapping of in-plane Fermi surface.

On the other hand, other interlayer components of the magneto-resistance tensor, such as R_{xz} and R_{yz}, are not clarified yet. These interlayer off-diagonal parts arise from a slight tilt of the interlayer current when the field is rotated. They are expected to be very small, and usually disregarded in analyzing the interlayer conduction. In this study, we focused on a field-angular dependence of such interlayer off-diagonal components of the magneto-resistance tensor in layered conductors. We prepared a single crystal of a quasi two-dimensional organic conductor α-(BEDT-TTF)$_2$NH$_4$Hg(SCN)$_4$. Applying a current parallel to the interlayer *z*-direction and rotating the field from the *z*-direction to the intra-layer *x*-direction, we measured an interlayer off-diagonal magneto-resistance R_{xz} of the sample as a function of the field angle. For comparison, we also measured R_{zz} which showed AMRO. A signal of R_{xz} was much smaller than that of R_{zz} by two orders of magnitude and had a different symmetry from R_{zz} for the rotation of the field, but showed angular dependent oscillations under high fields whose oscillatory period corresponded with AMRO. To explain these results, we numerically calculated R_{xz} by solving the Boltzmann equation and compared it with experimental data. The numerical calculation reproduced experimental results fairly well, and the oscillation in R_{xz} was found to be essentially same with AMRO. This is the first study which clarifies experimental features of the interlayer off-diagonal magneto-resistance in layered conductors. We will also discuss experimental results of another component, the interlayer Hall resistance R_{yz}.