熱ホール効果のイメージング計測

Imaging of thermal Hall effect

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The thermal Hall effect (THE), or the Righi-Leduc effect, refers to the generation of a transverse temperature gradient along the cross product of an applied heat current and a magnetic field. The temperature gradient induced by the THE changes its polarization depending on that of the applied heat current, and the direction and magnitude can be controlled by those of the filed, enabling nonreciprocal heat manipulation. The driving force for bending the heat current is due to electromagnetic and quantum-mechanical forces acting on electrons, phonons, and magnetic excitations, carrying energy in solids. Many researches on the THE are performed in a variety of materials, including metals, insulators, and quantum systems for studying physical properties and finding materials with better efficiency [1-3].

Here, we report a new measurement method for the THE based on the lock-in thermography (LIT) technique, which realizes the spatial imaging of the THE by directly extracting the magnetic-field-dependent temperature-modulation. In LIT measurements, the spatial distribution of infrared emission intensity syncing with an applied input is recorded, and the intensity is transformed into the temperature modulation signal [4,5]. For the THE measurements based on the LIT, we applied an oscillating magnetic field to a sample with a heat current, and measured the oscillating temperature modulation. When the field polarization is reversed, the THE-induced temperature modulation is reversed while the temperature distribution due to the applied heat current does not change. Therefore, the LIT only outputs the THE-induced signal, leading to the sensitive detection.

In this presentation, we will show experimental results as well as the detail of the measurement method on the THE measurements using a standard ferromagnetic metal. We anticipate that this method will promote the investigation of the THE.

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