

## **Infrared studies of semiconductors, semimetals, and magneto-resistive materials at high magnetic fields**

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Using the infrared (IR) beamline BL43IR of SPring-8, one can perform broad-band IR spectroscopy of materials at high magnetic fields up to 14 T, both in the mid- and far IR ranges. This may provide unique opportunities of research on various materials. In this talk, I will review and discuss several magneto-optical studies on semiconductors, semimetals and magneto-resistive materials shown below, and will consider possible future studies using the magneto-optical apparatus at BL43IR.

(1) Black phosphorus (BP) – BP has a layered crystal structure, and is a semiconductor with a band gap of 0.3 eV at ambient condition. Recently, mid-IR reflectance spectra of BP have been measured up to 12 T at BL43IR, and spectral features due to Landau level formation have been observed [1]. Effective mass and other information have been extracted from the data.

(2) Magneto-resistive materials – Magneto-IR spectroscopy has been performed on magneto-resistive materials such as (Pr, Ca)MnO<sub>3</sub> [2], Tl<sub>2</sub>Mn<sub>2</sub>O<sub>7</sub> [3], and EuB<sub>6</sub> [4]. The evolution of electronic structure with magnetic field was examined, and a scaling was found between the obtained effective carrier density and the magnetization in the sample.

(3) Bismuth – Many studies have been performed on elemental Bi using IR magneto-optics [5-8], to probe the interesting “Dirac electron” states caused by strong spin-orbit coupling. At early stages, monochromatic IR sources were used to observe quantum oscillations with field [5,6], but more recently, broad-band IR spectra have been measured at high magnetic fields [7,8].

(4) Magneto-plasma resonance – In semiconductors such as InSb, the carrier effective mass is so small that the cyclotron frequency may become comparable to the plasma frequency of the free carriers. The coupling between Drude and cyclotron motions (magneto-plasma) at high magnetic fields leads to remarkable spectral features in the IR range [9].

### **References**

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