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_3 [2], $Tl_2Mn_2O_7$ [3], and EuB_6 [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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Studies of the structure of magnetic vortices in superconductors and the interactions that bind atoms and molecules to solid surfaces are also underway. For example, the point-contact tunneling amplitude for the fractional quantum Hall effect was recently exactly computed. Personnel.Â The class of materials that are of interest to the Louca group includes topological insulators and semimetals, spintronic antiferromagnets of the I-Mn-V class, transition metal dichalcogenides, disorder superconductors, layered semiconductors etc.Â "Field-induced antiferromagnetism and competition in the metamagnetic state of terbium gallium garnet", K. Kamazawa, Despina Louca, R. Morinaga, T. J. Sato, Q. Huang, J. R. D. Copley, Y. Qiu, Phys. Rev. B 78, 064412 (2008). High Magnetic Fields and Magneto-Resistance. Science topic. High Magnetic Fields.Â We developed high sensitive anisotropic magneto resistive sensor and used it for eddy current testing (ECT). Due to the high magnetic field sensitivity of AMR sensor at low frequency, the ECT system can be used to detect deep defect. The excitation coil was 50 turns with the diameter of about 30mm.Â We report a comprehensive study of the electrical and magneto-transport properties of nanocrystals of La0.67Ca0.33MnO3 (LCMO) (with size down to 15 nm) and La0.5Sr0.5CoO3 (LSCO) (with size down to 35 nm) in the temperature range 0.3â€“5 K and magnetic fields up to 14 T. The transport, magneto-transport and nonlinear conduction (Iâ€“V curves) were analy... Semimetals are also. possible alternative plasmonics materials in the infrared range because their carrier concentration. is 100 times less than that of noble metals [19].Â Chapter 3: The study of the heavily doped semiconductor silicon as a host for infrared surface plasmons is presented here. Theory of Hessel and Oliner is presented here for calculation of SPR spectra and for later use in subsequent chapters.Â Such considerations motivate our investigation of highly doped semiconductors, semimetals, and doped conducting polymers. Figure 1: shows the electrical conductivities of the materials from insulators to metals [25]. 6.Â This high field energy confinement at the interface is one reason why SPPs are attractive. for various applications [27]. We study magneto-transport properties in single crystals of TaSb2, which is a recently discovered topological semimetal. In the presence of magnetic field, the electrical resistivity shows onset of insulating behaviour followed by plateau at low temperature. Such resistivity plateau is generally assigned to topological surface states. TaSb2 exhibits extremely high magneto-resistance (MR = 3.55Ã—104 % at 2 K and 6 T) with non-saturating Bn (n = 1.78) field dependence. We find that aspects of extremely large magneto resistance and resistivity plateau are well accounted by classical Kohlerâ€™s scali... Semimagnetic Semiconductors define a new class of materials, whose electronic energy band structure can be tuned via the external parameters of magnetic field and temperature. The basic physical mechanism involved is the exchange interaction between the quasi-free band electrons and the localized electrons of paramagnetic ions substituted into the host material.Â Experimental data of magneto transport, FIR-magneto spectroscopy, and magnetization in strong fields up to 150 Tesla are presented. Special attention is given to the possible combination of Semimagnetic Semiconductors and Q2D-systems in form of the â€œspin superlatticeâ€, the transition from the Q2D- to Q3D-quantum Hall effect, as well as the â€œscattering superlatticeâ€.