Laboratoire des Solides Irradiés, UMR 7642

Soutenance de thèse

Vendredi 12 décembre 2014

Amphi Becquerel - 14h00

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Irradiation-induced doping of Bismuth Telluride Bi_2Te_3

Bismuth Telluride Bi_2Te_3 has attracted enormous attention because of its thermoelectric and topological insulator properties.

In this PhD, the Fermi surface of as-grown and electron irradiated p-type Bi_2Te_3 single crystals is thoroughly investigated using electrical transport experiments. For moderate hole concentrations, it is confirmed that electrical transport can be explained by a six-valley model and the presence of Zeeman-splitting. The g-factor of p-type Bi_2Te_3 is determined from a detailed analysis of Shubnikov-de Haas (SdH) oscillations measured in very high magnetic fields of 55 T as g=12.1. At high doping levels, the hole concentrations determined from Hall and SdH effect differ significantly, which is attributed to the filling of an impurity band

It is shown that it is possible to dope p-type Bi_2Te_3 in a very controlled manner using electron irradiation. Detailed in- and ex-situ electrical transport studies were performed on samples irradiated with 2.5 MeV electrons, both at room temperature and at low temperature. These studies show that the defects induced by the irradiation act as electron donors and can thus be used to convert the conduction from p- to n-type. The point of optimal compensation is accompanied by an increase of the low-temperature resistivity by several orders of magnitude. The observation of SdH oscillations implies the existence of a well-defined Fermi surface both in the p-type samples obtained after room temperature irradiation to intermediate doses, as well as those samples in which the conduction has been converted to n-type by irradiation.

In order to study the Hall effect and the magnetoresistance *in-situ* during low temperature irradiation, a new experimental setup has been developed during the course of this PhD. By studying the Hall coefficient in-situ, the coexistence of electron- and hole-type carriers is put into evidence around the point of optimal compensation. This coexistence is explained by the formation of charge puddles that result from spatial inhomogeneities in the distribution of defects and the associated charges. Further in-situ magento-transport measurement concentrate on localization effects induced by irradiation disorder.