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Specific Role of Impurities in Semimetals

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Abstract

We have shown that the Fermi energy dependence on temperature in semimetals keeps its well-known form, similar to that of semiconductors, down to T = 0. In the nearest vicinity of T = 0 this dependence is significantly changed, and the Fermi level is displaced toward the top of the valence band. The more different electron and hole effective masses in the model of the overlapped bands in semimetals are, the more sufficient is this displacement. We note the specific role of substitutional impurities in semimetals containing at least two atoms per elementary cell. Of particular interest is the case when an impurity is of donor type when it substitutes an atom in the host elementary cell, and of acceptor type when it substitutes another atom. This phenomenon can be observed experimentally at low temperatures as oscillations of the kinetic coefficients as functions of the impurity concentration, if the energies of the donor and acceptor levels are close to the Fermi energy. We present selected experimental data obtained in Bi, which exhibit these oscillations.

Keywords: Fermi energy, semimetals, electrons, holes