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D. V. Gitsu. Features of Transfer Phenomena in Crystals of the Bismuth Type. The results of a coordinated investigation of transfer phenomena in bismuth and bismuth-antimony alloys doped with donor (tellurium, selenium) and acceptor (tin, lead) impurities[1-8] are discussed. The limitations imposed by the point group of the crystal on the dynamics of development of the anisotropy of galvanothermomagnetic effects in arbitrary nonquantizing magnetic fields are analyzed on the basis of a polynomial representation of the kinetic coefficients[9,10].

Analysis of the expressions for the kinetic coefficients that were obtained in the relaxation-time approximation for various localizations of the vital extrema[11] indicates that the structure of the polynomial coefficients of the generalized resistivity tensor is determined by the number of vital extremes and by the orientation of the isoenergetic surfaces corresponding to them, while the structure of the coefficients of the generalized Seebeck tensor also depends on the dispersion law and relaxation mechanism. If only diffusion processes in the principal crystallographic directions are considered, the most important existence condition for odd terms of the magnetothermal emf reduces to the following: there exist several groups of nonequivalent vital energy extremes, and the principal axes of the effective-mass tensor of at least one of the groups do not coincide with the principal crystallographic directions.

In the experimental part of the study, attention is concentrated on the dynamics of development of the anisotropy of the galvanothermomagnetic effects in magnetic fields up to 4 T.

It is shown that in pure bismuth, the experimental angle diagrams are accurately reproduced theoretically within the framework of a two-band model (the L and T extremes are vital)[12]. The carrier concentration varies with temperature as $T^{3/2}$, and electron mobility nearly in accordance with a $T^{-5/2}$ law. The commutation effect of the magnetothermal efm at $T > 77°K$ is an effect of third order in the magnetic field in all crystallographic directions, a direct demonstration of the absence of phonon dragging of carriers. The results of a study of bismuth doped with donor impurities indicate that the dispersion in the conduction band is approximated more accurately by a nonellipsoidal nonparabolic model, and that the energy gap at point L increases with rising temperature. It was shown that the increase of the Hall effect with increasing field that is observed in certain crystallographic directions is due to strong anisotropy of electron mobility. In all alloys of this type, magnetoresistance is not saturated in strong fields, but increases almost linearly with the field; this is explained by a kind of inelastic scattering of electrons by quasilocal impurity states.

It follows from the aggregate of the data for alloys doped with acceptor impurities that the parabolicity of the principal valence band of bismuth persists over a broad energy range, and that no topological features are observed between the bottom of the conduction band and the L maxima[13]. Participation of L holes in transfer phenomena is registered reliably in strongly doped alloys from the increase in the anisotropy of the thermal emf and magnetoresistance and through the secondary appearance of a commutation effect of the magnetothermal emf. The observed uncommonly strong variation of the thermal emf with the magnetic field in weakly doped alloys of this type is explained by the fact that the asymptotic value of the emf is inversely proportional in strong fields to the electron-hole concentration difference. The basic kinetic parameters of L holes were determined. It was clearly shown that the effects of tin and lead impurities in bismuth and bismuth-antimony alloys differ not only quantitatively, but in certain cases even qualitatively.

In $Bi_{1-x}-Sb_x$ alloys, all measured quantities vary nonmonotonically with composition. These results clearly indicate that the energy spectra of these alloys vary substantially over the entire concentration range. Here there are multiple changes in the vital character of the energy extrema, and this results in changes of varying nature in the anisotropy of the galvanothermomagnetic effects in the various concentration ranges. Four such ranges can be distinguished near 77°K: $0 \leq x < 0.07$, $0.1 < x < 0.25$, $0.3 < x < 0.65$, and $0.75 < x \leq 1$, together with the transitional ranges corresponding to them. It was shown that considerable realignment of the spectrum occurs on variation of the temperature. As a result, for example, inversion of the L bands[14] occurs at 77°K at compositions with $x \approx 0.2$.

This is explained by saturation of magnetoresistance in the transverse mannetic field when the current is parallel to one of the bisector axes and B‖C_2. A band model of bismuth-antimony alloys at 77°K was constructed from the calculated energy spectra of bismuth[15] and antimony[16] and the experimental data that were obtained.

The causes of the noninteger concentration efficiency of the impurity in bismuth and bismuth-antimony alloys and the pronounced individuality of the effects of impurity atoms in these materials are discussed[17]. It is assumed that the phenomenon is due to the complexity of the energy spectrum which causes the impurity atoms to form quasilocal states that act as "traps" of a sort for free carriers. This lowers the effective carrier concentration. The efficiency of the impurities changes on realignment of the energy spectrum.

The results of a study of size effects on transfer phenomena in bismuth in the case of thin films and whiskers are also submitted[18].

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V. V. **Sobolev.** Spectroscopy of Intrinsic Energy Levels of Solids. A new and important field of solid-state physics has been developing rapidly since about 1960: the spectroscopy of solids in a broad intrinsic absorption band, i.e., the spectroscopy of interband transitions and exciton states at various points and in various directions of the Brillouin zone with participation of many valence and conduction bands.

The Optics Laboratory of the Moldavian Academy of Sciences Institute of Applied Physics has devoted ten years of study to solution of certain problems in this area. Initially, the reflection spectra of about 150 different crystals of the groups A^4, A^3B^5, A^2B^6, $A^2B^4C^5_2$, PbS, Mg_2Si, Se, A^2B^5, MoS_2, and others, as well as those of glasses of arsenic chalcogenides and strongly doped crystals of the groups A^4 and A^3B^5, were studied[1] over the entire vital range of interband transitions from 1 to 12.5 eV. As a result, the electronic spectra of the above solids were determined through the entire vital range of interband transitions, basic relationships in the spectra of related compounds were established, the first explanations of their specific nature in the scheme of the interband transitions and in various directions and at various points of the Brillouin zone were proposed, as yet unobserved transitions and the electron spectra of unstudied compounds were predicted, and the limits of validity of known theoretical energy-band calculations were determined. The fundamentally important questions as to the prevalent role of close-range order (as compared to long-range order) of the structure of the solid in determining the structure of the intrinsic energy levels and as to the applicability of the basic concepts of band theory to strongly doped crystals were solved experimentally.

Later, in 1966—1970, greatly improved theoretical calculations of the bands of many semiconductors were published, with prediction of the complex fine structures of the previously observed spectra that result from transitions in the volume regions of the Brillouin zone and relativistic effects. As before, the fundamental problems of band and exciton optics remained undeveloped: 1) the possibility of appearance of excitons with discrete spectra and the theory of excitons in the energy range $E \gg E_g$; 2) the interaction of excitons with a continuous background of interband transitions; 3) the interaction of interband transitions and excitons with photons, and others.

To attempt experimental verification of these band-theory predictions and to develop a basis for filling the above blanks in band and exciton theory, it was necessary first of all to use much more accurate experimental methods. The optics Laboratory therefore designed and built a set of automatic high-precision spectral units for registration of reflection and differential spectra in a broad range of self-absorption energies.

The Laboratory recorded a first in world optical-instrumentation practice by developing and building high-precision spectral instruments based on the SPM-2 and DFS-12 monochromators. The UDFS-12 instrument can measure reflection coefficients accurate to 0.02%, i.e., ten times more accurately than known units, in the 1—5 eV range at T = 77 and 293°K and with high dispersion (0.5 nm/mm). Below we shall briefly discuss the most interesting recent results that represent new progress[2].