ELECTROPHYSICAL PROPERTIES OF SEMICONDUCTORS

in Tables and Figures

Evgenii Z. Meilikhov
Sergey D. Lazarev
Russian Research Center
"Kurchatov Institute"
Moscow, Russia

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List of Symbols

σ	electrical conductivity
ρ	electrical resistivity
μ	carrier mobility
μ_d	carrier drift mobility
μ_H	carrier Hall mobility
μ_n	electron mobility
μ_p	hole mobility
n	electron density
p	hole density
n_i	intrinsic carrier density
N_{D}	donor concentration
N_{A}	acceptor concentration
R	Hall coefficient
R_n	electron Hall coefficient
R_p	hole Hall coefficient
$\mathcal{E}$	electric field
H	magnetic field
E	carrier energy
k	carrier wave number
τ_R	radiative recombination time
s	surface recombination time
L_D	diffusion length

(Continued)

E_g	forbidden gap
Δ_{so}	spin–orbit interaction energy
g^*	effective spectroscopic splitting factor
g_n^*	effective electron spectroscopic splitting factor
g_p^*	effective hole spectroscopic splitting factor
E_i	impurity ionization energy
m_0	free electron mass
m^*	effective mass
m_σ	ohmic effective mass
m_c	cyclotron effective mass
m_d	density-of-state mass
m_{dn}	electron density-of-state mass
m_{dp}	hole density-of-state mass
m_n	electron effective mass
$m_{n\perp}$, $m_{n\parallel}$	electron effective mass in ellipsoidal conduction band
m_p	hole effective mass
m_{p1}, m_{p2}	hole effective masses in spherical valence subbands
$m_{p\perp}$, $m_{p\parallel}$	hole effective mass in ellipsoidal valence band
T_D	Debye temperature
T_m	melting temperature
ω_l	limiting frequency of longitudinal optical phonons
ω_t	limiting frequency of transverse optical phonons
ε_0	static dielectric constant
ε_∞	high–frequency (optical) dielectric constant

1 Introduction

The substances in which at $T = 0$ K the uppermost of the energy bands occupied by electrons (the valence band) and the lowermost of the unoccupied energy bands (the conduction band) do not overlap are referred to semiconductors or dielectrics. The dividing line between the two classes of substances is rather arbitrary. Unlike dielectrics, in semiconductors the energy gap between the conduction band and the valence band is not too large. This gives rise to the appearance of a noticeable number of free charge carriers in the bands at $T \neq 0$ K.

The electrical resistivity of semiconductors (at $T = 290$ K) lies usually in the range $10^{-3} \leq \rho \leq 10^{10}$ Ohm.cm (in metals $\rho = 10^{-6}$–10^{-4} Ohm·cm).

The characteristic features of this class of substances are an increase in electrical conduction with temperature, low (as compared with metals) densities of current carriers, a high sensitivity of the electrical properties to radiations and impurities as well as the nonohmic behavior of contacts.

The forbidden gap width E_g represents an energy gap between the absolute maximum of the valence band and the absolute minimum of the conduction band. It is determined from the temperature dependence of resistance or by optical methods (absorption edge, long-wave threshold of photoconductivity). The value of E_g depends on temperature and pressure; the dependence is governed by the coefficients

$$\alpha_T = \frac{\partial E_g}{\partial T}$$

and

$$\alpha_P = \frac{\partial E_g}{\partial P}.$$

Carrier mobility and conductivity. The drift mobility

$$\mu_d = \frac{v_d}{\mathcal{E}},$$

where v_d is the drift velocity of carriers in the electric field $\mathcal{E}$, is determined by direct experiments from the time of propagation of an injected pulse of minority carriers in a sample. The electrical conductivity σ is related to the drift mobilities of electrons and holes μ_n, μ_p and to their densities n and p by the formula

$$\sigma = e\left(n\mu_n + p\mu_p\right).$$

The measurement of the Hall effect allows one to determine the Hall mobility

$$\mu_H = \mid R\sigma \mid,$$

where R is the Hall coefficient.

Hall effect. In a semiconductor placed in a magnetic field perpendicular to a current flowing in the semiconductor, there occurs an electric field perpendicular to both the current and the magnetic field. This is a so-called Hall effect described by the relationship

$$E_H = RjH,$$

where E_H is the strength of the Hall electric field; j is the current density; H is the strength of the magnetic field; R is the Hall coefficient.

In the case of one sort of carriers (with a density n)

$$R = \pm\frac{r}{ne}.$$

Here R is in cm^3/C; n in cm^{-3}; $e = 1.6\ 10^{-19}$ C; r is the numerical factor (so-called Hall-factor) whose value is determined by the mechanism of carrier momentum relaxation. The sign of R correlates with the sign of the carrier charge (R<0 in n-type samples: R>0 in p-type samples).

When two sorts of carriers (for example, electrons and holes) are present, R depends on the magnetic field strength:

$$R = \frac{R_n\sigma_n\left(1+\sigma_p^2H^2R_p^2\right) + R_p\sigma_p\left(1+\sigma_n^2H^2R_n^2\right)}{\left(\sigma_n+\sigma_p\right)^2 + \sigma_n\sigma_p\left(R_n+R_p\right)H^2}.$$

Here $\sigma_n = ne\mu_n$; $\sigma_p = pe\mu_p$; $R_n = -1/ne$; $R_p = 1/pe$.

For H$\rightarrow\infty$ R$\rightarrow$ $[e\,(p-n)]^{-1}$, if $p \neq n$, and

$$R = \frac{1}{ne}\frac{\mu_p - \mu_n}{\mu_p + \mu_n}$$

if $n = p$.

The Hall mobility of carrier μ_H is defined by the relationship $\mu_H = \mid R\sigma \mid$.

The lifetime of carriers represents a time for which the nonequilibrium density of carriers decreases down to the equilibrium value through their recombination. The basic recombination mechanisms are a radiative one (the energy of recombining electron-hole pair is emitted, as a photon), a phonon one (the energy is transferred to the lattice), and a collisional one (the energy of the pair is transferred to a third particle).

More frequently the recombination occurs not directly, but through recombination centers (impurities, defects).

The theoretical estimation of the radiative recombination time τ_R yields the upper limit of the τ value. For $T = 300$ K and a near-intrinsic density the values of τ_R are given in Table 1 along with the real values of τ.

Table 1. The recombination time τ and the radiative recombination time τ_R for some semiconductors [162] (near-intrinsic carrier density, $T = 300$ K)

Semiconductor	Si	Ge	InSb	InAs	PbS	PbSe	PbTe
τ_R, s	3	0.3	$3\cdot10^{-7}$	10^{-5}	10^{-5}	$3\cdot10^{-6}$	$2\cdot10^{-6}$
τ, s	$2\cdot10^{-3}$	$3\cdot10^{-3}$	$3\cdot10^{-7}$	10^{-7}	10^{-5}	—	—

Surface recombination. Besides the recombination in the bulk of a semiconductor the carriers can recombine at its surface. The surface recombination rate s is defined as the velocity of particle flow from the bulk to the surface such that required to maintain an excess of nonequilibrium carriers. The rate s depends strongly on the method of surface treatment. For example, for germanium $s \approx 10$ cm/s upon etching its surface by boiling H_2O_2 and $s \approx 10^5$ cm/s and more upon lapping. Usually $s \approx 10^2$ - 10^3 cm/s.

The diffusion length L_D is a distance characterizing the spatial decrease in the nonequilibrium carrier density down to the equilibrium value. The value of L_D is defined through the diffusion coefficient D and the lifetime τ by the relationship $L_D = \sqrt{D\tau}$. The diffusion coefficient and the mobility are related by the Einstein relation $D = kT\mu$ /e (in a nondegenerate semiconductor). The maximum diffusion length characterizes the degree of crystal perfection and purity. At $T = 300$ K, $L_D \approx 0.5$ cm in Ge, $L_D \approx 0.3$ cm in Si, and $L_D \approx 10^{-2}$–10^{-3} cm in InSb [162].

Band structure and effective masses. The effective mass of a carrier characterizes its motion in the crystal lattice. The reverse effective mass $(m^*)^{-1}$ is the tensor quantity defined by the dependence $E(p)$ of the energy of the carrier E on its quasimomentum p.

$$(m^*)^{-1}_{ij} = \frac{\partial^2 E(p)}{\partial p_i \partial p_j}$$

Usually it will suffice to know the behavior of $E(p)$ only in the vicinity of the extreme points: the energy minima or maxima. The isoenergetic surfaces near the extrema are often represented as spheres (with the effective mass, for example, for several subbands of the valence band m_{p1}, m_{p2}, etc.) or ellipsoids (with the effective masses for the conduction band $m_{n\|}$, $m_{n\perp 1}$, $m_{n\perp 2}$ [1].

To analyze experimental data the concept of a density-of-states effective mass (m_{dn} and m_{dp} for electrons and holes, respectively) is in frequent use. In the case of the ellipsoidal

isoenergetic surfaces this quantity is determined from the relationship

$$m_d = N^{2/3}\left(m_{\|} m_{\perp 1} m_{\perp 2}\right)^{1/3}$$

where N is the number of extrema in the band.

For the energy bands having the degenerate spherical surfaces of constant energy with the effective masses m_{p1}, m_{p2}, etc. the density-of-states effective mass is defined as follows:

$$m_{dp} = \left(m_{p1}^{3/2} + m_{p2}^{3/2} + \ldots\right)^{2/3}$$

The concepts of an ohmic effective mass m_σ and a cyclotron effective mass m_c are also introduced. They are defined by the relationships

$$\frac{1}{m_\sigma} = \frac{1}{3}\left(\frac{1}{m_{\|}} + \frac{1}{m_{\perp 1}} + \frac{1}{m_{\perp 2}}\right)$$

(the ellipsoidal isoenergetic surfaces),

$$m_c = \frac{h}{2\pi}\frac{\partial S}{\partial E}$$

(S is the area of the section of the isoenergetic surface by a plane normal to the magnetic field).

The general expressions for m_d, m_σ , and m_c see, for example, in [84].

The cyclotron resonance is a direct method for determining $E(p)$ and the effective masses. The valuable data about the band structure and the 3effective masses can be obtained in measuring the anisotropy of magnetoresistance, the Shubnikov-de Haas type effects, and the magnetoopic effects.

The intrinsic carrier density n_i corresponds to an ideally pure material and can be calculated, if the band structure and the effective masses are known, by the formula:

$$n_i = 4,82 \cdot 10^{15} T^{3/2}\left(\frac{m_{dn} m_{dp}}{m_0^2}\right)^{3/4} \exp\left(\frac{E_g - \alpha_T T}{2kT}\right)$$

where m_{dn} and m_{dp} are the density-of-states effective masses of electron and holes, respectively; m_o is the mass of a free electrons; k is the Boltzmann constant; α_T is the temperature coefficient of the energy gap width.

[1] Often $m_{\perp 1} = m_{\perp 2}$, then the symbol $m_\perp = m_{\perp 1} = m_{\perp 2}$ is used.

As a rule, n_i is determined experimentally from the data of measurements of the Hall effect and the conduction in the corresponding temperature range.

The Debye temperature T_D is defined through the limiting lattice vibration frequency ω_m by the relationship

$$kT_D = \hbar\omega_m$$

The different Debye temperatures correspond, generally speaking, to the different branches of vibrations. The values of T_D determined from thermal measurements are averaged over the vibration branches that are essential at the temperature of measurements. More comprehensive information can be obtained, for example, in measuring the elastic constants.

The limiting frequency of optical phonons ω_l, or ω_t , is the frequency of respective (longitudinal or transverse) optical lattice vibrations with wavelengths considerably longer than the interatomic distance. Determined from the infrared absorption and reflection spectra as well as by neutron spectroscopy. For elementary semiconductors (Ge, Si, etc.): $\omega_i = \omega_t = \omega_0$.

The spectroscopic splitting factor g in the conduction (or valence) band characterizes the splitting of the energy levels of carriers in a magnetic field due to their magnetic moments

$$E = (n + 1/2)\,\hbar\omega_H \pm 1/2g\hbar\omega_h$$

n =1,2 ..., where ω_H is the cyclotron frequency of charge carrier in the crystal which is determined from the measurement of the oscillation effects in the magnetic field by the para- and nuclear magnetic resonance methods.

Dielectric constant. The values of the dielectric constant ε_0 and ε_∞ are determined from static and high-frequency (or optical) measurements, respectively. In the tables everywhere, except as otherwise indicated, the presented values belong to $T = 290$ K.

The tables contain mainly the data on semiconductors with $E_g < 3$ eV. Ternary and more complex semiconducting compounds are not described [2]. Data on the parameters of semiconductor devices are also absent.

2 Elementary semiconductors

2.1 Silicon and germanium

Silicon and germanium are the widely used and best-investigated semiconductors. They crystallize into a diamond lattice and have a complex band structure.

In Si six equivalent absolute minima of the conduction band are located on the [100] axes inside the Brillouin zone. In the vicinity of each of these minima the isoenergetic surfaces represent ellipsoids of revolution (six ellipsoids).

In Ge eight equivalent absolute minima of the conduction band are located on the [111] axes at the boundary of the Brillouin zone.

In the vicinity of each of these minima the isoenergetic surfaces represent ellipsoids of revolution (the equivalent number of the ellipsoids is four).

The valence bands in Si and Ge are split into three subbands: two of them are degenerate at k = 0 and the third subband is split off due to spin-orbit interaction.

The electronic band structures of Si and Ge (with the symbols used in the tables) are shown in Figs. 22 and 23, respectively.

The electrophysical properties of Si and Ge are presented in Tables 2–5 and Figs. 24–43.

[2] For the properties of some classes of ternary compounds, see [16, 121, 123, 145, 289, 290].

References

1. Landolt–Bornstein, Zahlenwerte und funktionen aus physik, chemie, astronomie, geophysik, technik, Bd. 1, Springer, Berlin, 1955.
2. Wickoff, R W. G., Crystal structures, Intersci. Publ., New York, 1953.
3. Khartsiev, V. E., Fizika tverdogo tela, 4, 433, 1962 (in Russian).
4. Hoen, F. H., Boron, Eds. Kohn, J. A., Nye, W. F. and Ganle, C. K., Plenum Press, New York, 1960 (vol. 1).
5. Golikova, O. A., Soloviev, N. E., Ugai, Ya. A., Feigel'man, V. A., Fizika i tekhnika poluprovodnikov, 13, 825, 1979 (in Russian).
6. Golikova, O. A., J. Less-Common Met., 82, 362, 1982.
7. Golikova, O. A., Zhubanov, M. Zh., Klimashin, G. N., Fizika i tekhnika poluprovodnikov, 2, 548, 1968.
8. Asanable, S., J. Phys. Soc. Japan, 15, 989, 1960.
9. Harbeke, G., Tosatti, E., Proc. of the 12-th International Conf. on Phys. Sem., Stuttgart, 1974 (p. 626).
10. Bube, R., Photoconductivity of solids, New York, 1960
11. Smith, R., Semiconductors, Cambridge, 1959
12. Ybuki, I., J. Phys. Soc. Japan, 10, 549, 1955.
13. Drabbe, G., J. Phys. Soc., B69, 1101, 1956; B72, 380, 1958.
14. Golikova, O. A., Subanov, M. Z., Boron, Ed. Niemyski, T., Pol. Sci. Publ., Warsaw, 1970 (vol. 3).
15. Rodot, M., Phys. Stat. Sol., 3, 10, 1963.
16. Ugai, Ya. A., Introduction to semiconductor chemistry, Vysshaya shkola, Moscow, 1965 (in Russian).
17. Warschauer, D., J. Appl. Phys., 34, 1853, 1963.
18. Kot, M. V., Kretsu, L. V., Izvestiya Acad. nauk SSSR, Ser. "Physics", 281, 259, 1964 (in Russian).
19. Mort, J., Phys. Rev. Lett., 18, 540, 1967.
20. Caywood, J. M., Mead, C. A., J. Phys. Chem. Sol., 31, 983, 1970.
21. Hopfield, J. J., Thomas, D. G., Phys. Rev., 122, 35, 1961.
22. Dimmock, J. O., Wheeler, R. J., J. Appl. Phys., 32, 2271, 1961.
23. Noguet, P. C., J. Phys., 26, 317, 1965.
24. Lavine, C. F., Ewald, A. W., J. Phys. Chem. Sol., 32, 1121, 1971.
25. Bogomolov, V. N., Kudinov, E. K., Firsov, E. A., Fizika tverdogo tela, 9, 3175, 1967 (in Russian).
26. Prener, I., Woodbury, H. H., Intern. Conf. Semicond. Phys., Paris, 1964 (p. 1231).
27. Hilsum, C., Rose-Innes, A., Semiconducting III-V compounds, Oxford, 1961
28. Moss, T., Optical properties of semiconductors, London, 1959
29. Bresler, M. S., Red'ko, N. A., Zhurnal eksperimental'noi i teoreticheskoi fiziki, 34, 149, 1972 (in Russian).
30. Grosse, P., Springer tracts in modern phys., Ed. Hohler, G., J. Springer, Berlin – Heidelberg – New York, 1969 (vol. 48).
31. Gramatskii, V. I., Mushinskii, V. P., Izvestiya Acad. nauk SSSR, Ser. "Physics", 28, 1077, 1964.
32. Akhundov, A., Abdullaev, G. B., Gusseinov, G. D., Intern. Conf. Semicond. Phys., Paris, 1964 (p. 1277).
33. Veric, C., New Develop. Semiconductors, Leyden, 1973.
34. Mirzabaev, M., Tuchkevich, V. M., Shmartsev, Yu. V., Izvestiya Acad. nauk SSSR, Ser. "Physics", 28, 1300, 1964 (in Russian).
35. Parfeniev, R. V., Pogarskii, A. M., Farbshtein, I. I., Fizika tverdogo tela, 4, 2630, 1963 (in Russian).

36. Evans, R. L., Hazelwood, R. A., P. Phys, D., 2, 1507, 1969.
37. Gibbons, Dy., Spear, W. E., J. Phys. Chem. Sol., 27, 1917, 1966.
38. Fuldner, J., Proc. XI Conf. Phys. Semicon., Warsaw, 1972 (p. 351).
39. Nitzki, V., Stossel, W., Phys. Stat. Sol., 39(b), 309, 1970.
40. Rodot, M., Compt. Rend. Acad. Sci., 260, 1908, 1965.
41. Emtage, P. R., Phys. Rev., 138, 24, 1965.
42. Botling, J. F., J. Chem. Phys., 33, 305, 1960.
43. A handbook on semiconductor diodes, transistors and integrated circuits, Ed. Goryunov, N. N., Eneriya, Moscow, 1972 (in Russian).
44. Von Liebe, L., Ann. Phys., 7, 179, 1965.
45. Salzer, O., Nieke, H., Ibid., 7, 192, 1965.
46. Onuki, J. Phys. Soc. Japan, 20, 171, 1965.
47. Kot, M. V., Panasyuk, L. M., Simashkevich, A. V., Tsurkan, A. E., Fizika tverdogo tela, 7, 1242, 1965 (in Russian).
48. Yaschke, R., Ann. Phys., 7, 106, 1965.
49. Lomakina, G.A., Fizika tverdogo tela, 7, 600, 1965 (in Russian).
50. Komiga, H., Phys. Rev., 133, A1679, 1964.
51. Suchet, J., Compt. Rend. Acad. Sci., 259, 3219, 1964.
52. Resenman, M. J., Ibid., 259, 2621, 1964.
53. Adams, A. R., Spear, W. E., J. Phys. Chem. Sol., 25, 1113, 1964.
54. Hacke, J., J. Appl. Phys., 35, 2484, 1964.
55. Redin, A. D., Phys. Rev., 109, 1916, 1958.
56. Rodot, M., Compt. Rend. Acad. Sci., 258, 5414, 1964.
57. Jeavons, A. P., Sannders Y. A., Phys. Royal Soc., A310, 415, 1969.
58. Bludau, W., Onton, A., Heinke, W., J. Appl. Phys., 45, 1846, 1974.
59. Dunstadter, H., Z. Phys, 137, 383, 1954.
60. Vol'fshtein, V. M., Fistul', V. I., Electronics and its application, Ser. "Itogi nauki i tekhniki", VINITI AN SSSR, Moscow, 1974 (vol. 4) (in Russian).
61. Sommer, A.H., Photoemissive materials. Preparation, properties and uses, Wiley, New York, 1968
62. Physical properties of chalcogenides - rare-earth elements, Ed. Zhuze, V. P., Nauka, Leningrad, 1974 (in Russian).
63. Irvin, J. C., Bell Syst. Tech. J., 41, 387, 1962.
64. Jacoboni, C., Canali, C., Ottaviani, G., Alberigi Quaranta, A., Solid State Electron., 20, 77, 1977.
65. McLean, T. P., Progress in Semiconductors, Ed. Gibson, A. F., Heywood, London, 1960 (vol. 5).
66. Park, V. S., Phys. Rev., 143, 512, 1966.
67. Lott, S. A., Synch, D. W., Ibid., 141, 681, 1966.
68. Camassel, J., Auvergne, D., Matthieu, H., Solid State Comm., 13, 63, 1973.
69. Marby, J. A., Phys. Rev., 140, 304, 1965.
70. Arumi, Z., Mancu, P., Rend. Semin. Fac. Sci. Univ. Gagliari, 33, No 3-4, 26, 1963.
71. Morin, F. J., Phys. Rev., 93, 62, 1954.
72. Prince, M. B., Ibid., 92, 681, 1953.
73. Golikova, O. A., Moizhes, B. Ya., Stil'bans, L. S., Fizika tverdogo tela, 3, 3105, 1961.
74. Logan, R. A., Rowell, J. M., Trumbore, F. A., Phys. Rev., 136A, 1751, 1964.
75. Whitaker, J., Solid State Electron., 8, 649, 1965.
76. Braunstein, R., Moore, A. R., Herman, F., Phys. Rev., 109, 695, 1958.
77. Zdanowich, W., Wojkowski, A., Phys. Stat. Sol., 8, 569, 1965.
78. Douglas, R., J. Phys. Chem. Sol., 21, 329, 1965.

79. Richard, D., Ibid., 26, 439, 1965.
80. Busch, G., Vogt, O., Helv. Phys. Acta, 33, 437, 1960.
81. Wooten, J., Condas, Y. A., Phys. Rev., 131, 657, 1963.
82. Tamura, H., Masumi, T., Solid State Comm., 12, 1183, 1973.
83. Hall, R. F., Wright, H. C., Brit. J. Appl. Phys., 18, 33, 1967.
84. Tsidil'kovskii, I. M., Electrons and holes in semiconductors, Nauka, Moscow, 1972 (in Russian).
85. Orlova, N. I., Shishkin, P. T., Izvestiya Acad. Nauk SSSR, Ser. "Physics – Mathematics", No 4, 53 1964 (in Russian).
86. Winker, H., Helv. Phys. Acta, 28, 633, 1955.
87. Mell, H., Stuke, J., Phys. Stat. Sol., 45, 163, 1971.
88. Sorokin, G. P., Izvestiya vuzov, Ser. "Physics", No 4, 140, 1965 (in Russian).
89. Wallis, Y., Ann. Phys., 17, 401, 1956.
90. Pollack, Y. P., Triivch, D., J. Appl. Phys., 46, 163, 1975.
91. Okamoto, K., Kawai, S., Jap. J. Appl. Phys., 12, 1130, 1973.
92. Voskanyan, A. A., Inglizyan, P. N., Lalykin, S. P., Fizika i tekhnika poluprovodnikov, 12, 2096, 1978 (in Russian).
93. Gorbachev, V. V., Putilin, I. M., Phys. Stat. Sol. (a), 16, 553, 1973.
94. Sorokin, G. P., Penshev, Yu. M., Oush, P. T., Fizika tverdogo tela, 7, 2244, 1965 (in Russian).
95. Ksendzov, Ya. M., Drabkin, I. A., Ibid., 7, 1884, 1965 (in Russian).
96. Fortin, E., Weichman, F. L., Phys. Stat. Sol., 5, 515, 1964.
97. Junod, P., Phil. Mag., 36, 941, 1977.
98. Aliev, S. A., Suyunov, U. Kh., Arasly, D. G., Aliev, M. I., Fizika i tekhnika poluprovodnikov, 7, 1086, 1973.
1.99. Aulich, E., Brebner, J. L., Mooser, E., Phys. Stat. Sol., 31, 129, 1969.
100. Ugai, Ya. A., Zaval'skii, Yu. P., Ugai, V. A., Doklady Acad. nauk SSSR, 163, 663, 1965 (in Russian).
101. Junod, P., Helv. Phys. Acta, 32, 567, 1959.
102. Davlen, V. R. M., Phys. Rev., 143, 666, 1966.
103. Komiga, U., Ibid., A133, 679, 1964.
104. Minder, R., Ottaviani, G., Canali, C., J. Phys. Chem. Sol., 37, 417, 1976.
105. Leotin, J., Barbaste, R., Askenazy, S., Solid State Comm., 15, 693, 1974.
106. Wassher, J. D., Seuter, R. M. J., Haas, C., Intern. Conf. Semicond. Phys., Paris, 1964 (p. 1269).
107. Kolomietz, B. T., Lebedev, E. A., Mazek, F. T., Ibid., p. 1283.
108. Wood, C., Harrap, C., Kane, W. M., Phys. Rev., 121, 978, 1961.
109. Masumi, T., Ahrenkiel, R. K., Brown, F. C., Phys. Stat. Sol., 11, 163, 1965.
110. Ponpon, L. P., IEEE Trans. Nucl. Sci., S-22, 182, 1975.
111. Beyer, W., Mell, H., Stuke, J., Phys. Stat. Sol. (b), 45, 153, 1971.
112. Krevs, V. E., Lutsiv, R. V., Pashovskii, M. B., Retrov, P.P., Ibid., 65, K43, 1974.
113. Hanson, R. C., J. Phys. Chem., 66, 2376, 1962.
114. Abrikosov, N. Kh., Semiconductor compounds, their manufacturing and properties, Nauka, Moscow, 1967 (in Russian).
115. Reimherr, A., General Survey of the Semiconductor Field, NBS Technical Note, 1962 (p. 153).
116. Semiconductors, Ed.Hannay, N.B., American Chem.Soc.Monograph Ser., Reynold Publ. Corp., New York, 1959
117. Materials used in semiconductor devices, Ed. Hogarth, C.A., Interscience Publishers, John Wiley and Sons, New York–London–Sydney, 1965
118. Thermophysical Properties of High Temperature Solid Materials, Purdue Univ., 1967.
119. Burnham, D. C., Brown, F. C., Knox, R. S., Phys. Rev., 119, 1560, 1960.
120. Ahrenkiel, R. K., Ibid., 18, 180, 1969.

121. Goryunova, N. A., Complex diamond–like semiconductors, Sovetskoye radio, Moscow, 1968 (in Russian).
122. Wargur, R. J., Ewald, K. A., J. Phys. Chem. Sol., 32, 697, 1971.
123. Rodot, M., Les materiaux semi–conducteurs, Dunod, Paris, 19651
124. Dobrolezh, S. A., Silicon carbide, Gosudarstvennoye izdatel'stvo tekhnicheskoi literatury UkrSSR, 1963 (in Russian).
125. Ravich, Yu. I., Efimova, B. A., Smirnov, I. A., Methods of semiconductor analysis as applied to lead chalcogenides, Nauka, Moscow, 1968 (in Russian).
126. Kolomietz, N. V., Lev, E. Ya., Sysoeva, L. M., Fizika tverdogo tela, 5, 2871, 1963 (in Russian).
127. Albers, W., J. Appl. Phys., Suppl. 32, 2220, 1961.
128. Champness, C. H., Kipling, A. L., Canad. J. Phys., 44, 769, 1966.
129. Sobolev, V. V., Fizika tverdogo tela, 12, 2687, 1970 (in Russian).
130. Cuhen, M. L., Au–Yang, M. T., Phys. Rev., 178, 1358, 1969.
131. Winkler, H., Helv. Phys. Acta, 28, 663, 1955.
132. Agrain, P., Balkansky, M., Table de constante des semiconducteurs, Pergamon Press, Paris, 1961.
133. Turner, W. J., Fischer, A. S., Reese, W. E., J. Appl. Phys., Suppl. 32, 2241, 1961.
134. Heller, M. W., Danielson, G. C., J. Phys. Chem. Sol., 23, 601, 1962.
135. Redin, R. D., Morris, R. G., Danielson, G. C., Phys. Rev., 109, 1916, 1958.
136. Li, P. W., Lee, S. N., Danielson, G. C., Ibid., B6, 442, 1972.
137. Crossman, L. D., Danielson, G. C., Ibid., 171, 867, 1968.
138. Physics and chemistry of II–VI compounds, Eds.Aven, M., Prener, J.S., North–Holland Publ. Company, Amsterdam, 1967
139. Hamilton, P. H., Semicond. Proc. Solid State Technology, 7, No 6, 15, 1964.
140. Betts, D. D., Canad. J. Phys., 39, 223, 1961. 141. Robic, R. A., Edwards, J. L., J. Appl. Phys., 37, 2659, 1966.
142. Rode, D. L., Phys. Rev., B2, 4036, 1970.
143. Miloslavskii, V. K., Shklyarevskii, O. N., Fizika i tekhnika poluprovodnikov, 5, 926, 1971 (in Russian).
144. Watanabe, H., Wada, H., Takahashi, T., Jap. J. Appl. Phys., 3, 617, 1964.
145. Rodot, H., J. Phys. Chem. Sol., 25, 85, 1964
146. Umeda, J., J. Phys. Soc. Japan, 19, 2052, 1964.
147. Geik, R., Hakel, W. J., Perry, C. H., Phys. Rev., 148, 824, 1966.
148. Balkansky, M., Zellag, B. A. M., Longen, D., J. Phys. Chem., 27, 299, 1966.
149. Segall, B., Lorenz, M., Woodbury, H., Phys. Rev., 129, 2471, 1963.
150. Medvedeva, Z. S., Chalcogenides of the IIIB subgroup elements of the Periodic table, Nauka, Moscow, 1968 (in Russian).
151. Tagiev, B. F., Phys. Stat. Sol. (a), 3, K119, 1970.
152. Catsuyama, C., Watanabe, Y., Hamaguchi, C., J. Phys. Soc. Japan, 29, 150, 1970.
153. Aven, M., J. Appl. Phys., 42, 1204, 1971.
154. Park, Y. S., Hemenger, P. M., Chung, C. H., Appl. Phys. Lett., 18, 45, 1971.
155. Reignold, D. G., Litton, C. W., Collins, T., Phys. Rev., 146, 1726, 1965.
156. Seiler, D. G., Galazka, R. R., Becher, W. M., Ibid., B3, 4274, 1971.
157. Bashirov, R. I., Tadzhiev, R. M., Fizika tverdogo tela, 4, 1936, 1970 (in Russian).
158. Bush, G., Moldanova, M., Helv. Phys. Acta, 35, 500, 1962.
159. Dietz, R. F., Hopfield, J. J., Thomas, D. G., J. Appl. Phys., 32, 2282, 1961.
160. Pigon, K., Helv. Phys. Acta, 41, 1104, 1968.
161. Fisher, P., Fan, H., Bull. Amer. Phys. Soc., 4, 409, 1959. 162. Ryvkin, S. M., Photoelectric phenomena in semiconductors, Fizmatgiz, Moscow, 1963 (in Russian).
163. Zdanowicz, W., Kenkie, Z., Bull. Acad. Pol. Sci., Ser. Sci. Chem., 12, 729, 1964.

164. Fingold, L., Phys. Rev. Lett., 13, 233, 1964.
165. Shevchenko, V. Ya., Zhurnal neorganicheskikh materialov, 11, 1719, 1975 (in Russian).
166. Zdanowicz, W., Wielzak, B., Zdanowicz, P., Acta Phys. Polon., A48, 27, 1975.
167. Turner, W. C., Fischler, A. S., Reese, W. G., Phys. Rev., 121, 759, 1961.
168. Black, J., J. Phys. Chem. Sol., 2, 240, 1957.
169. Smirnov, I. A., Shadrichev, E. V., Kutasov, V. A., Fizika tverdogo tela, 11, 3311, 1969 (in Russian).
170. Madelung, O., Physics of III–V compounds, John Wiley and Sons, New York–london–Sydney, 1964
171. Long, D., Energy bands in semiconductors, Sydney Interscience Publ., a division John Wiley and Sons, New York - London, 1968.
172. Minden, H. T., Appl. Phys. Lett., 17, 358, 1970.
173. Kessler, F. R., Phys. Stat. Sol., 6, 3, 1964.
174. Stordeur, M., Kuhnberger, W., Phys. Stat. Sol. (b), 69, 377, 1975.
175. Damon, D. H., Miller, R. C., Emtage, P. R., Phys. Rev. B, 5, 2175, 1972.
176. Becla, P., Gummieuny, Z., Misiewicz, J., Opt. Appl., 9, 143, 1979.
177. Shevchenko, V. Ya., Marenkin, S. F., Ponomarev, V. F., Zhurnal neorganicheskikh materialov, 13, 1898, 1977 (in Russian).
178. Steigmeier, E. F., Kudman,I., Phys. Rev., 141, 767, 1966. 179. Pigon, K., Bull. Acad. Pol. Sci., Ser. Sci. Chem., 9, 751, 1961.
180. Masumoto, K., Komiya, H., J. Jap. Instrum. Met., 28, 273, 1964.
181. Tsurkan, A. E., Maksimova, O. G., Verlan, V. I., Complex semiconductors and their physical properties, Shtinitsa, Kishinev, 1971 (in Russian).
182. Naake, M. J., Belcher, S. C., J. Appl. Phys., 35, 3064, 1964.
183. Domingo, G., Itoga, R. S., Kannewur, C. R., Phys. Rev., 143, 536, 1966.
184. Markov Yu. F., Investigation of the optical properties of semiconducting compounds in the far IR spectrum range, Phys.- mat. candidate theses, A. Ioffe Phys. Tech. Institute, Leningrad, 1972 (in Russian).
185. Ehrenreich, H., Phys. Rev., 120, 1951, 1960. 186. Panfilov, V. V., Subbotin, L. S., Vereshchagin, L. F., Doklady Acad. nauk SSSR, 96, 559, 1971 (in Russian).
187. Semiconductor compounds of groups II – V, Nauka, Moscow, 1978 (in Russian).
188. Heller, M. W., Babiskin, J., Radff, R. L., Phys. Rev., A36, 363, 1971.
189. Zdanowicz, W., Wojakowski, A., Phys. Stat. Sol., 16, K129, 1966.
190. Zdanowicz, W., Wojakowski, A., Ibid., 8, 569, 1965.
191. Arushanov, E. K., Lashul, A. V., Mashovets, D. V., Phys. Stat. Sol. (b), 102, K121, 1980.
192. Gelten, M. J., Von Liehout, A., van Es, C., Blout, F. A. P., J. Phys., C11, 227, 1978.
193. Slack, G. A., J. Appl. Phys., 143, 666, 1966.
194. Moroz, A. I., Odarich, V. A., Ukrainskii fizicheskii zhurnal, 16, 1501, 1971 (in Russian).
195. Kozlov, S. F., Phys.-math. doctorate, Kurchatov Inst. of Atomic Energy, Moscow, 1985 (in Russian).
196. Bloom, F. A. P., Gelten, M. J., Ibid., B19, 2411, 1979.
197. Kolomietz, B. T., Mazets, T. F., Sarsembinov, Sh. Sh., Fizika i tekhnika poluprovodnikov, 5, 2301, 1971 (in Russian).
198. Shutov, S. O., Sobolev, V. V., Smeshlivyi, L. I., Semicondictor compounds and their solid solutions, Izdatel'stvo Acad. nauk MoldSSR, Kishinev, 1970 (p. 155) (in Russian).
199. Whitsett, C. R., Nelson, D. A., Phys. Rev. B, 5, 3125, 1972.
200. Overhof, H., J. Phys. Chem. Sol., 43, 221, 1971.
201. Miller, K. A., Schneider, J., Phys. Lett., 4, 288, 1963.
202. Look, D. C., Moore, D. L., Phys. Rev. B, 5, 3406, 1972.
203. Kohler, H., Fabricins, A., Phys. Stat. Sol. (b), 71, 487, 1975.

204. Bloom, F. A. P., Intern. Summ. School on Narrow-Gap Semicond. Physics and Applications, Nimes (France), 1979 (p. 191).
205. Kawasaki, T, Tanaka, T., J. Phys. Soc. Japan, 21, 2475, 1966.
206. Eichler, W., Simon, G., Phys. Stat. Sol. (b), 86, K85, 1978.
207. Helbig, R., Wagner, P., J. Phys. Chem. Sol., 35, 327, 1974.
208. Hagenberg, F., Thesis D83, T.U., Berlin, 1980.
209. Grant, F. A., Rev. Mod. Phys., 31, 646, 1959.
210. Yu, P. Y., Cardona, M., J. Phys. Chem. Sol., 34, 29, 1973.
211. Frederikse, H. P. R., J. Appl. Phys., Suppl. 32, 2211, 1961.
212. Austin, I.G., Mott, N.E., Adv. Phys.,18, 41, 1969
213. Madelung, O., Semiconductors: group VI elements and III–IV compounds, Ed. Madelung, O., Springer–Verlag, Berlin, 1991.
214. Kesamanly, F. P., Fizika i tekhnika poluprovodnikov, 8, 225, 1974 (in Russian).
215. Kikuchi, Y., Chubachi, N., Iinuma, K., Sendai Symp. Acoustoelectron. Jpn., 1968.
216. Handbook of a chemist, Khimia, Moscow, 1964 (in Russian).
217. Spear, W. E., Mort, P., Proc. Phys. Soc., 81, 130, 1963.
218. Krupishev, R. S., Abagyan, S. A., Davydov, A. A., Fizika i tekhnika poluprovodnikov, 6, 75, 1972 (in Russian).
219. Kahan, A., Lipson, H. G., Loewinstein, E. V., Intern. Conf. Semicond. Phys., Paris, 1964 (p. 1067).
220. Mitra, S. S., Marshall, R., Ibid., p. 1085.
221. Kireev, P. S., Semiconductor Physics, Vysshaya Shkola, Moscow, 1969 (in Russian).
222. Zallen, R., Phys. Rev., B1, 4058, 1970.
223. Szusukiewicz, W., Phys. Stat. Sol. (b), 91, 361, 1979.
224. Wright, G. B., Strauss, A. J., Harman, T. C., Phys. Rev., 125, 1534, 1962.
225. Fistul', V. I., Strongly alloyed semiconductors, Nauka, Moscow, 1967 (in Russian).
226. Prince, M. B., Phys. Rev., 93, 1204, 1954.
227. Lehoczky, S. L., Broerman, J. G., Nelson, D. A., Whitsett, C. R., Ibid., B9, 1598, 1974.
228. Brebrick, R. P., Scanlon, W. W., Ibid., 99, 598, 1954.
229. Stradling, R., Solid State Comm., 6, 665, 1968.
230. Cardona, M., Phys. III – V compounds, Academic Press, 1966 (vol. 3).
231. Stradling, R., Electronic components, Pergamon Press, London, 1958 (p. 1135).
232. Walton, A., Mishra, U., Proc. Phys. Soc., 90, 1111, 1967.
233. Stradling, R., Phys. Lett., 20, 217, 1966.
234. Gavrilenko, V.I., Grekhov, A.M., Korbutyak, D.V., Litovchenko, V.G., Optical properties of semiconductors, Naukova dumka, Kiev, 1987 (in Russian).
235. Kot, M. V., Prilepov, V. D., Tsurkan, A. E., Semicondictor compounds and their solid solutions, Izdatel'stvo Acad. Nauk MoldSSR, Kishinev, 1970 (p. 3) (in Russian).
236. Mashkovskii, M. V., Foreign electronic technology, Izdatel'stvo CNII "Electronika", Moscow, 1974 (No 12, p. 3) (in Russian)
237. Kalashnikov, S. G., J. Phys. Chem. Sol., 8, 52, 1959.
238. Ewald, A. W., Tutle, O. N., Ibid., p. 523.
239. Ivanov-Omskii, V. I., Kolomietz, B. T., Ogorodnikov, V. K., Fizika i tekhnika poluprovodnikov, 4, 264, 1970 (in Russian).
240. Galazka, R. R., Phys. Lett., 32A, 101, 1970.
241. Nasledow, D. N., Shevchenko, V. Ya., Phys. Stat. Sol. (a), 15, 3, 1973.
242. Crystal–chemical, physical and chemical properties of semiconductor materials, Izdatel'stvo standartov, Moscow, 1973 (in Russian).
243. Gel'mont, B. L., Ivanov-Omskii, V. I., Kolomietz, B. T., Fizika i tekhnika poluprovodnikov, 5, 266, 1971 (in Russian).

244. Szymanska W., Physics narrow-gap semiconductors, Proc. III Internat. Conf., Warsaw, Sept. 1977, Eds. Rauluszkewicz, J., Gorska, M. and Kaczmarek, F., PWN–Polish–Sci. Publishers, Warsaw, 1978.
245. Dziuba, Z., Wrobel, J., Phys. Stat. Sol. (b), 100, 379, 1980.
246. Landolt–Bornstein, Numerical data and functional relationship in science and technology, Ed. Madelung, O., Springer–Verlag, Berlin, 1987 (vol. 22, subvol. a).
247. Kato, N., Kummura, M., Iwami, M., Kawabe, K., Jap. J. Appl. Phys., 16, 1623, 1977.
248. Grigas, J., Krist. Techn., 13, 683, 1978.
249. Sominskii, M. S., Semiconductors, Nauka, Leningrad, 1967 (in Russian).
250. Stirn, R. J., Becker, W. M., Phys. Rev., 148, 907, 1966.
251. Reid, F. J., Willardson, R. K., J. Electron. Control., 5, 54, 1958.
252. Baars, J., Jorger, F., Solid State Comm., 10, 875, 1972. 253. Ilegems, M., Montgomery, H. C., J. Phys. Chem. Sol., 34, 885, 1973.
254. Burstein, E., Pinczuk, A., Wallis, R. F., Ibid., 32, Suppl. No 1, 251, 1971.
255. Rode, D. L., Semiconductors and semimetals, Eds. Willardson, R. K. and Beers, A. C., Academ. Press, New York, 1975 (vol. 10).
256. Casey, H. C., Ermanis, F., Wolfstirn, K. B., J. Appl. Phys., 40, 2945, 1969.
257. Solomon, R., 2nd Intern. Symp. GaAs and Related Compounds, Inst. Phys., London, 1968 (p. 11).
258. Roy, B., Chakraberty, B. R., Bhattacharya, R., Dutta, A. K., Solid State Comm., 25, 937, 1978.
259. Wiley, J. D., Semiconductors and semimetals, Eds. Willardson, R. K. and Beers, A. C., Academ. Press, New York, 1975 (vol. 10).
260. Vilms, J., Garrett, J. P., Solid State Electron., 15, 443, 1972.
261. Marshall, J. M., J. Phys. C, 10, 1283, 1977.
262. Dakhno, A. N., Emel'yanenko. O. V., Lagunova, T. S., Metreveli, S. G., Fizika i tekhnika poluprovodnikov, 10, 677, 1976 (in Russian).
263. Golovanov, V. V., Metreveli, S. G., Snukaev, N. V., Starosel'tseva, S. P., Ibid., 3, 120, 1969 (in Russian).
264. Stillman, G. E., Wolfe, C. M., Dimmock, J. O., Semiconductors and semimetals, Eds. Willardson, R. K. and Beers, A. C., Academ. Press, New York, 1977 (vol. 12).
265. Trifonov, V. I., Yaremenko, N. G., Fizika i tekhnika poluprovodnikov, 5, 953, 1971 (in Russian).
266. Yaremenko, N. G., Potapov, V. T., Ivleva, V. S., Ibid., 6, 1238, 1972 (in Russian).
267. Rode, D. L., Phys. Rev., B3, 3287, 1971.
268. Schein, L. B., Ibid., B15, 1024, 1977.
269. Filipchenko, A. S., Bol'shakov, L. P., Phys. Stat. Sol., 77, 53, 1976.
270. Likhter, A. I., Pel, E. G., Prisyazhnyuk, S. I., Phys. Stat. Sol (a), 14, 265, 1972.
271. Kipperman, A. H. M., Solid State Comm., 9, 1825, 1971.
272. Kipperman, A. H. M., Van der Leeden, G. A., Ibid., 6, 657, 1968.
273. Kipperman, A. H. M., Vermij, C. J., Nuovo Cimento, B63, 29, 1969.
274. Tatsuyama, C., Hamaguchi, C., Tomita, H., Nakai, J., Jap. J. Appl. Phys., 10, 1698, 1971.
275. Fivaz, R., Mooser, E., Phys. Rev., 163, 743, 1969.
276. Fivaz, R., Shmid, Ph. E., Physics and Chemistry of Materials with Layered Structures, Ed. Lee, P. A., vol. 4: Optical and electrical properties, D. Reidel Publ. Comp., London, 1976 (p. 343).
277. Fisher, G., Brebner, J. L., J. Phys. Chem. Sol., 23, 1363, 1962.
278. Gouskov, L., Gouskov, A., Solid State Comm., 28, 99, 1978.
279. Fielding, P., Fisher, G., Mooser, E., J. Phys. Chem. Sol., 8, 434, 1959.
280. Nishino, T., Hamakawa, Y., Jap. J. Appl. Phys., 16, 1291, 1977.
281. Damon, R. W., Redington, R. W., Phys. Rev., 96, 1498, 1954.
282. Sugaike, S., Mineral J., 2, 63, 1957.
283. Itoga, R. S., Kannewurf, C. R., J. Phys. Chem. Sol., 32, 1099, 1971.

284. Ikari, T., Hashimoto, K., Phys. Stat. Sol. (a)., 31, K115, 1975.
285. Makita, Y., Kobayashi, K., Kanada, M., Kawai, T., J. Phys. Soc. Japan, 25, 816, 1968.
286. Kobayashi, K., Kawai, T., Kanada, M., Ibid., 23, 305, 1967.
287. Kawai, T., Kobayashi, K., Kurita, M., Makita, Y., Ibid., 30, 1101, 1971.
288. Physical and chemical properties of semiconductors. Handbook, Nauka, Moscow, 1979 (in Russian).
289. Berchenko, N. N., Krevs, V. E., Sredin, V. G., Semiconductor solid solutions and their application, Voenizdat, Moscow (in Russian).
290. Landolt–Bornstein, Numerical data and functional relationship in science and technology, Ed. Madelung, O., Springer–Verlag, Berlin, 1982 (vol. 17, subvol. b).
291. Conwell, E.M., High field transport in semiconductors, Academic Press, New York – London, 1967
292. Landolt–Bornstein, Numerical data and functional relationship in science and technology, Ed. Madelung, O., Springer–Verlag, Berlin, 1982 (vol. 17, subvol. a).
293. Landolt–Bornstein, Numerical data and functional relationship in science and technology, Ed. Madelung, O., Springer–Verlag, Berlin, 1983 (vol. 17, subvol. e).
294. Landolt–Bornstein, Numerical data and functional relationship in science and technology, Ed. Madelung, O., Springer–Verlag, Berlin, 1983 (vol. 17, subvol. f).
295. Kamath, G. S., Mater. Res. Bull., 4, S57, 1969.
296. Van Daal, H. J., Knippenberg, W. F., Wasscher, J. D., J. Phys. Chem. Sol., 24, 109, 1963.
297. Nimitz, G., Schlicht, B., Springer tracts in modern phys., Springer–Verlag, Berlin, 1983 (vol. 98).
298. Van den Dries, J., Lieth, R., Phys. Stat. Sol. (a), 5, K171, 1971.
299. Stourac, L., Zavetova, M., Abraham, A., Proc. of the 12-th International Conf. on Phys. Sem., Stuttgart, Teubner 1974 (p. 621).
300. Stanchev, A., Vodenicharov, C., Thin Solid Films, 38, 67, 1976.
301. Asanabe, S., Okazaki, A., J. Phys. Soc. Japan, 15, 989, 1960.
302. Kyriakos, D. S., Valassiades O., Economou, N. A., Instrum.Phys.Conf., 1979, ser.43, chapt.8.
303. Anisimov, B. B., Gabedova, A. A., Dzhamagidze, Sh. Z., Izvestiya Acad. nauk SSSR, Ser. "Inorganic materials", 14, 1417, 1978 (in Russian).
304. Bahl, S. K., Chopra, K. L., J. Appl. Phys., 41, 2196, 1970.
305. Yabumoto, T., J. Phys. Soc. Japan, 13, 972, 1958.
306. Albers, W., Haas, C., Vink, H., J. Appl. Phys., 32, 2220, 1961.
307. Umeda, J., J. Phys. Soc. Japan, 16, 124, 1961.
308. Maier, H., Daniel, D. R., J. Electron. Mater., 6, 693, 1977.
309. Sagar, A., Miller, R. C., Proc. of International Conf. on Phys. Semicond., Exeter, July 1962, Ed. Stickland, A. C. (p.653)
310. Allgaier, R. S., Houston, B., Phys. Rev., B5, 2186, 1972.
311. Fonstad, C. J.,Rediker, R. H., J. Appl. Phys., 42, 2911, 1971.
312. Gowers, J. P., Lee, P. A., Solid State Comm., 8, 1447, 1970.