However, with certain values of the parameters $a$, $b$, and $\beta$ (e.g., $a = 10$, $b = 0.5$, and $\beta = 1$) condition (3.15) holds only with quite large energy gaps — more than 1 eV (if we use the same values of $\omega_0$ as in section 2 for the estimate). In such cases a frequency dependence of the type of (3.16) could not be detected experimentally.

Our present results, notably the representation of $\alpha(\omega)$ as a sum of terms with different frequency dependences, differ slightly from those of Esser et al. [9, 10], who derived a frequency dependence of the absorption coefficient that can be described by a linear exponential with a temperature-dependent slope of the absorption edge. The origin of this difference seems to be that our approach, though in many ways similar to that of Esser et al. diverges significantly at several points — in particular their random field is definitely not smooth [9, 10].

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LITERATURE CITED


ELECTRICAL RESISTANCE OF BINARY ALLOYS WITH SHORT-RANGE ORDER (THE WEAK SCATTERING APPROXIMATION IN THE COHERENT POTENTIAL APPROXIMATION)

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A simple version of the coherent-potential approximation is proposed for taking into account the short-range order in the first coordination sphere in a binary alloy. The residual electrical resistance is calculated in the limit of weak scattering. It is shown that the correlation contribution to the resistance depends very much on the position of the Fermi energy in the band, and that a nonmonotonic variation in the resistance is possible when short-range order develops in the alloy. The results are used for a qualitative interpretation of the different nature of the dependence of the resistance of alloys on the degree of short-range order.

1. The coherent-potential approximation [1, 2] enables one to study the electron structure and the kinetic properties of alloys of arbitrary composition with component parameters that differ by as much as...
desired. The coherent-potential approximation was first proposed for completely unordered alloys and was then generalized to the case of alloys possessing some type of ordering. The effect of long-range order on the density of states and the resistance was considered in [3-5]. Many papers have been published in which the coherent-potential approximation is generalized to take short-range order into account, but the treatment used is extremely complicated and does not enable one to estimate directly the effect of short-range order on the properties of alloys, so that the problem cannot finally be solved. The effect of short-range order on the density of states has been considered, in particular, in [6, 7], and the effect on the conductivity has been considered in [8].

In the present paper we use a simple version of the coherent-potential approximation, similar to that used in [6], to calculate the residual resistance of a binary alloy with short-range order. In the limit of weak scattering, which is obviously realized in metal systems, where current transfer occurs mainly by s-electrons, it is possible to obtain an analytical expression for the resistance in terms of the concentration of the components and the correlation parameter. Similar relations have been investigated previously by the kinetic-equation method for elastic [9] and inelastic (phonon and magnon) [10] scattering mechanisms.

2. Consider a binary substitution alloy A-B with component concentrations \( c_A \) and \( c_B = (1 - c_A) \). The short-range order in the alloy will be taken into account only in the first coordination sphere, by introducing a correlation parameter \( \varepsilon = \varepsilon_{AB} \). The a priori probability that a random pair of short-range neighbors will be a pair of the \( \alpha-\beta \) type (\( \alpha, \beta = (A, B) \)), is (see e.g., [9])

\[
p_{\alpha\beta} = c_{\alpha} c_{\beta} + \varepsilon (1 - 2c_{\alpha}).
\]  

(1)

We will choose the model Hamiltonian in the form

\[
H = \sum_n \varepsilon_n |n > < n| + \sum_{n, \Delta} h_{n, n+\Delta} |n > < n + \Delta|,
\]

(2)

where \( \{|n\rangle\} \) is the set of Første states, \( \{|\Delta\rangle\} \) are the radius vectors of the closest neighbors, \( \varepsilon_n \) is the electron energy and the lattice point \( n \), which takes values of \( e_A \) or \( e_B \) depending on the sort of atom at the lattice point, and \( h_{n, n+\Delta} \) is the migration integral which, for simplicity, we will assume to be independent of the sorts of atoms at the lattice points \( n \) and \( n + \Delta \) (i.e., \( h_{n, n+\Delta} = h \)), although, as will be shown, this is not essential.

As is well known, the equation of the single-point coherent-potential approximation can be obtained from the condition that additional scattering, produced by one atom, introduced into the effective medium, is, on average, zero [11]. Using this condition for the case of a pair of atoms of closest neighbors, introduced into the effective sphere, we obtain

\[
< G_{\alpha\beta} > = \tilde{G},
\]

(3)

where

\[
G_{\alpha\beta} = \tilde{G} + \tilde{G} t \tilde{G}, \quad t = W [1 - \tilde{G} W]^{-1}.
\]

(4)

\( \tilde{G} = (z - \tilde{H})^{-1} \) is Green's function of the effective medium described by the Hamiltonian

\[
\tilde{H} = \sum_{n, \Delta} h |n > < n| + M(z),
\]

(5)

with the eigen-energy operator

\[
M(z) = \sum_n \sum_{\Delta} |n > < n| + \sum_{n, \Delta} \sum_{\Delta'} |n > < n + \Delta|;
\]

(6)

\[
W = \tilde{G}^{-1} - G_{\alpha\beta}^{-1} = 0 < 0 | (\varepsilon_\alpha - \varepsilon) + 1 < 1 | (\varepsilon_\beta - \varepsilon) - \Delta (|0 < 1| + |1 < 0|).
\]

(7)

the lattice points 0 and 1 are an arbitrary pair of closest neighbors.

If the migration integrals are assumed to be random, we have \( \tilde{H} = M(z) \), and in the expression for \( W \) we have the term \( (|0 < 1| + |1 < 0|) h_{0,1} \).