The theory of electrical conductivity. Superconductivity.

The clarification of the nature of metallic bonding and the physical nature of electrical conductivity has allowed us to advance in explaining the phenomenon of superconductivity.

Currently (in 2010), two theories are used to explain the phenomenon of superconductivity – the magnetic vortex theory and quantum-mechanical theory.

The discoverer of superconductivity Kammerlingh Onnes. (1911),

www.superconductors.org

The magnetic vortex theory

The ancestors of high-temperature superconductivity. Nobel Prize winners, Alex Muller and Georg Bednorz,

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The magnetic vortex theory

When a superconductor enters a magnetic field, the field penetrates it, in the form of thin fluxes called vortices. Electric currents emerge around each vortex. These vortices replicate themselves and are scattered when the temperature of the material increases. Since the vortices tend to be attached to long thin holes in the material, called the prismatic defects, researchers assumed that the vortices would behave differently in the presence of such defects. They also found that when the number of vortices is greater than the number of holes, the vortices begin to scatter in two stages instead of one as the temperature rises.

If we manage to delay the process of the scattering of the vortex flows, it will be possible to achieve the effect of superconductivity at higher temperatures.

Quantum-mechanical theory

Authors of the most popular model of superconductivity (BCS) - John Bardeen, Leon Cooper, John Schrieffer (1957),

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The quantum-mechanical theory of superconductivity (BCS theory) considers this phenomenon to be the superfluidity of Bose-Einstein condensate of a Cooper pair of electrons in metal, with the absence of friction attributable to superfluidity. The conductivity electrons move freely in a superconductor, without “friction” with the inhomogeneities of the crystal lattice. The main peculiarity of superconductors is that the mutual attraction of electrons, which causes the formation of electron pairs (called Cooper pairs), emerges in them. The reason for this attraction is the additional (to the Coulomb repulsion) interaction between the electrons under the influence of a crystal lattice, which leads to the attraction of the electrons.

In the quantum theory of metals, the attraction between electrons (the exchange of phonons) is associated with the emergence of the elementary excitations of the crystal lattice. An electron moving in a crystal and interacting with another electron through the lattice converts this lattice to an excited state. In the process of the transition of the lattice into the ground state, an energy quantum of sound frequency (a phonon) is radiated and then absorbed by another electron. The attraction between electrons can be represented as an exchange of electrons by phonons, and the attraction is most effective if the pulses of interacting electrons point in opposite directions.

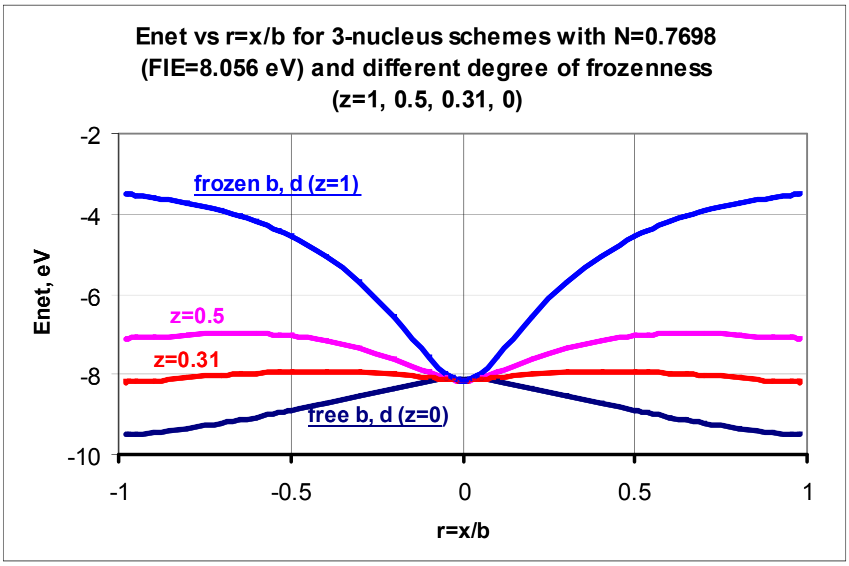
The emergence of the superconducting state of a substance is connected with the possibility of the formation of bound pairs of electrons (Cooper pairs) in the metal. The evaluation shows that the electrons that form a pair are separated by distances of about a hundred periods of the crystal lattice. The whole electronic system of the superconductor is a close-knit formation extending to enormous distances, according to the atomic scale.

If, at incredibly low temperatures, the Coulomb repulsion between electrons prevails over the attraction that forms pairs, the substance (metal or alloy) retains its usual properties. If, at the temperature $T_{c,}$ attractive forces dominate repulsive forces, the substance passes into a superconductive state.

We have a different explanation of the phenomenon of superconductivity, which we believe is clearer than those described above. The explanations mentioned above are based on the existence of free elecrtons and electrons pairs.

We believe that there are no free electrons, but electrons moving along chmical bonds do exist.

In the articles "Theory of electrical conductivity" (by Y. Gankin, V. Gankin) and "Semiquantative modelling of electrical conductivity in metals and nonmetals" (by Y. Gankin, V. Gankin, A. Sanin), it was shown that the difference between the electrical conductivity of metals and of nonmetals is determined by the different natures of chemical bonding in metals and nonmetals. In metals, this bonding is one-electron and dynamic, and in non-metals the bonding is two-electron and static. The bonding energy in nonmetals is 70 times greater than the bonding energy in metals. Electric current in metal is a movement of valence electrons along the bonds under the influence of the field. The mathematical model that we have developed allows us to calculate the energy change of electrons as they move along the chemical bond, for two cases of double and triple-core models. We determine the dependence of electron energy on the ionization potential of bonded atoms and on the degree of freezing of the system, which is defined as the modification in proportion of the velocity of transport of nuclei and electrons along with reduction of temperature. The model shows that the smallest change in energy of the system occurs when the ionization potentials of the bonded atoms are close to 8 eV and the degree of freezing is 30%.



According to experimental data[1], superconducting alloys discovered in the period from 1910 to 1993 include the following metals: niobium (6.88)[2], aluminum (5.98) tin (7.34), beryllium (9.32), lanthanum (5.61), barium (8.3), copper (7.72), tallium (7.88), cobalt (7.86), mercury (10.43), germanium (7.88) and calcium (6.11). These figures allow us to confirm that the experimental data and model calculations do not contradict each other.

[1] J.H. Schon, Ch. Kloc, B. Batlogg, Bell Laboratories
[2] In a parenthesis the ionization potential of these metals in electron-volts is set