Yu. A. Osip'yan. *Dislocational (quasi-one-dimensional) electrical conductivity in semiconductors.* Our basic concepts of the influence of dislocations on the electrical properties of semiconductors are based on a model of the dislocation chain as a row of atoms with broken chemical bonds. These atoms may capture electrons from the conduction band, thereby acting as acceptors. The magnitude of the acceptor effect on introduction of dislocations can be judged from experimental study of the decrease in conduction-electron concentration. At the same time, dislocations may also have a donor effect. What happens essentially in the donor-effect mechanism is that unpaired electrons, having been removed from atoms in the dislocation chain, descend upon acceptor centers and "stuff" them, lowering their concentration. This lowers the probability of thermal-electron capture by acceptor centers, i.e., lowers the concentration of free holes in the valence band. It has also been possible to observe this experimentally through the decrease in hole concentration in p-type crystals on introduction of dislocations. Several years ago, I discussed experiments in this area at one of the scientific sessions of our Division.[1]

However, the fact that the dislocations turn out to be electrically charged is another aspect of the matter when electrons are captured on dislocations or when unpaired electrons are given up. In the case of a negatively charged dislocation, a positively charged cylinder forms around it and the charge of the cylinder screens the negatively charged dislocation. When the dislocation is positively charged, on the other hand, negative charges are concentrated within the screening cylinder. The result is that a crystal with dislocations is a heterogeneous system. It might be assumed that the carrier mobilities would differ substantially along and across the dislocation lines, i.e., along and across the cylinders. In fact, we have succeeded in our experiments in observing sharp anisotropy of carrier mobility along and across dislocations introduced into a crystal.[2]

In a special case, the cylinders that screen the dislocation charges intersect. Difficulties then arise for conduction electrons in the form of a change in conditions for the passage of electric currents. However, everything that we have said above boils down to study of the influence of dislocations on the behavior of band electrons. We have made an attempt to follow the behavior of dislocation-captured electrons or of the actual electrons of the ruptured bonds. We have succeeded in observing effects of dislocation conduction, a phenomenon in which a rather high electrical conductivity that does not depend on temperature and is not accompanied by the appearance of the Hall effect is observed at low temperatures, when there are practically no electrons in the conduction band.[3]

Application of a technique for measurement of microwave conductivity figured in our subsequent experiments. In dc measurements, when motion of carriers from contact to contact is required for detection of conductivity, all types of singularities in the dislocation structure (crossing of dislocations, bends and steps on the dislocations, etc.) come into play. In microwave methods, absorption of the microwave signal can be observed even if the segment of the dislocation along which the motion of the dislocations occurs is short. Using this method, we did indeed succeed in observing sharply anisotropic microwave absorption the anisotropy of which conformed to that of a specially created dislocation structure. The dislocation structure in these experiments consisted of lines parallel to the [110] crystallographic direction. The number of dislocations in this direction was 10 times larger than the number encountered in any other direction. The amount of microwave absorption, as determined from the shape of the resonance curve, was also approximately 10 times larger than the absorption in any other direction.

A tentative model of dislocation bands in germanium and silicon was arrived at from analysis of the temperature dependence of microwave absorption and the dependence of the amount of absorption on the dislocation density at various donor and acceptor concentrations.[4-8]

[1] Yu. A. Osip'yan, Usp. Fiz. Nauk **104**, 681 (1971) [Sov Phys. Usp. **14**, 542 (1972)].

[2] Yu. A. Osip'yan and S. A. Shevchenko, Pis'ma Zh. Eksp. Teor. Fiz. **18**, 256 (1973) [JETP Lett. **18**, 153 (1973)].

[3] Yu. A. Osip'yan and S. A. Shevchenko, *ibid*. **20**, 709 (1974) [**20**, 328 (1974)].

[4] V. A. Grazhulis, V. V. Kveder, V. Yu. Mukhina, and Yu. A. Osip'yan, *ibid*. **24**, 164 (1976) [**24**, 142 (1976)].

[5] Yu. A. Osip'yan, V. I. Tal'yanskii, and S. A. Shevchenko, Zh. Eksp. Teor. Fiz. **72**, 1543 (1977) [Sov. Phys. JETP **45**, 810 (1977)].

[6] Yu. A. Osip'yan, V. I. Tal'yanskii, A. A. Kharlamov, and S. A. Shevchenko, Zh. Eksp. Teor. Fiz. **76**, 1655 (1979) [Sov. Phys. JETP **49**, 840 (1979)].

[7] V. N. Erofeev, V. I. Nikitenko, V. I. Polovinkina, and É. V. Suvorov, Kristallografiya **16**, 190 (1971) [Sov. Phys. Crystallogr. **16**, 151 (1971)].

[8] Yu. A. Osip'yan, V. M. Prokopenko, V. I. Tal'yanskii, A. A. Kharlamov, and S. A. Shevchenko, Pis'ma Zh. Eksp. Teor. Fiz. **30**, 123 (1979) [JETP Lett. **30**, 111 (1979)].