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Meetings and Conferences

ALL-UNION CONFERENCE ON DISLOCATIONS AND MECHANICAL PROPERTIES OF CRYSTALS

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A conference on the problems related to the motion of dislocations in crystals was held in Odessa between 12th and 16th May, 1964. Over 300 representatives of the leading scientific institutes of the U.S.S.R. Academy of Sciences, the Academies of Sciences of the Union Republics, State Committees and higher educational establishments (81 organizations in all, from 28 Soviet cities) took part in this Conference. Thirty-seven papers on the following subjects were heard and discussed:

1. Mobility of dislocations in crystals.
2. Theoretical problems of the motion of dislocations.
3. Influence of external fields and impurities on the mobility of dislocations in crystals.
4. Relationships governing the multiplication and motion of dislocations under various deformation conditions.
5. Interaction of dislocations with block and twin boundaries; twinning dislocations.
6. Role of the motion of dislocations in the processes of creep, relaxation and fracture.
7. Nonconservative motion of dislocations.

The opening paper of the Conference was a detailed review of the first subject. It was presented by a member of the staff of the Leningrad Physico-technical Institute, **É. M. Nadgornyĭ**, who showed that current developments of the experimental techniques for the visualization of dislocations in crystals make it possible to obtain quantitative data on the laws of motion of dislocations. Comparison of the experimental data with the theoretical predictions reveals considerable flaws in the theory. However, there are very few quantitative results on the motion of dislocations. So far only NaCl, LiF, Ge, MgO, and Fe–Si have been investigated.

The second paper came from a member of the staff of the Crystallography Institute of the U.S.S.R. Academy of Sciences, **A. A. Urusovskaya,** who dealt with the results of the work she had carried out with Tyaagaradzhan (student of the Institute for Solid State Physics in Delhi). They have succeeded in supplementing the information on the velocity of dislocations by quantitative measurements of the dependence of the velocity of edge dislocations in GJ(sic!) crystals on the applied stress. Shear stresses necessary for the generation of dislocations in these crystals (2000 g/mm^2), for initiating their motion (1 g/mm^2) and for multiplication (3–4 g/mm^2) were measured. Layer-by-layer chemical etching of the samples was used to plot the shape of the dislocation lines during their motion. Retardation of the lines by impurities and transverse slip segments was observed.

Much interest was aroused by the third paper. **F. F. Lavrent'ev, O. P. Salita** and **V. I. Startsev** (Physico-technical Institute, Khar'kov) investigated, by selective etching, the influence of temperature and the degree of perfection of zinc crystals on the value of the stress necessary to start the motion of dislocations in pyramidal slip planes. On cooling from room temperature to liquid nitrogen temperature, the starting stress increases by a factor of 10. A lively discussion took place on the possibility and methods of determining the value of the starting stress.

N. A. Toropov and **Yu. P. Udalov** (Leningrad Technological Institute) reported the first investigations of "The motion of dislocations in potassium bromide crystals."

The morning and evening sessions of the second day were devoted to theoretical problems of the motion of dislocations in crystals. Nine papers were presented. We shall consider only the most interesting of them.

A. M. Kosevich (Khar'kov Physico-technical Institute) considered in his paper, "Theory of moving dislocations," the thermally activated motion of edge dislocations in a slip plane at stresses below the starting stress necessary to overcome the Peierls-Nabarro forces (diffusion mechanism).

The motion of mixed dislocations with jogs was the subject of the contribution from **A. N. Orlov** (Leningrad Physico-technical Institute). He discussed the motion of kinks and jogs of mixed dislocations in face-centered cubic metals, and considered the derivation of transport equations for the densities of kinks and jogs.

V. L. Indenbom showed in his paper, "The mobility of dislocations according to the Frenkel'-Kontorova model," that, depending on the form of the potential distribution, a great variety of cases is possible, including complete absence of the resistance of the lattice to the motion of dislocations.

L. I. Vasil'ev discussed various possible geometrical mechanisms of strengthening of ordered alloys associated with the interaction of dislocations and antiphase boundaries.

The third day of the Conference was given over to the fourth and fifth of the subjects listed above. Here, we must record the paper of M. P. **Shaskol'skaya** (Steel Institute) on the problem of the influence of impurities on the motion of dislocations in ionic crystals. She reported her results which showed that impurities affect the static and dynamic mechanical properties of crystals differently. She found that some impurities reduced the strength. Impurities are precipitated at old dislocations, blocking them, but do not affect the motion of fresh dislocations. The dislocation charge affects the motion but quantitative data were not yet available.

From the communication of E. G. **Shvidkovskiĭ** and N. V. **Zagoruĭko** (Moscow State University), it followed that, when dislocations were subjected to an electric field a considerable fraction of them moved along the field. Their mobility decreases rapidly with time. It was suggested that dislocations lost their charge partly or completely during the motion.

L. M. **Soĭfer**, in "Investigation of the behavior of dislocations in antimony crystals," reported observations of the motion of low-angle boundaries under the action of a linear stress tending to straighten the dislocations forming these boundaries.

On the last day, subjects 5, 6, and 7 were considered. Of special note was the morning-session paper of V. M. **Stepanova** and A. A. **Predvoditelev**, "Investigation of the retardation of dislocations by dislocation walls in crystals." The authors showed that the stress necessary for the breakthrough of edge dislocations through walls formed during growth is independent of the angle of approach of the dislocation to the wall and depends linearly on the density of dislocations in the wall.

The evening of the last day of the Conference had the largest number of noteworthy papers.

A. L. **Roĭtburd** (Metal Physics Institute of the Scientific Research Institute for Ferrous Metallurgy, Moscow) developed a general theory of nonconservative steady-state motion of dislocations and, using electron-microscopic studies, investigated in detail the case of conservative climb of screw dislocations. The dislocation moves on the average in a slip plane but vacancies are exchanged between the various parts of the helix.

A. L. **Roĭtburd**, M. P. **Usikov** and L. M. **Utevskiĭ** established, by electron-microscopic investigations of the process of creep in nickel and its alloys, that the mechanism of high-temperature creep amounts to the conservative climb of screw dislocations discussed in the paper of A. L. Roĭtburd just referred to. The dislocations form helices around their Burgers vectors. The experimental observations were in good agreement with the theoretical estimates. The diffusion paths were found to be of the order of the helix diameter.

From their electron microscope observations on the interaction of moving dislocations with prismatic dislocation loops in zinc foil, V. N. **Rozhanskiĭ** and A. A. **Predvoditelev** concluded that this interaction is accompanied by the strong diffusion of point defects along edge dislocations. The coefficient for linear self-diffusion along dislocations was estimated to be 10 orders of magnitude greater than the volume diffusion coefficient. This new form of the diffusion interaction between dislocations, taking into account the high value of the climb diffusion along dislocations, could be important in the processes of plastic flow, relaxation of stresses, and fracture of crystals.

The paper of N. K. **Rakova** and A. A. **Predvoditelev** on "The motion of dislocations and relaxation of stresses" merits special attention. They were the first to establish clearly, by an experimental study of the process of stress relaxation in sodium chloride single crystals, that, in the initial stage, the relaxation does indeed represent the dislocation displacements observed experimentally.

The Conference resolution read: "The Conference notes the intensive development, in recent years, of the dislocation theory of the strength of crystals. New results have been obtained on the motion and interaction of dislocations in crystals and orderable alloys, the nonconservative motion of dislocations, the influence of electric fields and structural defects on the motion of dislocations in ionic crystals, etc.

Insufficient attention has been paid to the study of the influence of the nature of interatomic forces on the mobility of dislocations and the study of the influence of defects of various origins (produced, in particular, by irradiation) on the retardation of dislocations. Investigations of the crystal structure defects by means of the Mössbauer effect, n.m.r. and e.s.r. methods have not been sufficiently intensive. It is noted that the rate of progress of the scientific research work on crystal structure defects still lags behind the work outside the Soviet Union.

The Conference is of the opinion that further studies of crystal structure defects should be concentrated in the following areas:

1. Experimental and theoretical investigations of the mobility of single dislocations in metals, ionic crystals, and semiconductors.
2. Microscopic and continuum theories of dislocations.
3. Comparison of the results of studies of dislocations with macroscopic characteristics of the plastic deformation of crystals.
4. Influence of point defects and impurities, and of their interaction with dislocations, on the mechanical properties of crystalline solids.
5. Nonconservative motion of dislocations.
6. Investigation of the behavior of charged dislocations in ionic crystals.
7. Development of methods offering new ways of obtaining data on the mechanisms of the formation, interaction, and motion of crystal structure defects.

In experimental and theoretical work on dislocations, it is necessary to pay greater attention to the solution of the urgent problems arising in the physics of the more important technological properties of various new technical materials.

The Conference has heard communications on the work carried out cooperatively by several establishments (Physico-technical Institute of the Ukrainian Academy of Sciences and Physics Institute of the Georgian Academy of Sciences; Crystallography Institute of the U.S.S.R. Academy of Sciences and Moscow State University, etc.). This method of carrying out scientific research, particularly in the case of comprehensive studies, deserves serious attention and wide application. The principle accepted by the Organizing Committee of the Conference that meetings should be convened on narrow key problems, with wide-ranging and detailed discussions, deserves further development."

The organizers of the Conference were the Council on the Physics of Strength of the U.S.S.R. Academy of Sciences, the Crystallography Institute of the U.S.S.R. Academy of Sciences, and the I. I. Mechnikov State University in Odessa.

Translated by A. Tybulewicz