with some intended change of their structure and consequently of their properties.

In patterns of the distribution of valence electrons in crystals and molecules obtained on the basis of x-ray diffration data it is easy to establish, for example, the spatial localization of the unpaired electron responsible for paramagnetism of the compound. Laser crystals pose for precision structure analysis of the problem of localization of small activating impurities in them.

The problem of establishing relations between the structure and properties of crystals was posed long ago, but only the contemporary level of precision structural crystallography permits an adequate solution of this problem.

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V. R. Regel'. *Some problems of contemporary research on the mechanical properties of crystals.* In connection with the fortieth anniversary of the Institute of Spectroscopy we shall start by briefly recalling several pioneer studies carried out at our institute in the course of forty years in the Laboratory of Mechanical Properties of Crystals organized by M. V. Klassen-Neklyudova: work on the production and study of fiberglass-reinforced plastic composition materials,[1] visualization of the domain structure in ferroelectric salts,[2] study of the phenomenon of kink formation,[3] and development of a number of original instruments for measurement of the mechanical properties of crystals.[4,5] The laboratory made a serious contribution to the study of the laws of plastic deformation and fracture of crystals, including the development of the dislocation theory of deformation. These studies have continued up to the present time. As an example one can cite the study of the evolution of dislocation structure and of the mechanism of hardening of MgO crystals during deformation over a wide range of temperatures from $-180°$ to $+2200$ °C.[6]

At the present time the laboratory is studying a number of new problems related to the mechanical properties of crystals. We shall mention some of these below.

We are studying the phenomenon of superlocalization of plastic deformation in crystals at high temperatures approaching the melting point.[7] This effect has not yet been completely explained and deserves further detailed study. Related to this problem is the study of the local heating of slip bands of crystals during deformation, in particular by the method of depositing liquid-crystal coverings and analysis of the change in their coloration.[8]

Efforts are being concentrated on studies of the actual structure and mechanical properties of surface layers of crystals in order to obtain information on the influence of the surface state on the bulk mechanical properties of crystals. Here special attention is being given to study of the involvement of point defects in development of deformation in fracture and to verification of the suggested idea that plastic deformation of refractory crystals occurs as the result of collective displacement of point defects without participation of dislocations.[9] A method has been developed for observation of the displacement of point defects by detection of the cathodo-luminescence from these defects in a scanning electron microscope *in situ* on application of a concentrated load at the crystal surface. It has been shown that the displacement of ensembles of point defects is crystallographically directed and reaches hundreds of microns. The kinetics of this process is being studied. The observed phenomena have not yet received a definitive theoretical explanation.

In the laboratory a method is being developed for the solid-phase joining of single crystals, both identical and different, and also of elements of them.[10] The method has made possible the production of a number of fundamentally new products for contemporary technology, for example, composition crystal laser elements, optical Q modulators for laser systems, composite crystalline containers for thermal processing of various products under especially pure conditions, and so forth. The development of the mechanism of the solid-phase joining process for crystals is based on a model of multiple indentation, and in addition to taking into account diffusion processes considers the need of taking into account the possible mass transfer resulting from dislocation-free displacement of ensembles of point defects, and also possible participation of explosive (shock) mechanisms of crystallization. Further studies of the structure and properties of the boundaries of the solid-phase junction are planned, in order to develop a definitive theory of processes which develop in a solid-phase junction.

An area of work related to studies of the influence of point defects on the mechanical properties of crystals is study of the influence of ionizing radiation on the actual structure and properties of bombarded crystals. Experiments carried out jointly with the Nuclear Reactions Laboratory at the Joint Institute for Nuclear Research on study of the influence of bombardment of crystals (and metals) by heavy ions of high energy, including crystals in a state of stress,[11,12] have shown that the existing theories of radiation damage require further development to explain the experimental data which have been obtained.

The problems enumerated, on solution of which the Laboratory of Mechanical Properties of Crystals at the Institute of Crystallography is working, show that further detailed experimental research and theoretical development are necessary for the solution of these problems.

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