EXPERIMENTAL OBSERVATION OF THE INFLUENCE OF LIGHT ON PLASTIC DEFORMATION OF CADMIUM SULFIDE

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In mechanical tests of CdS single crystals we observed an influence of the presence of light on the plastic deformation of the crystals.

The observed effect consisted in the following:

The sample was placed between two plungers in a special chamber and was deformed by uniaxial compression at a constant rate.

During the stage of the plastic deformation, the crystal was illuminated with visible light. At the instant of illumination, an appreciable strengthening was observed, wherein the mechanical stress needed to continue the plastic deformation of the crystal increased abruptly to a definite value, beyond which saturation set in and the crystal continued to be deformed, but now at a larger stress. When the light source was turned off, the load dropped rapidly and the subsequent part of the stress-strain curve had the same form as without the application of the light.

The stress bursts occurring upon illumination of the crystal could be observed during the entire interval of plastic deformation of the sample.

A typical compression diagram demonstrating the strengthening of the crystal under the influence of the light is shown in Fig. 1.

The effect was observed in CdS crystals obtained by different methods, both by crystallization from the melt and by sublimation from the gas phase, independently of the electric resistivity, which fluctuated from 10^{-1} to 10^{5} ohm-cm in connection with the stoichiometry of the composition and with the different impurity contents.

The samples were cut from ingots and were in the form of a rectangular prism measuring 3 x 3 x 6 mm.

The samples were so oriented that their compression took place in the $\langle 11\bar{2}3\rangle$ direction. With such a compression, the deformation was due to dislocation with a slip plane (0001) and

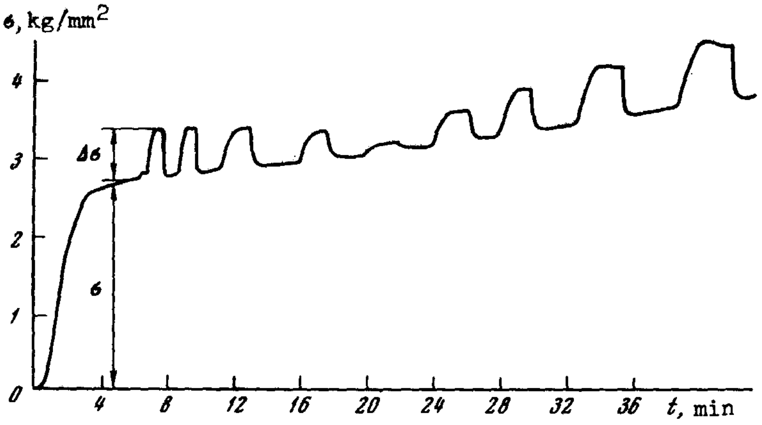

Fig. 1. Compression diagram of CdS crystal. t = 75°C is the sample test temperature; v = 10^{-5} cm/sec is the rate of sample compression. The differences of the additional stress $\Delta\sigma$ are determined by the different illumination of the sample.

a slip direction ⟨11$\bar{2}$0⟩. Slip rows were observed on the side faces ($\bar{1}$100).

The sample was placed between two plungers in a special chamber that could be heated, and was compressed at a constant speed, 10^{-5} cm/sec.

The load acting on the sample was registered with an automatic plotter as the ordinate of the plotter chart. The abscissa of the chart was the strain, which was proportional to the loading time (Fig. 1).

The tests were made at temperatures 50, 75, 100, 150, and 200°C.

The temperature was monitored with the aid of a thermocouple and regulated with accuracy ±1°C.

The illuminator was a KZhP-2 500-watt motion picture projection lamp, and the illumination was calibrated and regulated by varying the filament current.

The same source, together with a set of interference spectra having a spectral width not exceeding 12 mm, was used to illuminate the sample with monochromatic light.

The plots of Fig. 2 illustrate the dependence of the relative increase of the load at which the plastic deformation occurs on the illumination and on the temperature.

We see that the effect decreases with increasing temperature.

When the illumination of the sample increases, the relative magnitude of the effect increases, and saturation sets in at an illumination ~1000 lux.

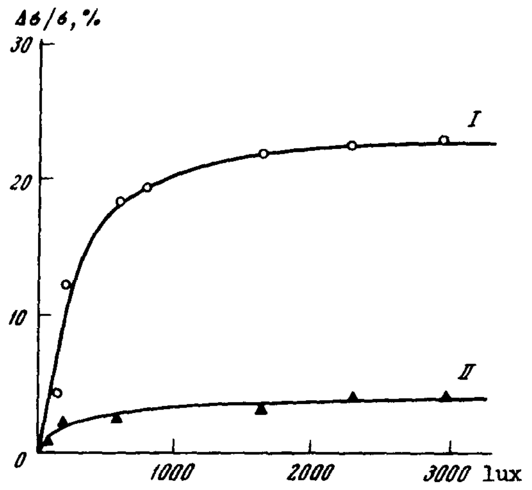

Fig. 2. Dependence of the relative increase of the load on the illumination and the temperature. I - test temperature 75°C, II - test temperature 200°C.

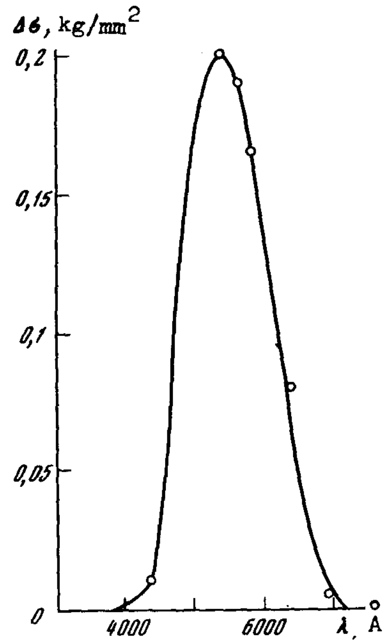

Fig. 3. Spectral characteristic of the effect.

The total deformation of the samples to which Fig. 2 pertains was about 4% at the end of the experiments.

The spectral behavior of the effect can be seen from the plots of Fig. 3. The effect was observed in the wavelength region coinciding with the band of intrinsic absorption of light by CdS.

The effect is maximal when the illumination wavelength is close to the intrinsic-absorption maximum (5300 Å). The spectral dependence of the effect was plotted at 75°C at a constant illumination of 150 lux.

The sole purpose of the present note is to report the experimental facts. We assume that the observed phenomenon is due to the change of the conditions for the motion of dislocations during the time of illumination. This can pertain either to the change in the density of the free electrons interacting with the moving dislocations [1] or with the change in the form of the potential relief along which the dislocation moves (Peierls barriers) during the course of photoionization of the atoms constituting the crystal lattice of the CdS. The presence of a maximum of the effect in the region of the intrinsic absorption gives grounds for assuming that the nature of the observed phenomenon differs from the change in the state of the local centers capable of pinning the moving dislocation, as is observed in colored ionic crystals illuminated with light in the F-band [2].

Further experiments will be aimed at a detailed study of the nature of the observed phenomenon.

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CRITICAL VELOCITIES IN He II

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As is well known, at velocities higher than critical ($v_c \equiv v_{cl}$), i.e., at velocities corresponding to complete dragging of the He II by the vessel wall (in the case of translational or rotational motion of the vessel), the fountain effect and the second sound remain in force, while the velocity of the second sound remains the same as in the precritical mode [1]. This is evidence that when $v > v_{cl}$ the He II does not go over into the normal phase, and moreover, the ratio of the density ρ_n of the normal component to that of the superfluid one (ρ_s) does not change noticeably. However, such a behavior of He II does not contradict Landau's known point of view that when $v \geq v_c$ the number of excitations produced is unlimited, owing to the interaction of the He II with the vessel walls (i.e., all the He II goes over to the normal phase), since the usual identification of the Onsager-Feynman vortex filaments, which determine v_{cl}, with microscopic excitations is not fully correct. It is known that: (i) the vortex filaments represent macroscopic motions of the superfluid com-