ffect of light on the hysteresis loop of the ıagnetic semiconductor $CdCr_2Se_4$

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The effect of light on the shape of the hysteresis loop of the magnetic semiconductor $CdCr_2Se_4$ was investigated. It is observed that when the sample is illuminated with white light, its coercive force increases by approximately three times, and the dynamic permeability decreases by a factor of ten or more. The remanent magnetization of the sample is found to depend only on the illumination at the instant of the magnetization and is not altered by subsequent changes of the illumination.

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It was shown in[1,2] that illumination decreases the dynamic magnetic permeability μ' of the magnetic semiconductor $CdCr_2Se_4$, and the spectral and temıral characteristics of this photoferromagnetic effect were presented.[2–4] The fect of light on the general shape of the magnetization curves of this substance

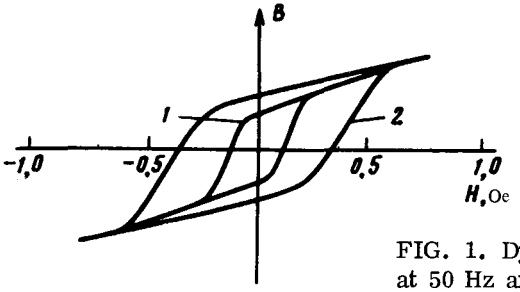

FIG. 1. Dynamic hysteresis loops of $CdCr_2Se_4$ at 50 Hz and $T = 77°K$: 1—in darkness, 2—in white light.

has remained unclear, however. To observe these curves, a torus of approximate thickness 300 μ was cut from a $CdCr_2Se_4$ single crystal measuring 2—3 mm. Two windings of 3—10 turns were wound on the torus. An acoustic-frequency voltage was applied to the primary winding, and the signal from the secondary winding was fed through an amplifier and then to an oscilloscope. A the measurements were performed at liquid-nitrogen temperature. Figure 1 shows the hysteresis loops of $CdCr_2Se_4$ in darkness and after illumination with white light of intensity 5 mW/cm^2. It is seen from the figure that the illumination increases greatly the coercive force of the material, which amounts to ~ 0.1 Oe for pure $CdCr_2Se_4$ in darkness. Measurement of the dynamic permeability μ' in darkness yields values on the order of 10^3. Illumination with white light of power 5 mW/cm^2 decreases μ' by a factor of 10 and more, as follows from Fig. 2. It is important to note that similar phenomena observed earlier i ferrites[5,6] are subject to a much larger time delay than in our case. The spe tral characteristic of the observed effects has a maximum in the region of 1.2 eV, corresponding to the spectral characteristic of the photoferromagnetic effect.[2] This means that these phenomena have apparently the same characte that can be attributed to the $Cr^{3+} \rightarrow Cr^{2+}$ transition that takes place when the electrons are photoexcited from the valance band. The Cr^{2+} ions greatly influence the anisotropy of the material and can play the role of centers that interact effectively with the domain walls. A change of the hysteresis loop under th influence of light is observed not only in pure $CdCr_2Se_4$, but also in samples doped with Ga and Ag, and also in samples of the solid-solution systems $Cd_{1-x}Zn_xCr_2Se_4$ and $CdCr_2Se_{4-x}S_x$, which exhibit the photoferromagnetic effect.

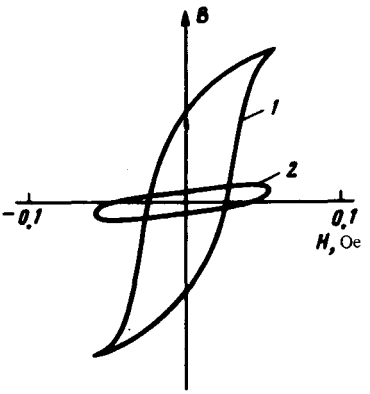

FIG. 2. Dynamic hysteresis loops of $CdCr_2Se$ in weak excitation fields: 1—in darkness, 2—i white light.

is of interest to note that the remanent magnetization of the samples is de-
mined only on whether the sample was illuminated at the instant of magneti-
ion or not, and does not depend on the subsequent changes of the
umination.

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