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# Magnetoconductivity in Boron at Low Magnetic Fields

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The magnetoresistance in boron has been observed by CARMICHEL and DORE [1], NEFT and SEILER [2], LONC and JACOBSMAYER [3]. The effect has been reported to be independent of the relative orientation of the magnetic and electric fields. In different sintered and polycrystalline samples its sign can be positive or negative, but in both cases saturation has been observed at low magnetic fields. According to LONC and JACOBSMAYER [3] the saturation value of the effect is smaller in samples of a higher degree of purity.

We have studied the influence of the magnetic field on the electrical conductivity in nearly monocrystalline boron of high purity. We shall discuss our results in terms of magnetoconductivity, defined as the relative change of the electrical conductivity due to the magnetic field

$$\frac{\Delta\sigma}{\sigma} = \frac{\sigma(B) - \sigma(0)}{\sigma(0)}$$

High-resistance, $\beta$-rhombohedral boron samples have been prepared after the method described by NIEMYSKI and OLEMPSKA [4] and NIEMYSKI et al. [5]. In such material the magneto-photoconductivity $\Delta\sigma_{ph}/\sigma_{ph}$, i.e. the change of photoconductivity due to the magnetic field, has been found earlier by us [6]. It has been proved that the $\Delta\sigma_{ph}/\sigma_{ph}$ is independent of the light intensity and of the relative orientation of magnetic and electric fields. The saturation of $\Delta\sigma_{ph}/\sigma_{ph}$ takes place at about 500 G.

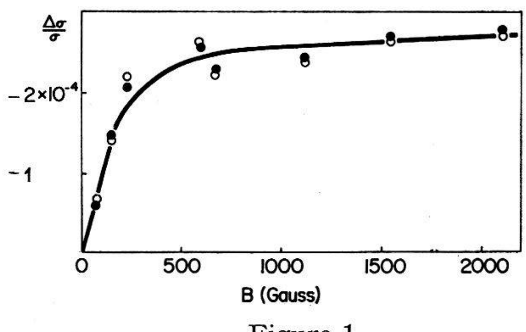


Figure 1

The longitudinal (○) and transversal (●) magnetoconductivity vs. the magnetic induction.

Now we present the results of measurements of the magnetoconductivity. The investigation was carried out in the temperature range between $-60\,°C$ and $+50\,°C$, in the magnetic field up to 2000 G. The typical dependences of $\Delta\sigma/\sigma$ for the longitudinal ($\boldsymbol{B} \parallel \boldsymbol{E}$) and the transverse ($\boldsymbol{B} \perp \boldsymbol{E}$) case are shown in Figure 1. There is no significant difference between the effects in these two orientations. The temperature dependence of the conductivity $\sigma$, of the magnetoconductivity $\Delta\sigma/\sigma$ and the $\Delta\sigma$, measured in the saturation region (at 1500 G) are shown in Figure 2. In this range of temperature the conductivity $\sigma$ changes by a factor of about 15, but the absolute value of the change of conductivity $\Delta\sigma$ is nearly constant. It might be presumed that there are two components of electrical conductivity $\sigma = \sigma_1 + \sigma_2$, one of them being strongly dependent on temperature but non sensitive to the magnetic field, the other one being nearly constant in this temperature range but changing in the magnetic field and thus giving the effect of magnetoconductivity.

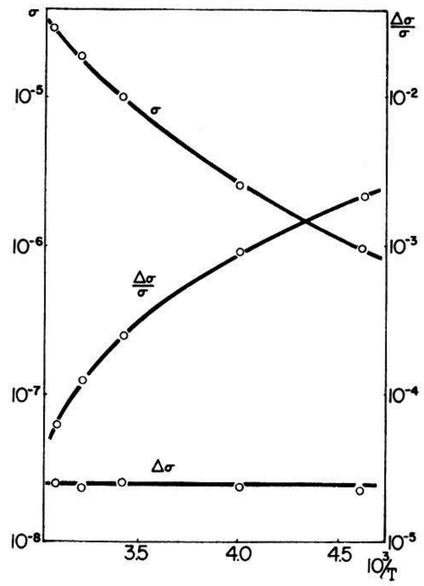


Figure 2

The conductivity $\sigma$, the magnetoconductivity $\Delta\sigma/\sigma$ and $\Delta\sigma$ vs. the reciprocal temperature.

The lack of difference between the longitudinal and transversal magnetoconductivity and its anomalous dependence on the magnetic field leads us to the assumption, that the conventional mechanism of the magnetoresistance cannot be responsible for the effects observed in boron. The saturation of $\Delta\sigma/\sigma$ $(B)$ occurs at such a low magnetic field, that the electron spin interaction with the magnetic field, being of order $10^{-5}$ eV, is much smaller than $kT$. Thus the influence of the magnetic field on the electron transport through the ordering electron spins seems to be improbable.

The nature of this anomalous effect in boron has not been explained up to now and further investigations are necessary.

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