ON PHOTOCONDUCTION OF VANADIUM PENTOXIDE

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Photoconduction was observed on samples split from V_2O_5 single crystals; the relative photocurrent resulted to 1.35‰. The voltage dependence of the photocurrent is linear in the voltage range measured; its dependence on illumination points to linear recombination mechanism.

Most of the experimental results concerning semiconductivity of vanadium pentoxide are connected with measurement of its electrical conductivity and thermoelectricity [1—6]. Also the absorption and reflexion spectra of V_2O_5 are known in a comparatively wide wavelength range [7—11]. However, to our knowledge, papers on its photoconductivity have not been published up to this date, only absence of the latter is mentioned in some publications, though the existence of this effect, albeit not of immediate practical importance, could give valuable information e.g. in clearing up the conduction mechanism. The present paper reports on some experimental results concerning the photoconductivity of V_2O_5 single crystals.

In connection with the possibility of observing experimentally photoconduction in V_2O_5, two difficulties should be borne in mind: namely (i) that the relative photocurrent of only $1.35^0/_{00}$ is difficult to detect, and (ii) V_2O_5 is excessively sensitive to thermal effects; the resulting change in dark current may be of the same order of magnitude as the photocurrent.

The samples used for our measurements were prepared from V_2O_5 single crystals grown using the method described in [12], by splitting plates of $1.5\times0.04\times8$ mm^3 in the (010) plane. For meassuring the electrical conductivity, electrodes of In-Ga eutectic were applied. The direction of the current was parallel with the crystallographic *c*-axis. The constant temperature (20 °C) of the sample was secured by a thermostat consisting of Dewar-flasks.

A diagram of the experimental arrangement is shown in Fig. 1. A 50 W halogen-filled tungsten lamp served as light source *LS*; its light was projected by the lenses L_1 and L_2, through the slit *Sl*, onto the sample *S*. To exclude heat radiation, a 10 mm thick water filter was placed in the light path. For reducing the light intensity, a graded gray wedge *W* was used. The photocurrent of only 10^{-8} to 10^{-11} A was measured by a pA-meter TESLA type BM 483 in the circuit shown in the figure, to compensate the dark current, the intensity of wich exceeded the photocurrent by several orders. The voltage on the sample was measured by a digital voltmeter *DV*, ELPO type V 523.

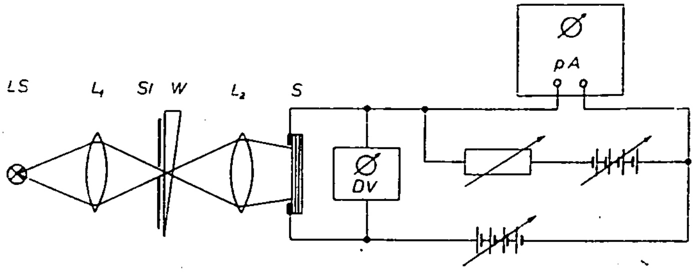

Fig. 1. Diagram of the experimental arrangement used for measuring the photoconductivity of samples prepared from V_2O_5 single crystals.

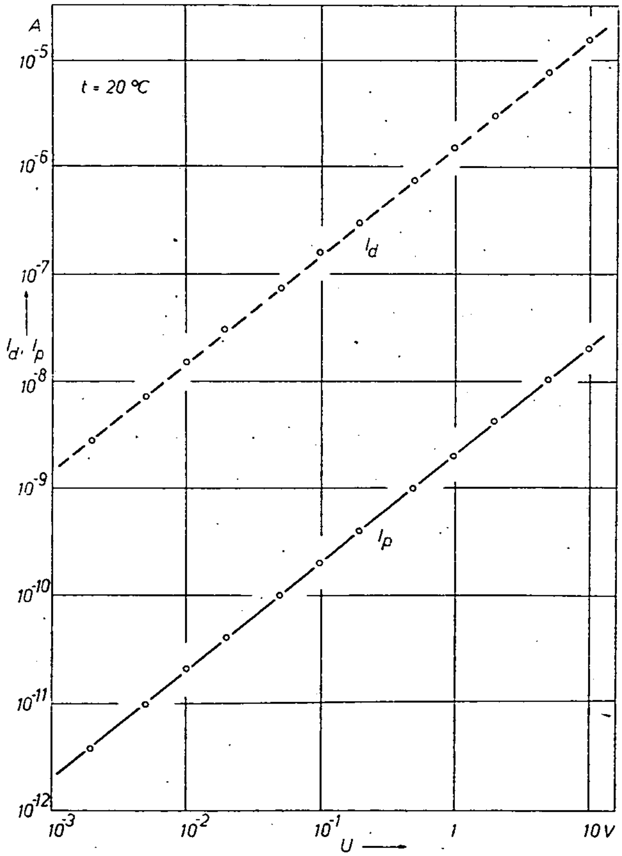

Fig. 2. Current-voltage and photocurrent-voltage characteristic of a sample prepared from V_2O_5 single crystal (measured at 20 °C).

Fig. 2 shows the voltage dependence of the dark current I_d and of the photocurrent I_p in the sample described above. It can be seen from the I_d curve that, in the range of 10 mV to 10 V, the sample shows ohmic behaviour. The photocurrent is not saturated in the voltage range mentioned, and its dependence on voltage is linear. As can be seen from the figure, the photocurrent is about three orders of magnitude less than the dark current. Though with higher voltages more intensive photocurrents would to be expected, an increase in temperature due to the comparatively low resistance of the samples (1 to 10 kΩ) is to be taken into consideration; because of the resulting incertainties in measuring the photocurrent, experiments were not made above 10 V.

The photocurrent of V_2O_5 samples followed the changes in illumination immediately within the range of inertia of the pA-meter. The photoconduction described above was observed with all samples studied.

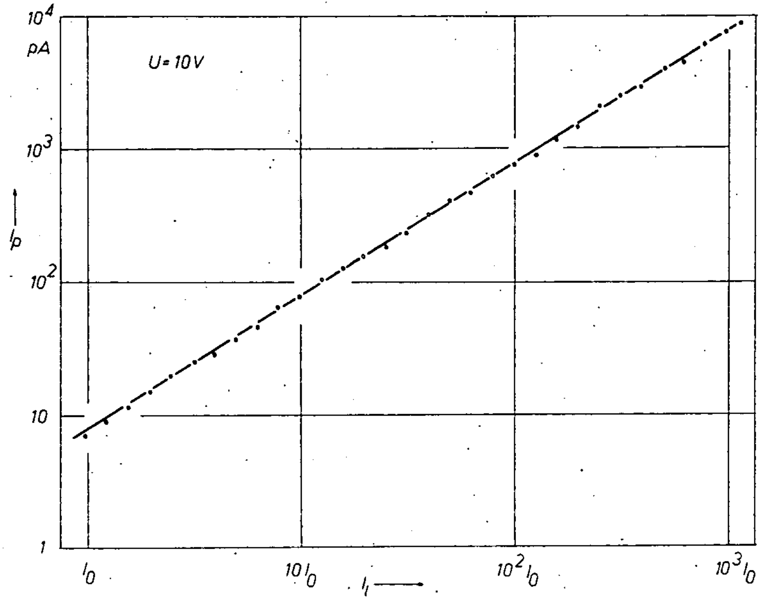

Fig. 3. Dependence of the photocurrent on light intensity I_l (in relative units) for a sample prepared from V_2O_5 single crystal.

In Fig. 3 the light intensity—photocurrent characteristic of the V_2O_5 sample for white light is presented. The photocurrent was found to depend linearly on illumination, therefore a linear recombination model is to be supposed for describing the mechanism of photoconductivity.

As in the arrangement described the intensity of the spectrally resolved light of the tungsten lamp proved to be too low for measuring the spectral sensitivity of the photocurrent, we used the light of 6328 Å wavelength of a $\sim$2 mW He-Ne gas-laser as monochromatic illumination and, by projecting the whole light of the laser on the sample, we obtained photocurrents of 1 to 10 nA at 1 V with V_2O_5 samples of different dimensions. The comparatively great changes in current obtained with monochromatic illumination of the above wavelength seem to prove that the change is really a photoeffect, and not due to heat radiation.

Further investigations on the spectral sensitivity of photoconducting V_2O_5 single crystals and on relaxation effects are in course.

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К ФОТОЭФФЭКТУ МОНОКРИСТАЛЛОВ V_2O_5

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На образцах, полученных из монокристалла V_2O_5, обнаружена фотопроводимость. Относительный фототок составлял 1.35‰-ых. В исследованной нами области напряжения зависимость фототока от напряжения оказалась линейной. Люкс-амперная характеристика указывает на линейный рекомбинационный механизм.