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PHOTOVOLTAIC EFFECT OF WEDGE-SHAPED PHOTOCONDUCTING THIN FILM

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Previously described photovoltaic effect was found to exist at wedge-shaped thin films which didn't possess photoconducting properties[1,2].The experimental results,such as dependence of the polarity,and the **value** of photovoltage upon the sign of free carriers, the geometry of the film and the intensity and wavelenght of the light,,sugested that the generation of photovoltage was due to the energisation of free carriers by inpiding photons,and reflexion of the energised carriers from the inclined surface of the wedge-shaped film.

The aim of this work was to examine photovoltaic properties of a wedge-shaped thin film which possessed very good photoconductivity,since it was found that such films gave fairly high photovoltage at moderate illumination.Even more,the polarity of the voltage with respect to the sign of free carriers and orientation of the wedge was opposite to that found at nonphotoconducting films.

Preparation of the films

Thin photoconducting CdS films were prepared in two different ways.The first one was usual vacum evaporation technique. In order to get wedge-shaped films with defined angle of inclination, it was applied the technique by four rotary cylinders. So prepared films didn't exibit photoconductivity but they shew weak photovoltaic properties.After additional thermal treatment by which excess Cd was removed,the films became good photoconductors,and exibited very good photovoltaic properties.

The second way of films production was chemical deposition of sprayed solution of thiourea and $CdCl_2$,onto warm glass substrate[3]. The films shaped by means of programable movement of a screan,placed between the sprayer and the substrate.So prepared films possessed very good light-dark conductivity ratio. The variation of the thickness by the lenght of the films was measured by means of light absorption densitometer,and controled by resistance measurement.All the films had linear variation of the thickness,which could be seen from the logarithmic presentation of the absorption of light with respect to the lenght of the films. The mean thickness of the films was determined from the deposed mass of the CdS. The films prepared by two different techniques were of N-type, and no existence of P-N junction was found, which was important for the study of the photovoltaic effect by the wedge-shaped thin film.

Results of the measurements

The photovoltage V_{ph} and photoconductivity Y measured successively by means of vacum-tube voltmeter-ohmeter. The measurements were carried out with white and monochromatic light. Becouse of the high resistivity of the films with respect to the input resistance of the voltmeter, the measured V_{ph} wasn't exatly the open circuit voltage. The results of the measurements for the film prepared by vacum evaporation technique, are presented on Fig.1, and for the film prepared by chemical deposition are presented on Fig.2

From the both one can see that as far as photoconductivity is linear with the light intensity the photovoltage has complex

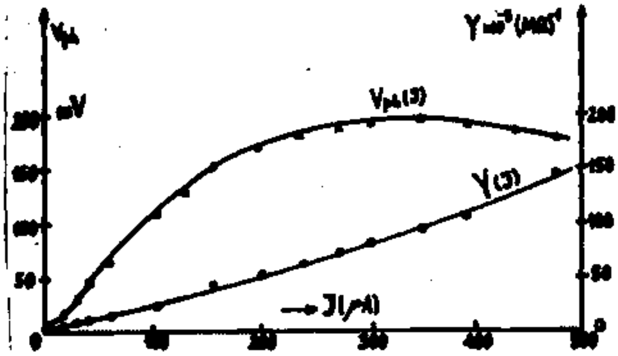

Fig.1. Dependence of V_{ph} and Y on the light intensity for evaporated film.

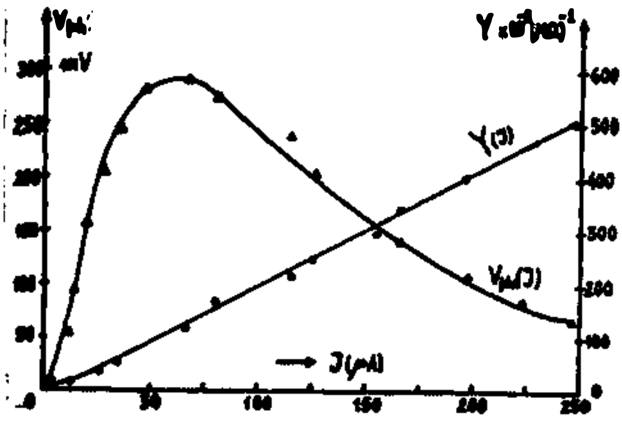

Fig.2. Dependence of V_{ph} and Y on the light intensity for chemicaly deposed film.

dependence i.e. at certain intensity it becomes maximal, and after that it falls down. The measurement on numerous films showed that the maximal voltage and the optimal intensity is strongly dependent on the geometry of the film. The measurements carried out by monochromatic light showed that V_{ph} is strongly dependent on the wavelenght of the light, and the long wavelenght limit for the photovoltage is the same with that for the photoconductivity. This gives an idea that the photoelectrons are the main cose of photovoltage generation in the wedge-shaped photoconducting films.

The dependence of V_{ph} uppon the angle of the wedge has been examined on four films simultaneuosly prepared by vacum-evaporation technique. For the sake of better comparison all the films has been prepared to have same mean thickness 0,82 μm, and angles of the wedge in proportion 2,9 : 2,3 : 1,6 : 1, starting with the film № 1,2,3,4. Measurement of the maximal voltage, wich has been reached at different light intensities showed that the angle of the wedge has strong influence on the generation the photovoltage.

Discusion of the results

For moderate light intensity V_{ph} has logarithmic dependence, which sugests that the concentration gradient of photogenerated free carriers should be responsible for the voltage generation. Qualitative examination of the electrons concentration by means of thermoprobe, showed existance of concentation gradient from the thicker to the thinner end. Since the light absorbtion of CdS films was very weak, the apearence of the concentracion gradient uppon illumination could be ascribed to the dependence of lifetime of the photoelectrons on the thickness of the film[4]. As a result of this a photovoltage would be given by

$$V_{ph} \sim \frac{kT}{e} \ln \; n_1/n_2$$

where n_1 and n_2 are concentrations of the electrons at the thicker and thinner end respectively.

The decrease of V_{ph} with the light intensity, which happens for the high intensities, should be ascribed to the existance of shunt photoresistance. From this it comes out that the film should be cosidered as to be composed of triangular part, which acts as a photogenerator, and planparalel part which is parasitic.

On the bases of all these, an equivalent circuit given on Fig.3 could describe photovoltage-light intensity characteristics of the films. From this it comes out that the measured photovoltage should be given by

$$V_{ph} = \frac{Y_1 \frac{kT}{e} \ln AJ}{Y_1 + Y_2 + Y_0(1+J)}$$

where Y_1-is conductivity of the active part of the film, Y_2-input conductivity of the voltmeter, $Y_0(1+J)$-shunt photoconductivity, J-light intensity, and A-proportionality constant.

This expression describes very well the light photovoltage-light intensity characteristics given on Fig.1 and 2.

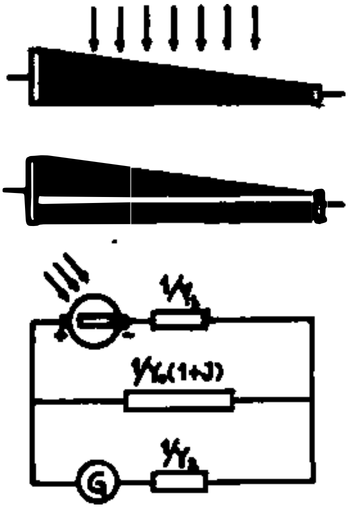

Fig.3. Equivalent circuit of wedge-shaped photoconducting film

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