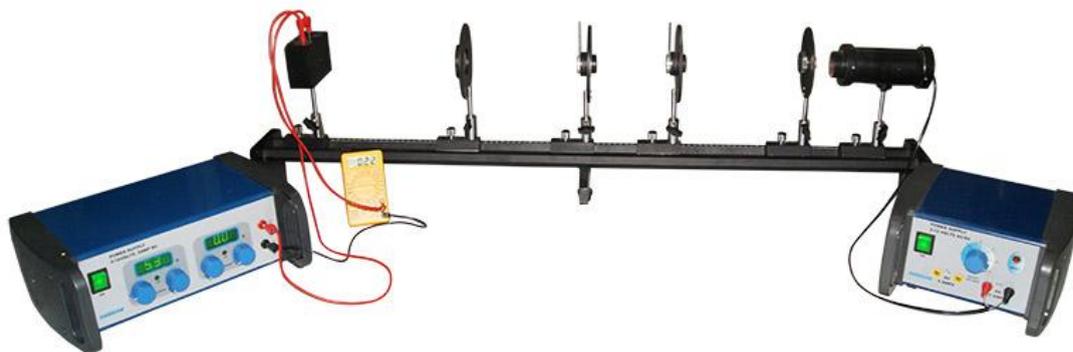


INSTRUCTIONAL MANUAL

Photoconductivity



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EXPERIMENT: To study the Photoconductivity of CdS photo-resistor at constant irradiance and constant voltage

- a. To plot the current- voltage characteristics at constant irradiance.
- b. To measure photocurrent I_{ph} as a function of irradiance Φ at constant voltage.

APPARATUS: Lamp housing, adjustable slit, polarizer, analyzer, two convex lens, photo-resistor, multimeter, an optical bench with fixing mounts.

THEORY:

Photoconductivity is an optical and electrical phenomenon in which a material become more electrically conductive due to the absorption of electromagnetic radiation such as visible light, ultraviolet light, infrared light, or gamma radiations. It is the effect of increasing electrical conductivity Φ in a solid due to light absorption. When the so-called internal photo effect takes place, the energy absorbed enables the transition of activator electrons into the conduction band and the charge exchange of traps with holes being created in the valence band. In the process, the number of charge carriers in the crystal lattice increases and as a result, the conductivity is enhanced.

When light is absorbed by a material such as a semiconductor, the number of free electrons and electron holes changes and raises its electrical conductivity. To cause excitation, the light that strikes the semiconductor must have enough energy to raise electrons across the band gap.

When a photoconductive material is connected as part of a circuit, it functions as a resistor whose resistance depends on the light intensity. In this context the material is called a photoresistor. Fig.1 depicts the current flow in a photoresistor when exposed to light rays.

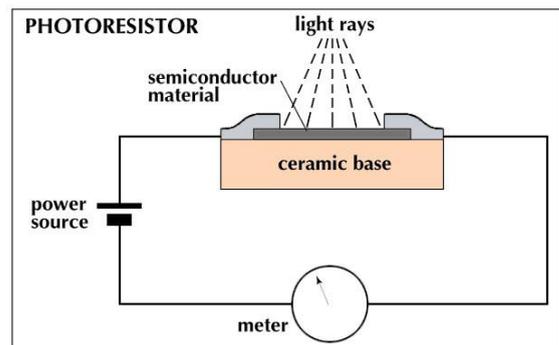


Fig.1 Working of a photoresistor

Semiconductor resistors that depend on the irradiance (photoconductive cells) are based on this principle. They have opened up a wide field of applications and are, among other things, employed in twilight switches and light meters. The semiconductor materials most commonly used are cadmium compounds, particularly CdS.

The photocurrent is studied as a function of the voltage applied to the photoresistor at a constant irradiance (current-voltage characteristics) and as a function of the irradiance at a constant voltage (current-irradiance characteristics).

Block diagram:

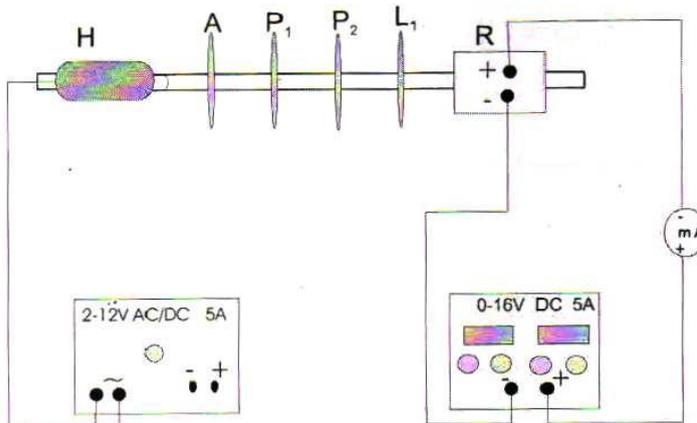


Fig. 2

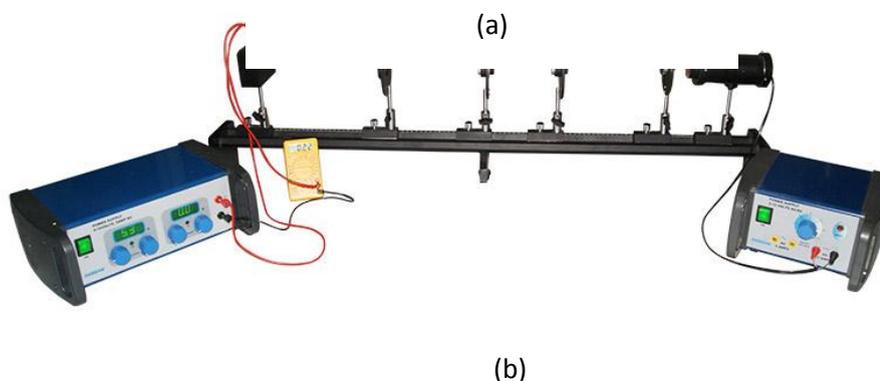


Fig.2 Experimental setup for recording the current-voltage characteristics of a CdS photoresistor.

PROCEDURE :

1. Mount the lamp housing (H), adjustable slit self-centering (A), polarizer (P_1), analyzer (P_2), lens (L_1), and photo-resistor (R) on the optical bench as shown in Fig.2.
2. Connect the leads of the lamp housing to the power supply (0-12V AC/DC, 5A) and apply 10V AC to the lamp.
3. Adjust the height of the lamp housing, adjustable slit self-centering, polarizer, analyzer, lens and photo-resistor such that all of them lie on the same optical axis.
4. Make the connections to the photo-resistor and multi-meter as shown in Fig. 2.
5. Initially set the polarizer and analyzer at 0° .
6. Adjust the lamp, lens and photo-resistor so that a homogeneous ray of light illuminates the photo-resistor.

7. Set the voltage of DC power supply (0-16V DC, 5A) to 20V.
8. Adjust the width of the self centering adjustable slit so that a current of about 9mA flows through the photo-resistor. Keep the width of the slit fixed for rest of the experiment.

OBSERVATION :

a) Measuring photocurrent I_{ph} as a function of voltage U at a constant irradiance Φ :

1. Set the analyzer at 0° mark provided on the analyzer scale.
2. Interrupt the path of the ray of light, and determine the photocurrent $I(0^\circ)$ due to the residual lightness.
3. Starting from 20V, reduce the voltage U to 0V in steps of 2V. Measure the photocurrent I_{ph} , each time and record it.
4. Repeat the series of measurements with α at 30° , 60° , and 90° .

U (Volt)	I_{ph} at 0° (mA)	I_{ph} at 30° (mA)	I_{ph} at 60° (mA)	I_{ph} at 90° (mA)
16				
14				
12				
10				
8				
6				
4				
2				

Table 1: The photocurrent I_{ph} as a function of the voltage U at a constant irradiance Φ

b) Measuring photocurrent I_{ph} as a function of irradiance Φ at a constant voltage U :

1. Set the voltage U to 16 V, interrupt the path of the ray of light and measure the photocurrent I due to the residual lightness.
2. In order to vary the irradiance Φ , increase the angle α between the polarization planes of the filters in steps of 10° from 0° to 90° . Measure the photocurrent I_{ph} , each time and record it.
3. Repeat the series of measurements at $U=8V$ and $U=1 V$.

α	$\text{Cos}^2\alpha$	I_{Ph} at 16V (mA)	I_{Ph} at 8V (mA)	I_{Ph} at 1V (mA)
0°				
10°				
20°				
30°				
40°				
50°				
60°				
70°				
80°				
90°				

Table 2: The photocurrent I_{Ph} as a function of irradiance Φ at a constant voltage U

ANALYSIS:

a) The photocurrent I_{Ph} as a function of voltage U at a constant irradiance Φ :

The relation between the photocurrent I_{Ph} and the voltage U applied at a constant irradiance (constant angle α between the polarization planes of the filters), i.e. the current-voltage characteristics, is shown in Fig.3. Even at an angle $\alpha = 90^\circ$ between the polarization planes of the filters a photocurrent flows, since in this position the polarization filters do not extinguish the ray of light completely.

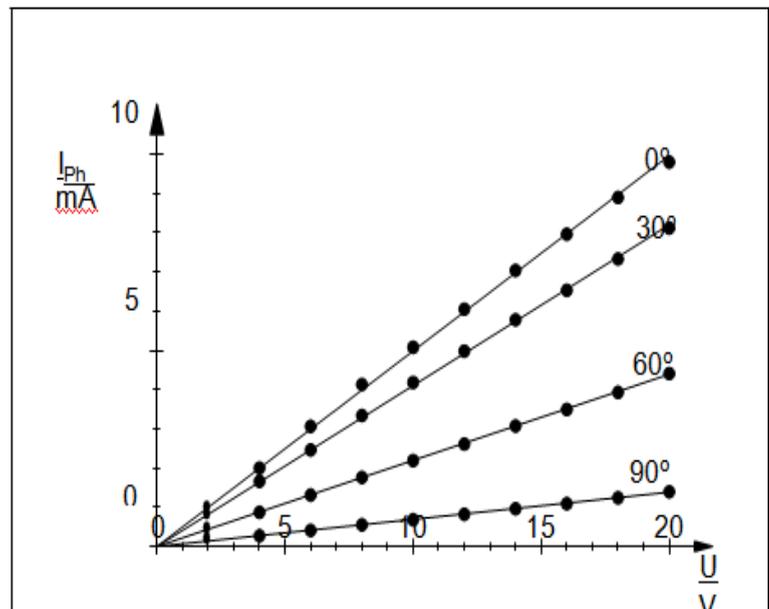


Fig. 3 Current–Voltage characteristics of CdS photoresistor

b) Measuring photocurrent I_{ph} as a function of irradiance Φ at a constant voltage U :

The relation between the photocurrent I_{ph} and the irradiance at a constant voltage, the current-irradiance characteristics, is shown in Fig. 4. The term $\cos^2\alpha$ is a relative measure for the irradiance (α angle between the polarization planes of the filters). As expected, the photocurrent increases with increasing irradiance. However, the characteristics are not perfectly linear. The slope rather decreases with increasing irradiance.

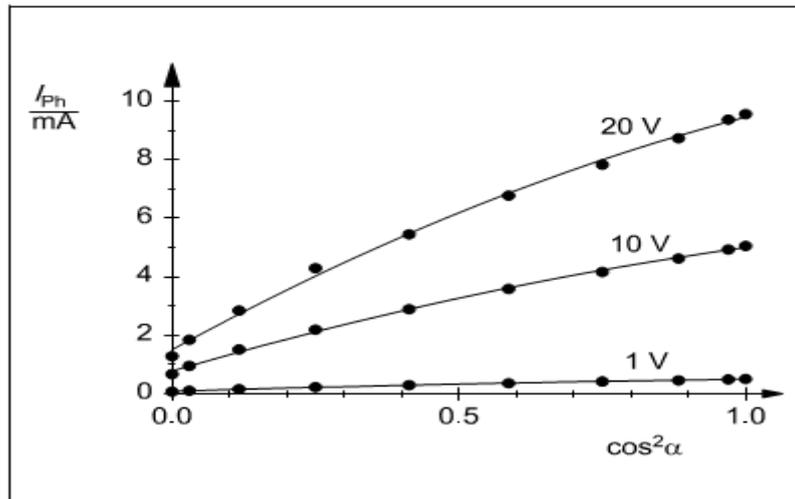


Fig. 4. Current-irradiance characteristics of the CdS photoresistor

RESULT:

The CdS photoresistor behaves like an ohmic resistance that depends on the irradiance.

VIVA-VOCE:

1. What happens when light radiation falls on insulating crystal?
2. What is meant by space charge in a photo-conductor?
3. Effect of impurities on photosensitivity of the material?
4. What happens when light is suddenly switched off?
5. Does the photo-resistor behave like an ohmic resistance?