Abstract

A Photoresistor or light dependent resistor (LDR) is a resistor whose resistance decreases with increasing incident light intensity. It can also be referred to as a photoconductor or CdS device, which is the material from which the device is made and that actually exhibits the variation in resistance with light level

OBJECTIVE:

To determine the response of a photoresistor to the varying intensity of light falling on it and deduce the spectral sensitivity of the semiconductor material

APPARATUS (PHOTORESISTOR SET-UP):

The setup is a compact kit which is a portable top model. The circuit including different components is shown in the figure.

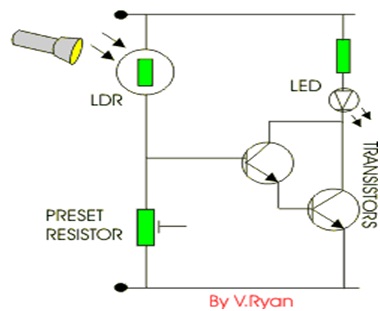
The setup is comprised of the following components:  
DC regulated power supply fixed to 10v output, voltmeter, LDR, Tungsten lamp, ammeter, Photovoltaic cell and a luxmeter.

LDR Circuit

It stands for Light Dependent Resistor or Photoresistor, which is a passive electronic component, basically a resistor which has a resistance that varies depending of the light intensity. A photoresistor is made of a high resistance semiconductor that absorbs photons and based on the quantity and frequency of the absorbed photons the semiconductor material give bound electrons enough energy to jump into the conduction band. The resulting free electrons conduct electricity resulting in lowering resistance of the photoresistor. The number of electrons is dependent of the photons frequency.

The resistance is very high in darkness, almost high as 1MΩ but when there is light that falls on the LDR, the resistance is falling down to a few KΩ(10-20kΩ @ 10 lux, 2-4 Omega; @100 lux) depending on the model.

A fixed DC supply (0-15V) furnishes the applied potential to LDR and is usually fixed around 10V. The resistor of 1kΩ is connected in series to the limit the current, which is measured by micro ammeter. This circuit consists of a photoresistor or Light Dependent Resistor (LDR) which is an opto-electronic device. The LDR used in this experiment is CdS semiconductor whose resistance falls with increasing intensity of light influx. The variation of resistance of LDR is owing to greater thermal ion-pair generation caused by incidence of light flux



Lux Meter

A photovoltaic cell, in short circuit mode, is also fitted in close vicinity of LDT. The photocurrent generated, in the short circuit mode, is proportional to intensity of incident light flux. This current is passed through and operational amplifier based current to voltage converter, which deflects an analog meter calibrated in terms of light intensity. The luxmeter is capable of measuring light intensity from close to zero to few klux.

Tungsten Lamp :

The tungsten lamp of power rating 12V and 21W is used to illuminate the LDR as well as photovoltaic cell. As can be seen from figure, the lamp is placed in such a manner that it is equidistant from LDR as well as photovoltaic cell so that light flux falling on two is same and measurement of incident flux can be made through the photovoltaic cell. The voltage applied across the lamp can be varied to change the light intensity of the lamp. The arrangement of tungsten lamp, LDR and photovoltaic cell are placed in light tight enclosure to avoid any stray light incidence.

THEORY:

Semiconductors often have the ability to respond to various spectral regions of electromagnetic radiation. Silicon, ermanium, Gallium-Arsenide and Cadmium Sulphide are materials which exhibit opto-electronic effects, thereby implying that their electrical properties are responsive to light. The conductivity of these materials increases as they are exposed to the increasing intensity of radiation. This is because of the fact that valence electrons in these materials are excited to conduction band on absorption of incident photons from radiation flux.

The conductivity of material is proportional to the concentration of charge carriers. Radiant energy causes the dissociation of covalent bonds thereby leading to thermal ion-pair generation (i.e. electron-hole pair), which results in increased free charge carriers and hence fall in overall resistance of materials. This is basic principle on which photoresistor works.Such devices working on this principle are called photoconductive cells or Light Dependent Resistors (LDRs).

The carriers generated by photo-excitation move under the influence of applied electric field and if they survive electron-hole recombination and reach ohmic contacts, then they constitute device current. The resistance of LDR constantly falls with the intensity of incident radiations while current increases non-linearly with the intensity of incident radiation. Small amount of current flows in the LDR circuit even when no light is incident on it and is referred to as Dark current. The origin of this current is owing to the thermal ion-pair generation caused by incident flux of radiation

The response of a photoresistor with varying light intensity is non-linear is given by:

Photoresistor

where RLDR is the resistance at light intensity at the surface of LDR, Rdark is the LDR resistance without light and b is the material constant of photoresistor used. The spectral sensitivity of the photoresistor also depends upon the wavelength of the incident radiation.

PROCEDURE:

1) Keep the lamp supply control to minimum. Switch ON the power. Note that the DC supply is 10V. Select µA range for LDR ammeter. If there is no deflection in ammeter, it implies LDR exhibits high resistance in dark. Otherwise not the value of dark current

2) Select lowest step for lamp intensity. Increase the intensity by means of lamp voltage in steps of 0.2klux and note the corresponding flowing through the LDR current for a current deflection with readable intensity. Change the ammeter range accordingly.

3) Keep in changing the lamp voltage level to higher steps and further note the variation of LDR current with intensity.

4) Plot the light intensity vs current curve from the observations. Find out the linear region and calculate the spectral sensitivity from the linear rising portion of the curve.

Conclusion

\*Least count of voltmeter: 0.2 V  
\*Least count of luxmeter: 0.05 klux  
\*Least count of ammeter: 0.2 mA (Range = 0-10 mA)  
\*Voltage applied across LDR: 10 V