SRM VALLIAMMAI ENGINEERING COLLEGE

(An Autonomous Institution)

SRM NAGAR, KATTANKULATHUR – 603 203

PHYSICS PRACTICALS MANUAL

1901209– APPLIED PHYSICS LABORATORY

(Second semester B.E/B.Tech. students for the Academic Year 2022-2023)

Prepared by

Dr.M.Anbuchezhiyan Dr.K.Thiruppathi,
Mrs. D. Praveena, Dr.S.Gandhimathi,
Dr. R.Nithya Balaji, Mrs. R.Sasireka, Mrs.S.Sowmiya
Dr. Ramya Rajan.M.P and Dr.S.Padmaja

Department of Physics

SRM VALLIAMMAI ENGINEERING COLLEGE

SRM NAGAR, KATTANKULATHUR – 603 203

DEPARTMENT OF PHYSICS

Instructions to the students

The following instructions must be followed by the students in their laboratory classes.

The following instructions must be followed by the students in their laboratory classes.

1. Students are expected to be punctual to the lab classes. If they are late, they will be considered absent for that particular session.
2. Students should strictly maintain the dress code.
3. Students must bring their observation note, record note (completed with previous experiment) and the calculator to every lab class without fail.
4. Students are advised to come with full preparation for their lab sessions by
   (i) Reading the detailed procedure of the experiment from the laboratory manual.
   (ii) Completion of observation note book (i.e.) Aim, Apparatus required, Formula (with description), least count calculation, diagrams and the tabular column should be written in the observation note before entering into the laboratory.
5. Data entry in the observation note book must be by pen only.
6. Students must get attestations immediately for their observed readings.
7. Students should complete their calculations for their experiments and get it corrected on the same day of that experiment.
8. Students who miss observation, record note they have to do the experiment once again and get it corrected.
9. Class assessment marks for each experiment is based only on their performance in the laboratory.
10. Record note has to be completed then and there and get corrected when the students are coming for the next lab class.
11. Students must strictly maintain silence during lab classes.
12. If any of the students is absent for the lab class for genuine reasons, he/she will be permitted to do the experiment during the repetition class only.
13. Students are advised to perform their experiments utmost care.

CONTENTS

L

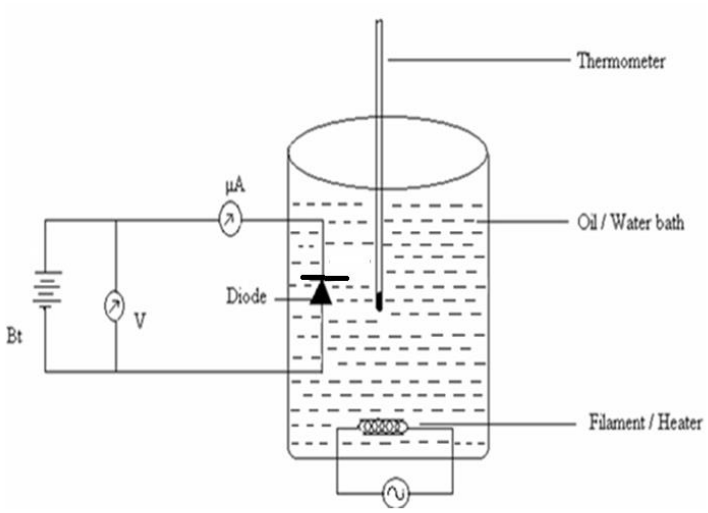

Fig 1.1. Circuit for band gap determination

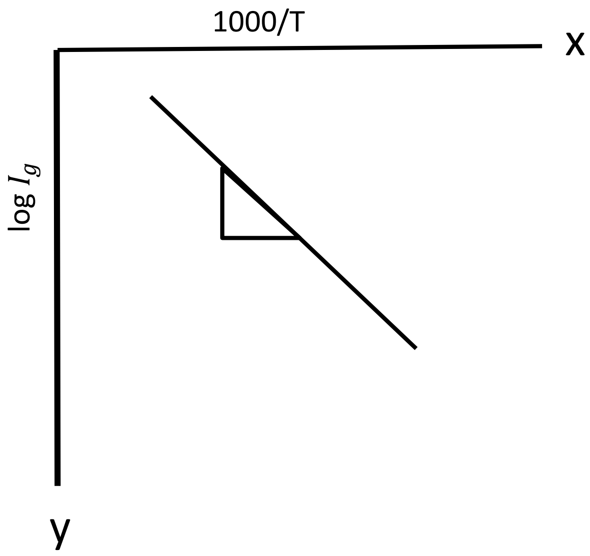

Fig1.2. Variation of current with inverse temperature in a reverse biased p n -diode

1. DETERMINATION OF BAND GAP OF A SEMICONDUCTOR

R

AIM

To determine the band gap energy of a semiconductor by varying the temperature

APPARATUS REQUIRED

Semiconductor diode, Heating arrangement to heat the diode, Ammeter, Voltmeter, thermometer.

FORMULA

Band gap energy $E_g = 0.198 \times \text{Slope}$ eV

$$\text{Slope} = \log I_s / (1000/T)$$

Symbol	Explanation	Unit
I_s	Saturation current	A
T	Absolute temperature	kelvin

PROCEDURE

The circuit is given as shown in Fig. (1.1). The semiconductor diode and the thermometer are immersed in the water or oil bath, in such a way that the thermometer is kept nearby the diode. The power supply is kept constant (2 Volts). The heating mantle is switched ON and the oil bath is heated up to 70°C.Now the heating mantle is switched OFF and the oil bath is allowed to cool slowly. For every one degree fall of temperature the micro ammeter the reading I_s is noted. A graph is plotted taking 1000/T along x axis and log I_s along negative y axis (Fig.1.2), (Since I_s in the order of micro-ampere, log I_s value will come in negative). A straight line obtained as shown in model graph. By finding the slope of the straight line, the band gap energy can be calculated using the given formula.

L

.

S.No	Temperature	Temperature	1000 /T	I_s	log I_s
unit	°C	K	K^{-1}	$\times 10^{-6} A$	
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					

CALCULATION

R

$E_g = 0.198 \times \text{Slope}$ eV

$E_g = 0.198 \times \log I_s / (1000/T)$ eV

$E_g =$ .... eV

RESULT

The band gap energy of the given diode is E_g = ... eV.

L

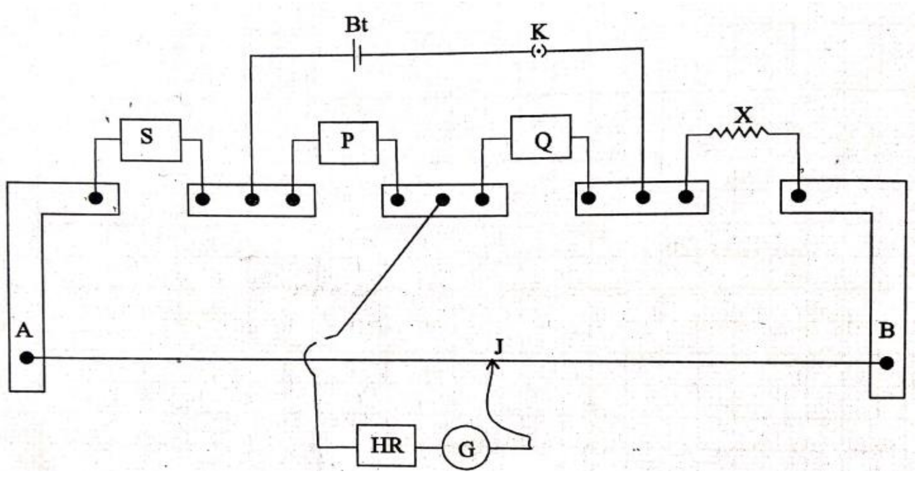

Fig 2.1 Carey foster Bridge experimental set up

2. DETERMINATION OF ELECTRICAL RESISTIVITY OF METAL AND ALLOY –CAREY FOSTER BRIDGE.

R

AIM

To determination of the specific resistance or resistivity of the material of the given wire

APPARATUS REQUIRED

Bridge wire resistance coil, Battery, 4 & 2 dial resistance boxes, copper strips, galvanometer, High resistance, key, Jockey, etc.,

FORMULA

Specific resistance of the wire $= \frac{X\pi r^2}{l}$ ohm metre

Unknown resistance = $X = S + \rho(l_2 - l_1)$ ohm

EXPLANATION

Symbol	Explanation	Unit
X	Resistance of the wire	Ohm
r	Radius of the wire	metre
ℓ	Length of the wire	metre

PROCEDURE

The circuit connections are as shown in the Fig. 2.1 the two equal resistance P and Q are connected in the inner gaps 1 and 2. A known low resistance S is connected in the end gap of right-hand side. The unknown resistance is connected to the in the end gap on the left-hand side. A lechlanche cell and a galvanometer are connected as shown in the Fig. 2.1 the circuit is closed by putting a key. The jockey is pressed near one end A of the bridge wire and then end B. The connections are correct only when the deflections are in opposite direction.

L

To find the resistance of the bridge wire per meter

Trial No	Resistance box in S	Balancing length		$l_1'{\sim}l_2'$	Resistance of the wire per meter $\rho = \frac{S}{l_2 - l_1}$
		Before interchanging l_1'	After interchanging l_2'		
	ohm	m	m	m	ohm/m

To determine the resistance of the coil (X)

Trial No	Resistance box in S	Balancing length		$l_1{\sim}l_2$	Unknown resistance $X = S + \rho(l_2 - l_1)$
		Before interchanging l_1	After interchanging l_2		
	ohm	m	m	m	m

R

The balancing length (l_1) is measured by pressing the jockey along the bridge wire for null deflection in the galvanometer. The second balancing length is found by interchanging X for S. For different values of S, l_1 and l_2 are found. The readings are tabulated, and using the formula $X = S + \rho(l_2 - l_1)$ the unknown resistance value is found. To find ρ, a thick copper strip of zero resistance is connected instead of X. the balancing lengths $l_1{}'$ and $l_2{}'$ are determined. In this case, X=0 so, $\rho = \frac{S}{l_2 - l_1}$ the experiment is repeated with different values of S and the mean value ρ is taken. The specific resistance of the wire is found using the formula by measuring r the radius of the wire and length *l* of the wire.

CALCULATION

Radius of the wire r = …………………………. metre

Length of the wire *l* = ……………………………metre

Resistance of the wire X = ……………………. Ohm

Specific resistance of the wire $= \frac{X\pi r^2}{l}$

RESULT

Resistance of the given wire = …………………………………. ohm.

Specific resistance of the given wire = ………………………ohm. metre.

L

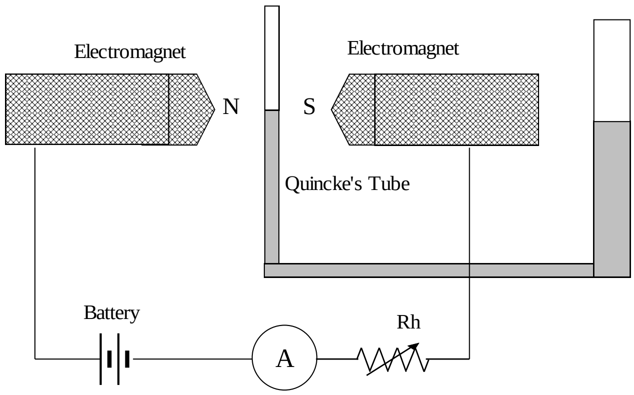

Fig 3.1 Quinke's Method

To find the rise in the capillary tube of the solution:

LC =0.001 cm

TR = MSR + (VSC $\times$ LC)

To find the value of h_1

S.No.	Microscopic reading without field (h_1)		
	MSR (cm)	VSC (div)	TR (cm)

To find the value of h_2

S.No.	Current (i)	Field (H)	Travelling microscope reading (h_2)			Difference $h = h_1 \sim h_2$	h / H^2
	Ampere	Gauss	MSR (cm)	VSC (div)	TR (cm)	$\times 10^{-2}$ m	(m^{-1})

Mean h/H^2 = m^{-1}

3. MEASUREMENT OF SUSCEPTIBILITY OF PARAMAGNETIC SOLUTION BY QUINCKE'S METHOD.

R

AIM

To measure the susceptibility of paramagnetic solution by Quincke's tube method.

Apparatus Required

Quincke's tube, Travelling microscope, sample ($FeCl_3$ solution), electromagnet, Power supply, Gauss meter.

FORMULA

The susceptibility of the given sample is found by the formula,

$$\chi = \frac{2(\rho - \sigma)gh}{H^2} \qquad \text{kg m}^{-1}\,\text{s}^{-2}\,\text{Gauss}^{-2}$$

EXPLANATION

Symbol	Explanation	Unit
ρ	Density of the liquid or solution	kg/m^3
σ	The density of air	kg/m^3
g	The acceleration due to gravity	ms^{-2}
h	Height through which the column rises	m
H	Magnetic field at the center of pole pieces	Gauss

PROCEDURE

The apparatus consists of U-shaped tube known as Quincke's tube. One of the limbs of the tube is wide and the other one is narrow. The experimental liquid or the solution ($FeCl_3$) is filled in the tube in such a way that the meniscus of the liquid in the narrow limb is at the centre of the magnetic field as shown in the Fig. 3.1. The level of the liquid in the narrow tube is read by the travelling microscope when the magnetic field is off (h_1). The magnetic field is switch on by switching on the electromagnet. Adjust the regulator knob available with the power supply to the electromagnet and fix the current to 0.3A. The raised level of the column is read with the travelling microscope and noted in the table as (h_2).The experiment is repeated by varying the field by changing the current in steps of 0.3A upto the maximum and reading is noted.

L

To determine the magnetic field (H), the Hall probe flux meter (Gauss meter) is used. The flat portion of the Hall probe is placed perpendicular to the magnetic field i.e., between the pole pieces at centre parallel to the poles. Switch off the electromagnet power supply. By adjusting the Gauss meter knob and fix the field to be zero. Switch on the magnet and adjust the current to be 0.3A. Note the field value from the Gauss meter. Repeat the same as before till attaining the maximum current and note the reading in the table. Calculate the magnetic susceptibility using the given formula

R

CALCULATION

The magnetic susceptibility of the given solution $\chi = \frac{2(\rho - \sigma)gh}{H^2}$

χ = …………..kg m^{-1} s^{-2}Gauss^{-2}

RESULT

The susceptibility of paramagnetic solution ($FeCl_3$) by Quinke' s tube method is given by

= …………. kg m^{-1} s^{-2} Gauss^{-2}

L

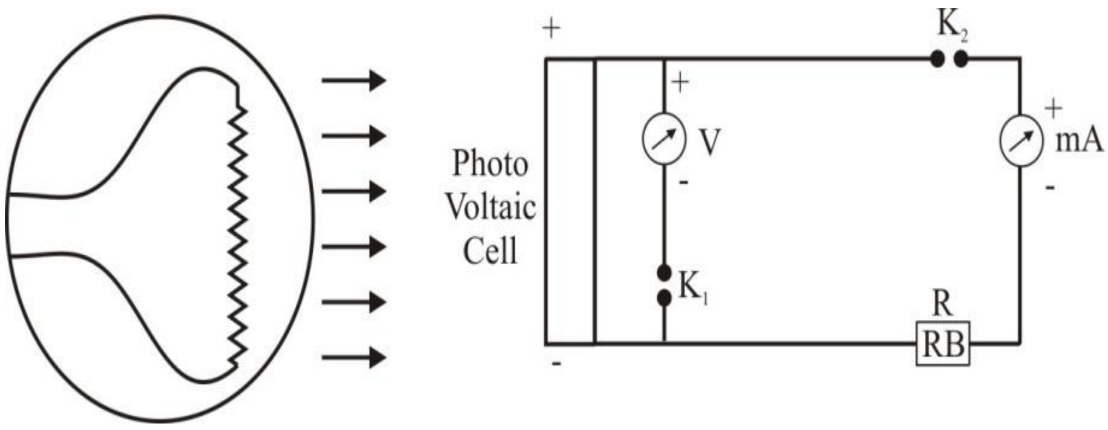

Fig.4.1 Schematic representation and circuit of Solar Cell

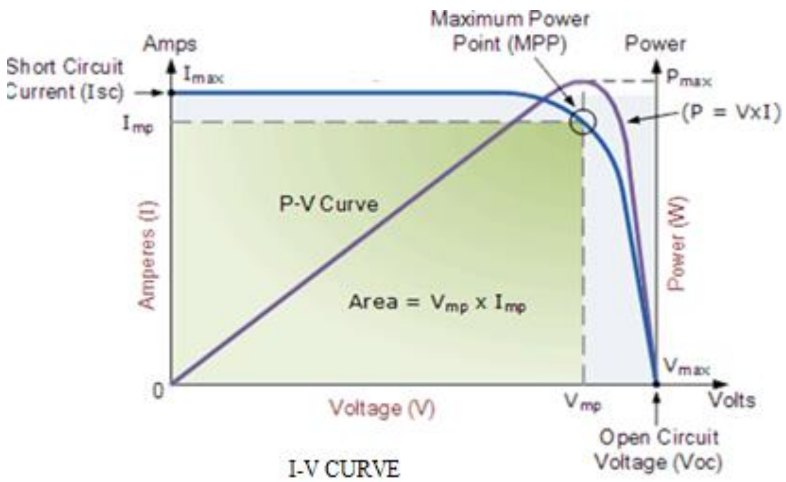

Fig.4.2. Model Graph for V-I Characteristics

R

4. STUDY OF I-V CHARACTERISTICS OF SOLAR CELL AND DETERMINATION OF ITS EFFICIENCY

Aim

To study the I-V Characteristics of a solar cell illuminated by an incandescent lamp and to determine its efficiency.

Apparatus Required

Solar cell, voltmeter, milliammeter, a dial type resistance box, Keys, illuminating lamps, connecting wires etc.

Formula

Efficiency of the solar cell $\eta = \frac{P_{max}}{AI_0} \times 100$

$$P_{max} = V_{mp} \times I_{mp} \text{ watt}$$

$$I_0 = \frac{P}{4\pi d^2} \text{ watt/m}^2$$

Explanation

Symbol	Explanation	Unit
V_{mp}	Maximum voltage point	volts
I_{mp}	Maximum current point	ampere
A	Area of the solar panel	m^2
P	Power of light	watt
I_0	Intensity of light	Wm^{-2}

PROCEDURE

Connect the solar cell to the potentiometer and multi meter as shown in Fig.4.1. Set the potentiometer at the minimum. Connect the incandescent lamp with its power supply. Switch on the lamp and adjust further so that maximum area of the solar cell can be illuminated. Record the distance between the lamp and the solar cell. Vary the potentiometer and record the values

L

of current and voltage across the solar cell, keeping the supply voltage to the lamp fixed. Plot I-V curve (Fig.4.2.) for each frequency and estimate short circuit current, no load voltage. Determine the maximum power output at the turning points on the curves.

To find the I-V characteristics

Distance between the solar panel and the bulb (d) = cm			Distance between the solar panel and the bulb (d) = cm		
Intensity of light $I_0 = Wm^{-2}$			Intensity of light $I_0 = Wm^{-2}$		
Resistance (ohm)	Voltage (V)	Current (mA)	Resistance (ohm)	Voltage (V)	Current (mA)

Result

The efficiency of the solar cell $\eta =$

R

L

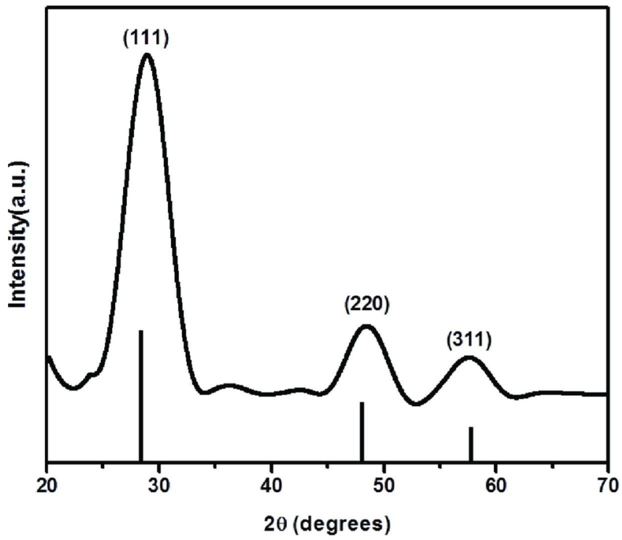

Fig 5.1 XRD pattern

h, k, l	$h^2 + k^2 + l^2$	*h, k, l*	$h^2 + k^2 + l^2$
100	1	300	9
110	2	310	10
111	3	311	11
200	4	322	12
210	5	320	13
211	6	321	14
220	8	400	16
221	9	410	17

Table 5.1 Value of $h^2 + k^2 + l^2$ for different planes

5. CALCULATION OF LATTICE CELL PARAMETER – X-RAY DIFFRACTION METHOD

R

AIM

The calculate the lattice cell parameters from the powder X-ray diffraction data.

APPARATUS REQUIRED

Powder X-ray diffraction diagram

FORMULA

For a cubic crystal

$$\frac{1}{d^2} = \frac{(h^2 + k^2 + l^2)}{a^2}$$

The lattice parameter and interplanar distance are given for a cubic crystal as,

$$a = \frac{\lambda}{2\sin\theta}\sqrt{h^2 + k^2 + l^2} \text{ Å}$$

$$d = \frac{a}{\sqrt{h^2 + k^2 + l^2}} \text{ Å}$$

Symbol	Explanation	Unit
a	Lattice parameter	Å
d	Interplaner distance	Å
λ	Wavelength of the CuKα radiation (1.5405)	Å
(hkl)	Miller indices	-

PROCEDURE

From the 2θ values on a powder photograph, the θ values are obtained. The $\sin^2\theta$ values are tabulated. From that the values of $1 \times \frac{\sin^2\theta}{\sin^2\theta_{min}}, 2 \times \frac{\sin^2\theta}{\sin^2\theta_{min}}, 3 \times \frac{\sin^2\theta}{\sin^2\theta_{min}}$ are determined and are tabulated. The values of $3 \times \frac{\sin^2\theta}{\sin^2\theta_{min}}$ are rounded to the nearest integer. This gives the value of h^2+k^2+l. From these the values of *h,k,l* are determined from the Table 5.1 .From the *h,k,l* values, the lattice parameters are calculated using the relation.

L

To find the Value of $h^2 + k^2 + l^2$ for different planes

S. No	2θ	θ	$sin^2\theta$	$1 \times \frac{sin^2\theta}{sin^2\theta_{min}}$	$2 \times \frac{sin^2\theta}{sin^2\theta_{min}}$	$3 \times \frac{sin^2\theta}{sin^2\theta_{min}}$	$h^2+k^2+l^2$	***hkl***	**a** Å	**d** Å

Lattice determination

Lattice type	Rule for reflection to be observed
Primitive P	None
Body centered I	*hkl* : $h + k + l = 2n$
Face centered F	*hkl* : *h, k, l* either all odd or all even

Depending on the nature of the *h,k,l* values the lattice type can be determined.

R

CALCULATION

Lattice parameter

$$a = \frac{\lambda}{2\sin\theta}\sqrt{h^2+k^2+l^2}\ \text{Å}$$

Interplanner distance

$$d = \frac{a}{\sqrt{h^2+k^2+l^2}}\ \text{Å}$$

Result:

The lattice parameters are calculated theoretically from the powder x-ray diffraction pattern.