Rayat Shikshan Sanstha's

Mahatma Phule Arts, Science and Commerce College, Panvel, Dist.-Raigad

Department of Physics

(Academic Year: 2022-23)

Experiment under DBT Star College Scheme

Class: F.Y.B.Sc. **Date:** **Time:**

Name of Student: **Roll Number:**

Title: UV-visible Absorption Spectroscopy

Aim: To determine the band gap energy of a nanomaterial by using UV-visible absorption spectra

Requirements: UV Spectra of nanomaterial

Formula:

$$h\nu\ (\mathrm{eV}) = \frac{hc}{\lambda} = \frac{1239.8\ (\mathrm{eV} \times \mathrm{nm})}{\lambda\ (\mathrm{nm})}$$

$(\alpha h\upsilon)^{\gamma} = A(h\upsilon - E_g)$

Where, α – absorption coefficient

h – Planks constant

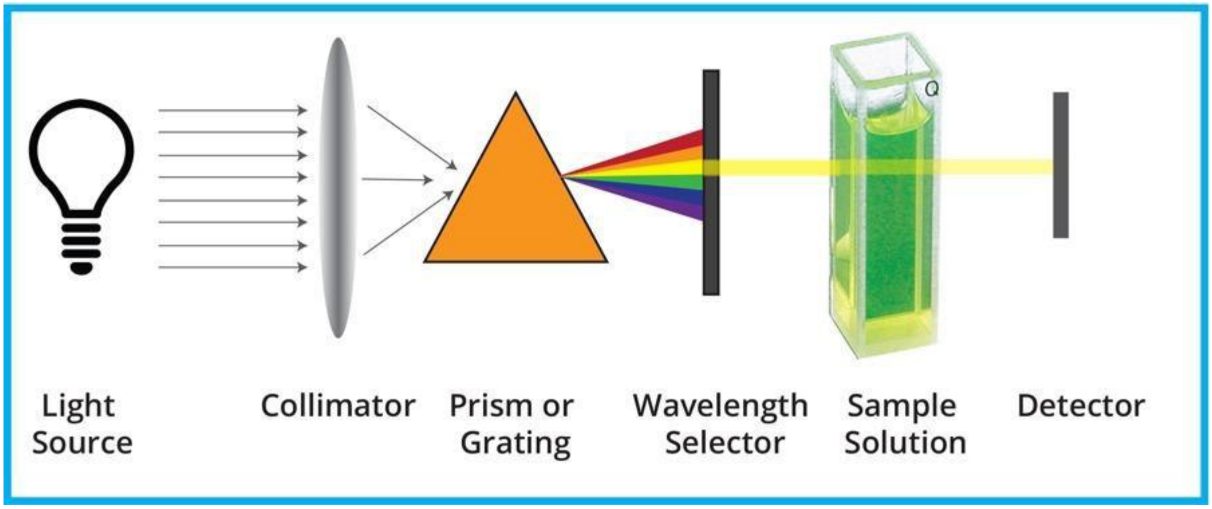
υ – Photon frequency

A – Proportionality constant

Eg – Band

γ – Nature of electronic transition – 2 for dielectric band gap – 0.5 (1/2) for indirect band gap

Figure:



Light absorption mechanism

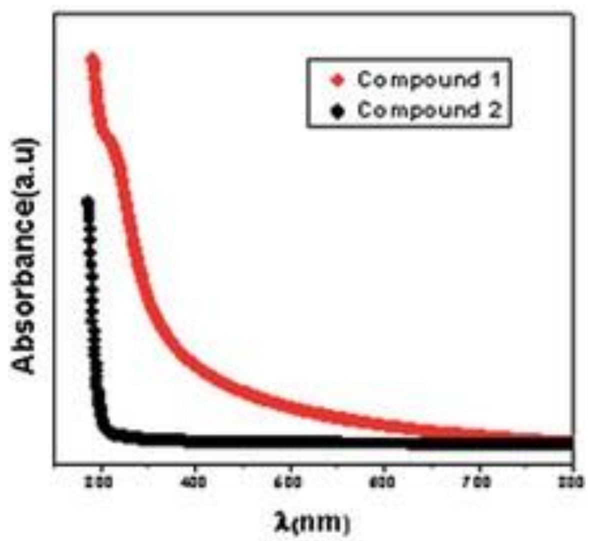


Figure 1. UV-Visible absorption curve

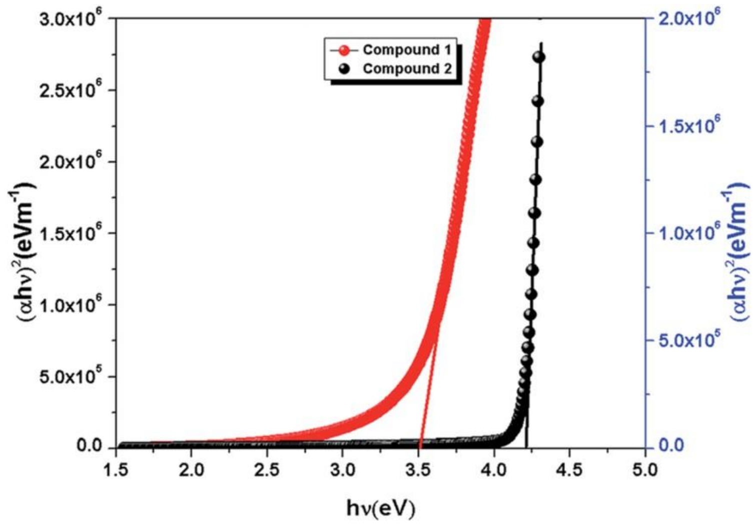


Figure 2. Tauc curve

Observations:

1. Intercept on X-axis for compound 1:
2. Intercept on X-axis for compound 2:

Results:

1. Eg of compound 1..................eV
2. Eg of compound 2..................eV

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Class: F. Y. B. Sc. **Date:** **Time:**
Name of Student: **Roll Number:**

Title: Determination of intensity of Electromagnetic waves (Visible light)

Aim:
To measure the intensity of light with the lux meter of:

(i) H.P. mercury vapour lamp, (ii) H.P. sodium vapour lamp

Requirements:

Luxmeter, H.P. mercury vapour lamp, H.P. sodium vapour lamp, connecting wires etc.

Theory:
Luxmeters (Light Meters):

The meters or light meters measure illumination in terms of luxes (lx) or foot candles (fc). A lux is equal to the total intensity of light that falls on a one square meter surface that is one foot away from the point of source of light. A foot candle is equal to the total intensity of light that falls on a one square foot surface that is one foot away from the point source of light. Most lux meters or light meters consist of a body, photocell or light sensor, and display. The light that falls on to the photocell or sensor contains energy that is converted to electric current. In turn, the amount of current depends on the amount of light that strokes the photocell or light sensor.

Luxmeters read the electrical current, calculate the appropriate value, and output the results to an analog digital video display. Since light usually contains different colours at different wave lengths, the reading represents the combined effects of all the wave lengths. Typically, standard colors or color temperatures are expressed in degrees kelvin (K). The standard colour temperature for the calibration of most lux meters is 2856°K, an amount that is more yellow than pure while.

Selecting luxmeters or light meters requires certain performance specifications include photo cell, illumination range. Lux resolution, operating temperature and foot candle resolution.

Analog devices display values on a dial usually with a needle or pointer. Digital devices display values as numbers letters. Lux meter may be portable or designed to sit atop a desk. Special feature includes low battery indicators, low voltage, alarms, remote light sensors etc.

Lux meters are used to measure levels of light in schools, hospitals, production areas, laboratories. They are also used to monitor light sensitive displays in museums, art galleries etc., special features include backlit displays, low battery indicators, low voltage alarms, built in memory. Auto powers off zero function.

Analog Luxmeter:

Analog Luxmeter display values on a dial usually with a needle or pointer it is operated with low voltage battery the intensity of light of any lamp can be measured by connecting loads from luxmeter to the lamp terminal when it is glowing.

Specifications of Luxmeter:

(i) Digital Luxmeter:

a. Compact and rugged design with large display

b. Widest range to 40,000 Fc/400,000 Lux is ideal for outdoor applications

c. Data Hold and Min/Max readings

d. Auto power off, zero function.

(ii) Analog Luxmeter:

a. Widest range of measurement upto 10,000 Lux with accuracy of ± 10% operating voltages of upto 300 V ac

Procedure: (To measure the Intensity of Light source):

1. Switch on the light source.

2. Keep the source of light one foot away from the light sensor.

3. Now switch on the lux meter.

4. Note down the reading from Luxmeter and record in observation table.

5. Repeat the above procedure for the mercury vapour lamp and sodium vapour lamp.

Observation Table/Graphs:

Sr. No.	Light Source	Distance (cm)	Intensity (Lux)
1	H. P. Mercury Vapour Lamp		
2			
3			
4			
5			
6			
7			
8	H. P. Sodium Vapour Lamp		
9			
10			
11			
12			
13			
14			

Results:

The intensity of the Light of

1.

2.

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(Academic Year: 2022-23)

Experiment under DBT Star College Scheme

Class: S.Y.B.Sc. **Date:** **Time:**

Name of Student: **Roll Number:**

Title: CuO Thin Film

Aim: Synthesis of Copper Oxide (CuO) thin film using chemical bath deposition method

Requirements:

Chemicals: Copper nitrate [$Cu(NO_3)_2.6H_2O$], Ammonia solution [NH4OH], Distilled water.

Instruments/Apparatus/Glassware: Heating Stirrer, beaker, glass substrate, stainless steel (SS) substrate, glass rod, magnetic stirring needle, Oven.

Theory:

Nonomaterials are broadly defined as material that has at least one dimension less than 100 nm. Thin film is defined as two-dimensional distribution of material with the third dimension less than 1 μm, Cooper Oxide (CuO) is a narrow band gap semiconductor material. Nanoparticles of copper oxide with a size below 100 nm have a large surface area, good optical, catalytic, sensing activities. The exact physical and chemical properties of zinc oxide Nanoparticles depend on the different ways they are synthesized, size, morphology, etc. Copper oxide nanoparticles are useful in a variety of industries applications, including paints rubber, cosmetics, and wastewater treatment.

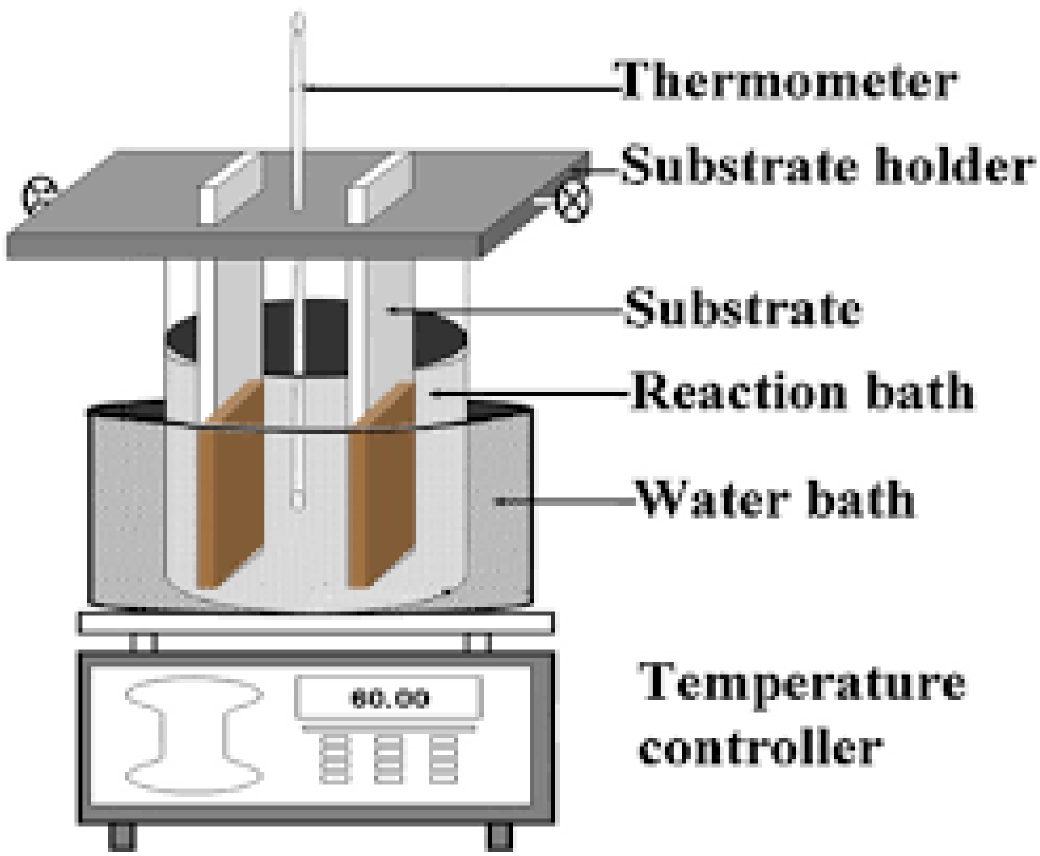
Reaction:

$$Cu(NO_3)_2.6H_2O + NH_4OH \longrightarrow CuO \text{ thin film}$$

Procedure:

1. Prepare 50 mL of 0.1 M zinc nitrate solution in a 100 mL beaker with double distilled water.
2. Add ammonia solution drop wise to it with stirring unless pH of solution becomes 12.
3. Further, Pre-cleaned Substrates (glass or stainless steel) dipped into solution
4. Then, the beaker kept in water bath on heating stirrer, whose temperature obtained to 80°C for 2 h.
5. Then, the substrates taken out of beakers, cleaned many times with double distilled water.
6. Furthermore, the substrates were dried at 100°C for 2 h.

Schematic Representation of Method:



Observations:

Dimensions of the coated substrate

Width........... cm

Breadth .... cm

Observation Table/Graphs:

Sr. No	Title	Mass on glass in g	Mass on SS in g
1	The substrate before coating		
2	The substrate after coating		
3	Coated thin film material		

Area Density: Mass of Coated thin film material/ (Width x breadth)

Calculations:

Results:

1. **Color of prepared thin film:**
2. **Areal density of prepared thin film:** g/cm^2

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Experiment under DBT Star College Scheme

Class: S.Y.B.Sc. **Date:** **Time:**

Name of Student: **Roll Number:**

Title: Application of Nanomaterial

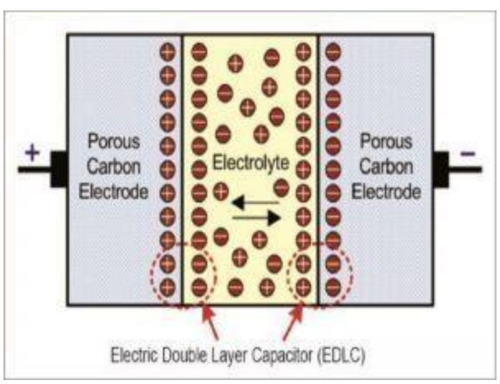
Aim: To study energy storage application of synthesized Copper oxide (CuO) thin film

Requirements:

Small container, CuO prepared thin film on stainless steel, filter paper, 2 M KOH electrolyte solution 50 ml.

Theory:

A supercapacitor typically works on the principle of storing electrical energy between two electrostatic double layers that are formed due to the deposition of thin layers of charge on the interface of the electrolyte and the inner side of the capacitor electrode plates.



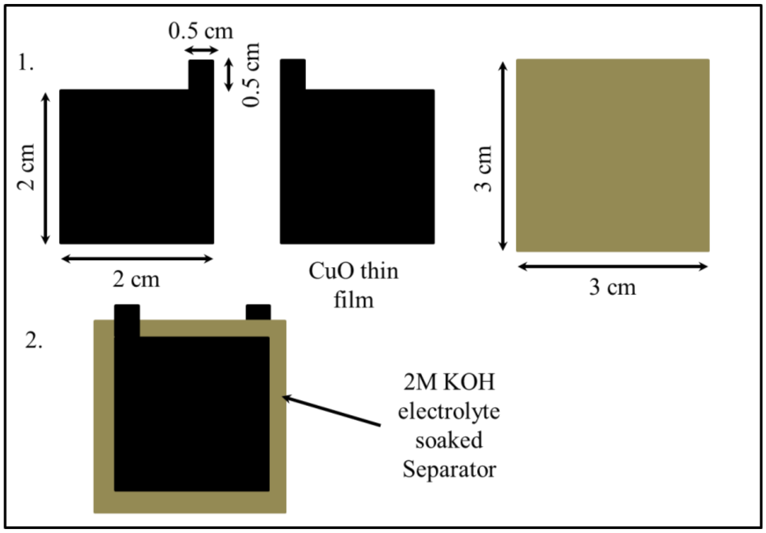
Construction of a Supercapacitor:

The construction of a supercapacitor is quite similar to that of a normal electrolytic capacitor. It consists of two metal electrode plates that are soaked into an electrolyte solution and are separated by a thin insulation layer. The surface area of the conduction plates of Supercapacitor is significantly large and the distance between the plates is less as compared to the traditional capacitors. A supercapacitor is an electrochemical device, but it does not make use of chemical reactions to produce electrical energy. The material used to construct the metal plates of a supercapacitor is generally coated with porous materials such as carbon, activated charcoal, etc. The electrolyte material present between the two plates provides the necessary insulation and protection to the device against charge leakage and short circuit. A supercapacitor is capable of storing a huge amount of charge value as the capacitance value of the capacitor is always directly proportional to the surface area of its conduction plates, which in this case is significantly large. Also, the value of capacitance is inversely proportional to the distance between the plates, which in the case of supercapacitors is considerably less as compared to the traditional capacitors.

Working of a Supercapacitor:

The capacitors make use of static electricity or electrostatics to store energy. The electrolyte solution present between the two plates of the supercapacitor contains both positively and negatively charged ions. When a voltage is applied across the plates of the supercapacitor, one of the plates tends to develop a positive charge, while the other plate gets negatively charged. This causes the negative ions present in the electrolyte solution to get attracted towards the positively charged plate and the positively charged ions to get attracted towards the negative metal plate. A thin layer of ions gets deposited on the inner side of both plates. This leads to the formation of an electrostatic double layer, which is comparable to a series connection of two capacitors. The distance between the charge layers of both the resultant capacitors is very thin, hence each of them possesses a high value of capacitance. The overall capacitance of the supercapacitor can be calculated by evaluating $(C1 \times C2)/(C1 + C2)$

Procedure:



(1) Cut the thin films (as electrodes) and separator as shown in above figure with specified dimension.

(2) Soak the separator in 2M KOH electrolyte solution.

(3) Sandwich the soaked separator in between two electrodes.

(4) Put the assembly into cubic container, which will be energy storage device, called as supercapacitor.

(5) Charge prepared supercapacitor at constant current and measure current and voltage during discharging.

Observation Table/Graphs:

Sr. No.	Constant Current for charging (mA)	Current during discharging (mA)	Voltage during discharging (V)
1			
2			
3			
4			
5			
6			
7			

Calculations:

Results:

1. Stable maximum current provided by supercapacitor during discharging:
2. Stable maximum voltage provided by supercapacitor during discharging:

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Class: S.Y.B.Sc. **Date:** **Time:**

Name of Student: **Roll Number:**

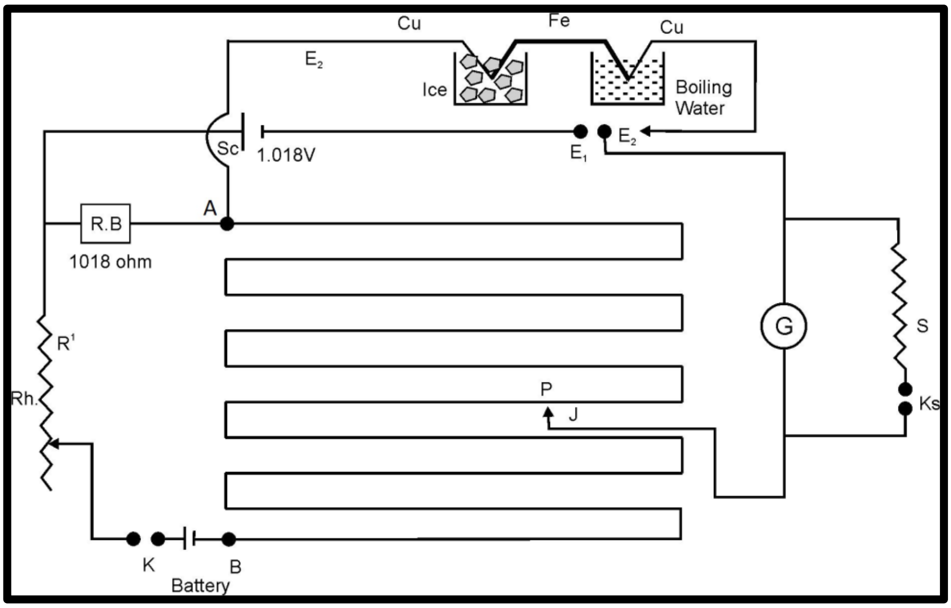
Title: Thermo EMF

Aim: To study variation of thermo EMF of a Cu-Fe thermocouple using potentiometer.

Seebeck Effect: The production of thermo emf across the junction of thermocouple when a temperature difference is maintained across the junction is called as thermoelectric effect or seebeck effect. The energy required to maintain the current is derived from the surroundings. In a Cu-Fe thermocouple current flow from Cu to Fe at hot junction**.**

Requirement: Beakers, Resistance Box, Galvanometer, Key, Rheostat, Battery, Standard Cell 1.018, Cu and Fe Thermocouple, Jockey, wires

Diagram:



Theory: Measurement of Electromotive Force

Ordinary potentiometer cannot measure the thermo emf as generated by thermocouple due to very small value (0.0013 volts for a temperature difference of 100ºC). It is measured by 10 wire potentiometers, so as to provide a PD of about one microvolt per cm length of potentiometer.

Consider the apparatus as shown in circuit diagram. Take out a resistance of about 1018ohms from R.B.Insert key K and E1 and adjust the Rheostat so that there is no deflection in the galvanometer. Now the PD across resistance R will be balanced by the emf of the cell. If E is the emf of standard cell and I the steady current through R or potentiometer wire we have.

$$E=IR \text{ ---------------- } 1.$$

Switch off E1 and switch on E2 to connect the cold junction to the galvanometer using jockey. Find out the balance point. The thermo emf of Cu-Fe thermocouple is equal to potential difference between A and P. The thermo emf e of wire of resistance r is:-

$$e=Ir \text{ --------------- } 2$$

dividing 2 by 1,

$$e\,/\,E=r\,/\,R \text{------------ } 3$$

If ρ is the resistance per unit length of wire then for balancing length l

$$r=\rho\, l$$

put in 3

$$e=\rho El\,/R=Kl$$

where K = ρ E/R

Procedure:

1. Arrange the Apparatus as shown, in Diagram.
2. Take out a resistance of about 1018.3 ohm from the RB
3. Shunt the galvanometer G using a key Ks by joining a small resistance (0.01 Ω) in parallel with it to protect it from strong current.
4. Switch on K and E1.

5. Adjust the rheostat R' until there is no deflection in the galvanometer.

6. Remove the shunt by taking switch to off position.

7. Adjust the rheostat finally until there is no deflection in the galvanometer which means the PD across R is balanced by the emf of standard cell.
8. Again shunt the galvanometer using Ks.
9. Switch on K and E2 to connect the cold junction of thermocouple stud to the galvanometer.
10. Find by trial by placing the sliding contact maker on various studs corresponding to the different coils and pressing the jockey over the stretched potentiometer wire.

11.Again remove the shunt from the galvanometer and determine the exact position of null point on the potentiometer wire.

12. Note down the number of coils and length of potentiometer wire between the sliding contact maker and the jockey P and find the equivalent length L of the potentiometer
wire. corresponding to the thermo electric emf of the Cu-Fe thermocouple.

13. Calculate the value of thermo emf from:- $e = pEL/R$

where p = known value of resistance per unit length.

14. Heat the oil (Lubrication engine oil) in a beaker to a high temperature and then allow to cool.

15. As the hot junction cools measure the thermo emf after an interval of temperature of about 50 until the temperature of hot junction falls about 30-35 degree.

16. Plot the graph taking temperature along X-axis and the corresponding thermo emf along the Y Axis.

17. This graph will be part of parabola which give the variation of thermo emf with temperature of hot junction.

Observations: -

Room temperature= °C

EMF of standard cell= 1.018V

High resistance R=

Observation Table:

Sr. No.	Temperature of Hot Junction	Length of potentiometer wire corresponding to the Thermo EMF			Thermo EMF $e = \frac{E\rho L}{R}$ microvolt
		No. of full coil	Balancing length L	Equivalent length L cm	
1)					
2)					
3)					
4)					
5)					
6)					

Calculation:

K = ρ E/R = micro volt/ohm

EMF = kL = micro volt

Result: The graph between thermos emf and temperature of hot junction is .... , which is in accordance with seebeck effect.

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Department of Physics
(Academic Year: 2022-23)
Experiment under DBT Star College Scheme

Class: S.Y.B.Sc. **Date:** **Time:**
Name of Student: **Roll Number:**

Title: Four Probes – Measurement of Resistivity

Aim:

i) To find the resistivity of the p-type Ge semiconductor material.

ii) To find the band gap energy of the p-type Ge semiconductor sample.

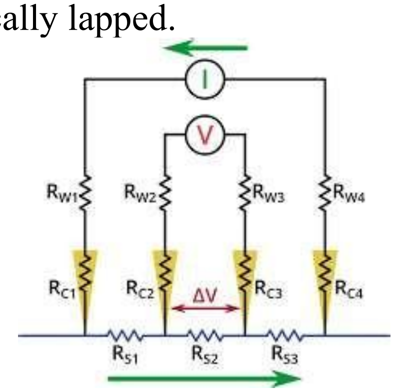
Requirements:

Pico-ammeter, Voltmeter, Heating platform, semiconductor material thin film to be used, thermometer, four probe setup.

Theory:

Four probe method: Measurement of resistivity of Ge crystal is made to determine the suitability for the fabrication of transistor of other semiconductor devices. The resistivity has to be measured very accurately. Since its value is critical in many devices. Some transistor parameters like the equivalent base resistance are at least linearly related to resistivity.

There are many methods for making resistivity measurement. But the standard and accurate method is four probe method. In its usual form, the four probes are collinear and current flows to the outer pair contacts and the potential across the inner pair is measured. If the flat surface in which the probe rest is adequately large of the crystal is big. The semiconductor may be considered to be a semi infinite volume. To present minority carrier injection and make good contacts the surface on which the probe rest may be mechanically lapped.



Formula:

i) Resistivity $\rho_0 = \frac{V}{I} 2\pi S \quad \Omega m$

Conductivity $\sigma = \frac{I}{V} 2\pi S \quad \Omega^{-1} m^{-1}$

Corrected resistivity $\rho = \rho_0 / G_7(W/S)$

Where

$I \rightarrow$ current applied to the probes

$V \rightarrow$ Voltage between the probes

$S \rightarrow$ spacing between the probes

$W \rightarrow$ thickness of the specimen

ii) Band gap energy $E_g = 2.303 \times 2 \times K_B \times \frac{\log \rho}{1/T}$

where

$K_B \rightarrow$ Boltzmann's constant

$T \rightarrow$ Temperature in Kelvin

Procedure:

First take out the four-probe arrangement from the oven and put it on a plane surface. Now put the sample on the circular base plate of the four-probe arrangement such that the non conducting surface of the crystal should be on the plate side and four probe are in the middle of the crystal. Apply some pressure slightly on the pipe. So that it clearly makes the contacts with the sample and tighter the screw. Now check the continuity between the sample and four probe by the multimeter.

1. If the contacts are loose, tighter the three screws provided on the top of the base stand till the four probes touch the crystal.
2. Put the thermometer in the probe provided in four probes arrangement to measure the oven temperature.
3. Put the four probe arrangement in the oven and check the continuity between the each pair of leads again.
4. Connected the green leads to the output terminals of the constant current source. Marked current and the range leads to the input terminals of the digital voltmeter marked "voltage".
5. Connect the setup to the a.c. mains and switch on.

6. Put the selector switch in current position and range multipliers. Switch at x1 position adjust current to zero with the help of current adj. knob change the selector switch in voltage position and adjust zero in DVM of shorting the voltage.
7. Again change the selector switch in current position and apply some current say 5mA with the help of current adj. knob and note that reading. Further change the selector switch. In voltage position and range multiplier. Switch in x10 range and note the corresponding voltage in DVM. Also note the corresponding temperature in thermometer. Record these readings in the table change the range multiplier switch in the range when the voltage reading reaches below 20mV. Check the current value by changing the selector switch. It must be fixed.
8. Connected the oven with the oven supply and adjust the oven supply switch in 1st position.
9. Measure voltage for different values of temperature, keeping the current constant. Record these readings.
10. Repeat the experiment for different values of current. The conductivity of the semiconductor material is calculated by

Given:

Probe Spacing s = 0.24 cm
Thickness of Sample, W = 0.05 cm

Observations:

Applied current across two outer probes.................V

Observation Table/Graphs:

Sr. No.	Temperature in °C	Temperature in K	Voltage (mV)	ρ_o (Ωm)	ρ (Ωm)

Calculations:

Results:

1. Resistivity of a semiconductor material p-type Ge semiconductor sample with temperature is studied. As temperature increases, resistivity decreases. The resistivity is _______________.

2. Band gap energy (Eg) of the p-type Ge semiconductor material is __________.

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Department of Physics

(Academic Year: 2022-23)

Experiment under DBT Star College Scheme

Class: T.Y.B.Sc. **Date:** **Time:**

Name of Student: **Roll Number:**

Title: X-ray diffraction (XRD) analysis of different nanomaterials

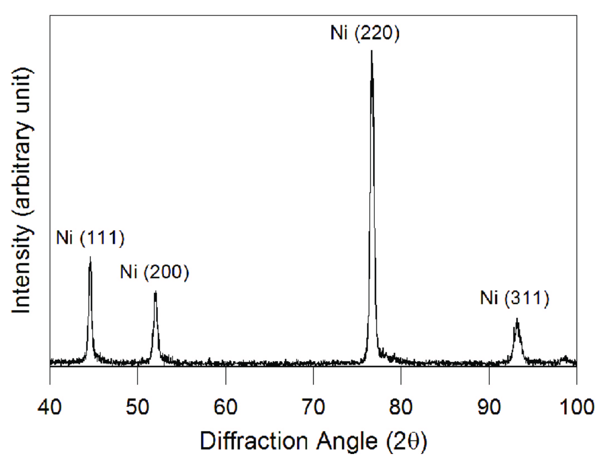
Aim: To determine the interplanar spacing and particle size of crystalline nanomaterials

Requirements: XRD patterns

Theory:

X-ray crystallography is the experimental science determining the atomic and molecular structure of a crystal, in which the crystalline structure causes a beam of incident X-rays to diffract into many specific directions. By measuring the angles and intensities of these diffracted beams, a crystallographer can produce a three-dimensional picture of the density of electrons within the crystal. From this electron density, the mean positions of the atoms in the crystal can be determined, as well as their chemical bonds, their crystallographic disorder, and various other information.

Diagram:



Formulae:

Brags Law to determine interplaner spacing:

$n\lambda = 2d \sin\theta$

Where, n- principle order, λ-wavelength of used X-ray, θ is diffraction angle, d- interplanar spacing.

Scherrer formula to determine particle size:

$D = k\lambda/\beta \cos\theta$

Where, D - particle size, K is known as the Scherrer's constant (K=0.94), λ is the X-ray wavelength, β is full width at half maximum (FWHM) of the diffraction peak

Given:

$\lambda = 1.54178$ Å

β (in radian) = FWHM $\times\pi/180°$

Observation Table/Graphs

Sr. No.	2θ	Θ	d	D

Calculations:

Results:

Interplanar spacing d =.................nm

Particle Size =......................nm

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(Academic Year: 2022-23)
Experiment under DBT Star College Scheme

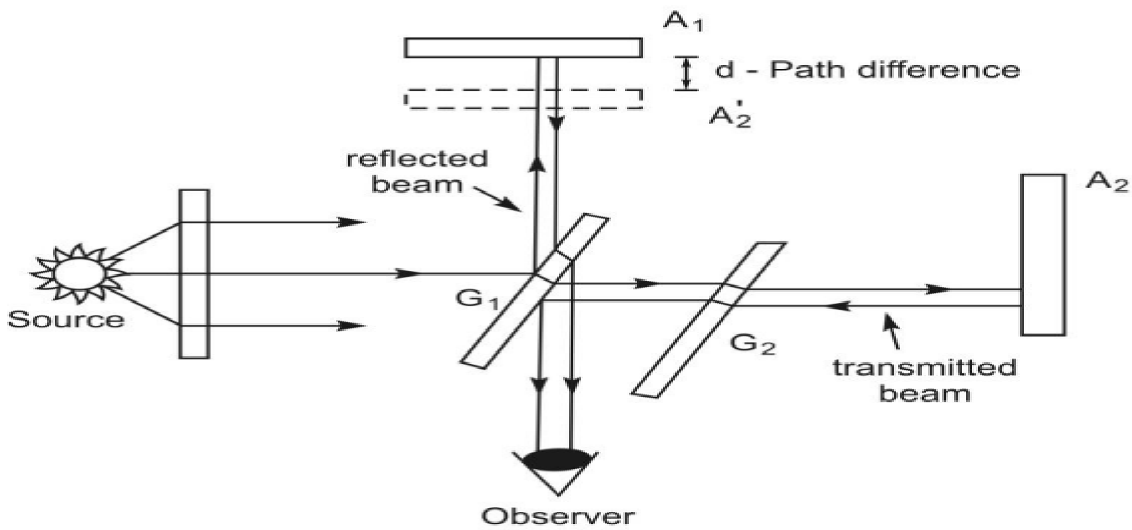
Class: **Date:** **Time:**
Name of Student: **Roll Number:**

Title: Michelson's Interferometer

Aim: Measurement of the wavelength of He-Ne Laser and Na lamp using circular fringe

Requirements: He-Ne Laser, Na- Source, Michelson Interferometer, etc.

Figure:

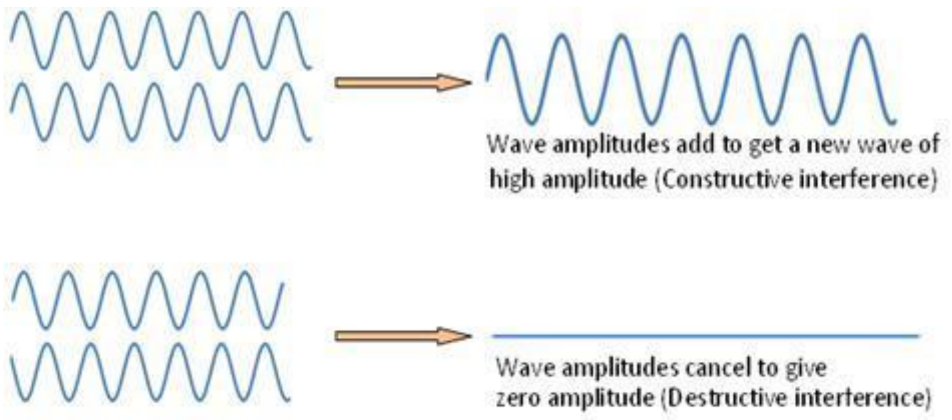


Theory:

Interference theory:

Light is a transverse wave. When two waves of same wavelength and amplitude travel through same medium, their amplitudes combine. A wave of greater or lesser amplitude than the original will be the result. The addition of amplitudes due to superposition of two waves is called interference. If the crest of one wave meets with the trough of the other, the resultant intensity will be zero and the waves are said to interfere destructively. Alternatively, if the crest of one wave meets with the crest of the other, the resultant will be maximum intensity and the waves are said to interfere constructively.

Suppose two coherent (i.e. their initial phase relationship remains constant) waves start from the same point and travel different paths before coming back together and interfering with each other. Suppose also that the re-combined waves illuminate a screen where the position on the screen depends on the difference in the lengths of the paths traveled by the two waves. Then the resulting alternating bright and dark bands on the screen are called interference fringes.



In constructive interference, a bright fringe (band) is obtained on the screen. For constructive interference to occur, the path difference between two beams must be an integral multiple $m\lambda$ of the wavelength λ, where m is the order, with m =0,1,2…

If the path difference between two waves is $(m+\frac{1}{2})\lambda$ the interference between them is destructive, and a dark fringe appears on the screen.

Michelson Interferometer:

The Michelson interferometer is the best example of what is called an amplitude-splitting interferometer. It was invented in1893 by Albert Michelson, to measure a standard meter in units of the wavelength of the red line of the cadmium spectrum. With an optical interferometer, one can measure distances directly in terms of wavelength of light used, by counting the interference fringes that move when one or the other of two mirrors are moved. In the Michelson interferometer, coherent beams are obtained by splitting a beam of light that originates from a single source with a partially reflecting mirror called a beam splitter. The resulting reflected and transmitted waves are then re-directed by ordinary mirrors to a screen where they superimpose to create fringes. This is known as interference by division of amplitude. This interferometer, used in 1817 in the famous Michelson- Morley experiment, demonstrated the non-existence of an electromagnetic-wave-carrying ether, thus paving the way for the Special theory of Relativity.

Procedure:

1. Turn the micrometer knob one full turn counter clockwise, continue turning until the zero on the knob is aligned with the index mark.
2. Adjust the position of your viewing screen so that one of the marks on the millimeter scale is aligned with one of the fringes in your interference pattern.
3. You'll probably find it easier to count fringes if the reference mark is one or two fringes out from the center of the pattern.
4. Rotate the micrometer knob slowly counterclockwise. Count the fringes as they pass your reference mark. Continue until 30 fringes (or so) have passed your mark. Make sure you do not count the fringe at the initial position of the micrometer knob as 1, but the next fringe.)
5. As you finish your count, the fringes should be in the same position with respect to your reference mark as they were when you started to count. Record the final reading on the micrometer dial. Ignore the numbers along the micrometer shaft.
6. The distance d (in µm, micrometers, 10-6 m) that the movable mirror moved toward the beam-splitter is the reading from the micrometer knob. Record d and N, the number of fringes that passed. Repeat the experiment two more times. For each trial, calculate the wavelength of the light and then average your results.

Formulae:

$\lambda = 2d/N$

Observation Table/Graphs:

Sr. No.	Light source	d (μm)	N Number of fringes	λ	λ average
1	He-Ne Laser				
2	He-Ne Laser				

Calculations:

Results:

1. Wavelength of He-Ne Laser source:
2. Wavelength of Na- source:

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Mahatma Phule Arts, Science and Commerce College, Panvel, Dist.-Raigad
Department of Physics
(Academic Year: 2022-23)
Experiment under DBT Star College Scheme

Class: **Date:** **Time:**
Name of Student: **Roll Number:**

Title: Hall Effect

Aim:
To study the Hall Effect in a given semiconductor and determine Concentration of charge carriers (n).

Requirements:
Semiconductor crystal (Ge), Hall probe, Hall effect setup, Electromagnet, Constant power supply (current), digital gauss mater etc.,

Theory:

When a magnetic field is applied perpendicular to the direction of current following in a conductor or semiconductor, a voltage is developed across the specimen in a direction perpendicular to both the current and applied magnetic field. This phenomenon is called the Hall Effect and the voltage so developed is called the hall voltage. Consider a specimen where it carries a current Ix along the X- direction under the application of a transverse magnetic field BZ along the Z-direction. Then a force called the Lorentz force is developed along the Y-direction. Due to the force, the charge carriers are forced to move downwards and they accumulate near the bottom face. If the specimen is a metal, where only one type of charge carriers (i.e.,) electrons exist, they are forced down to the bottom surface which becomes more negative, when compared to that of a top surface. Hence a potential difference is developed between the bottom and top surface.
If the specimen is an n-type semiconductor where the electrons are forced down into the bottom surface. Therefore, the top and bottom surfaces become positive and negative respectively. In a P-type semiconductor, the bottom surface is occupied by holes and becomes more positive compared to the top surface. In all the above cases, the potential; difference between the upper and the lower surfaces is known as Hall Voltage. Hall voltage is given by $V_H = BI/(ne\omega)$. Here $1/ne = R_H$ which is known as Hall Co-efficient and the same is given by $(R_H) = (V_H)\omega/BI$, where ω is thickness of the specimen, I is the current to the Ge crystal

and B is the magnetic field. Hall coefficient or Hall constant is material dependent. It is either positive or negative indicating the type of charge carriers. Negative and positive R_H indicates that the type as charge carriers is electrons and holes respectively. Its magnitude is larger for smaller n. The effect is smaller for good metallic conductor and becomes more prominent in semiconductors and semimetals. Concentration of charge carriers, n= 1/ (R_He) Mobility is defined as the ratio of the average drift velocity per unit electric field. It can be determined by using the relation $\mu = R_H\sigma$. If θ_H is the hall angle then one can calculate the same by using the relation tan $\theta_H = E_H/E_X$, where E_H is the hall field (i.e,.) the hall voltage measured per unit thickness of the specimen.
θ_H = tan-1[$10^{-8} R_H B\sigma$] where σ is the conductivity of the specimen which is assumed in the present study.

Formulae:

(i) Hall co-efficient, $(R_H) = (V_H)\omega/BI$
(ii) Concentration of charge carriers, n= 1/ (R_He)

Where,

VH	-	hall voltage
Ω	-	Thickness of the specimen
B	-	Applied magnetic field
I	-	current applied to the Ge crystal
e	-	charge of the carrier ($\rho=1.6x10^{-19}$c)

Figure:

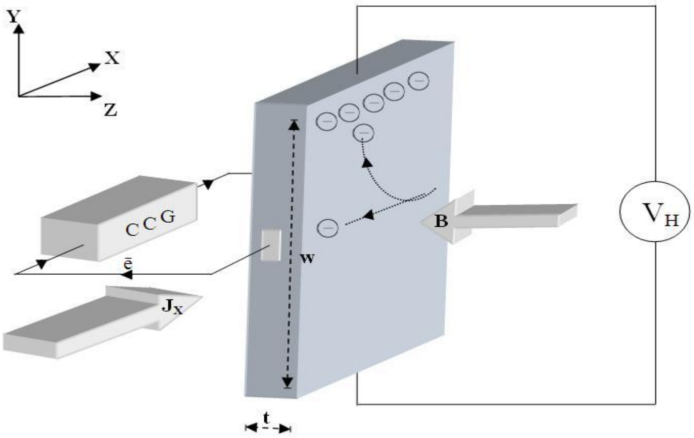

Fig.1 Schematic representation of Hall Effect in a conductor.

CCG – Constant Current Generator, J_X – current density, ē – electron, B – applied magnetic field, t – thickness, w – width, V_H – Hall voltage

Procedure:

I. The width-wise contacts of the Hall probe connect to the terminals marked as voltage; the lengthwise contacts are connected to the terminals marked as current.

II. The Hall Effect setup switch on and the current is set for few milliamperes. The display in the Hall Effect setup is set to the voltage side. There may be some voltage reading even when the specimen or hall probe is outside the magnetic field. This is due to the imperfect alignment of four contacts (two for measuring current and another two for measuring hall voltage) of the Hall probe and is generally known as zero field potential. In case its value is comparable to hall voltage it should be adjusted to a minimum as possible.

III. The probe place in a magnetic field now switches on the electromagnetic power supply and adjust the current to any desired value. The hall or the specimen is rotated till it becomes perpendicular to the magnetic field. Hall voltage is maximum in this adjustment.

IV. Hall voltage measure as a function of magnetic field keeping a suitable value of current fixed. The magnetic field is measured by using a gauss meter. Hall voltage are measured by changing the current directions for a given direction and magnitude of a magnetic field.

V. Similarly, V_H measure by exchanging the directions of the current and magnetic field.

VI. All the observations record as in table shown below for three different values of current. The values of the parameters viz., Hall coefficient, concentration of charge carriers and hall angle are calculated using the relations as discussed in the theory section.

VII. Plot of V_H as a function of B and also θ_H as a function of B are made and used for an analysis of the observations.

Observations:

Distance between the two pole pieces = ____ cm,
Residual magnetic field = 84 gauss,
Current to the Ge crystal = 1 mA, Zero field potential = 0.1mV

Observation Table/Graphs:

Sl. No	Current to electromagnet (amp)	Magnetic field (gauss)	Corrected magnetic field(gauss)	Voltmeter reading(mV)				Mean V_H(mV)	Corrected hall voltage(mV)
				Position I		Position II			
				$+V_H$	$-V_H$	$+V_H$	$-V_H$		
1.									
2.									
3.									
4.									
5.									
6.									
7.									
8.									

Calculations:

Results:

A study on Hall Effect for the given Ge crystal specimen has been performed. The type of carrier has been found to be p-type and also the following parameters have been determined from the result of the experiments.

(i) Concentration of charge carriers (n): ____

Signature of Student **Signature of Teacher**