Sudan University of Science and Technology

College of Graduate Studies

كلية الدراسات العليا

Electrical Classification of Mica Using its Optical Properties

التصنيف الكهربي للمايـكا باستخدام خصائصها البصرية

A thesis submitted in partial fulfillment of the requirement for the degree of Master of Science in physics (solid state physics)

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الآيـة

بسم الله الرحمن الرحيم

(يَرْفَعِ اللهُ الَّذِينَ آمَنُوا مِنكُمْ
وَالَّذِينَ أُوتُوا الْعِلْمَ دَرَجَـات)

صدق الله العظيم

المجادلة (11)

Dedication

To my parents, my brothers and sisters

To my friends, to anyone who helped me in this research

Acknowledgement

First I would like to thank Allah who gave me the power to complete this work. Then I would like to thank Professor Mubarak Dirar who patiently and kindly supervised this research and who gave me many valuable references which were of great help.

Finally thanks to everybody who helped me in this work.

Abstract

The optical properties of matter play an important role of determining its electrical properties.

The researchers concentrate on pure glass but not local mica, which is really a physical problem.

It needs intensive research in its physical properties.

The aim of this work is to study the optical properties of mica; to classify it electrically.

The absorption and transmission spectra shows maximum photon absorption at energy ~ 4.1 eV, with band gap of ~3.8 eV.

The two results are coincides with each other since photon energy is found to be just more than that of energy gap (4.1 eV> 3.8 eV)

The value of band gap shows that the mica is semiconductor

المستخلص

الخصائص الضوئية للمادة تلعب دور مهم في تحديد خصائصها الكهربية، ركز الباحثون علي الزجاج النقي دون المايكا المحلية التي تحتاج بحوث مكثفة في خصائصها الفيزيائية.

الهدف من البحث هو دراسة الخصائص الضوئية للمايكا وتصنيفها كهربائيا، وقد بين طيف الامتصاص والانبعاث ان طاقة الفوتون القصوي للطاقة 4.1 ا.ف مع فجوة طاقة 3.8 ا.ف وتتفق نتيجة القيمتين مع بعضهما حيث ان طاقة الفوتون اكثر من فجوة الطاقة ، وقيمة فجوة الطاقة بينت ان المايكا شبه موصل.

Table of Content

Chapter one

Introduction

1.1 Historical Background

Electrical properties of matter are very important in electronics.

Matter are classified as conductors, semiconductor, and insulators [1, 2, 3]

Conductors allows electric current to flow, insulators prevents electric Current flow, semiconductors allows current to flow when doped with impurities or when they are heated. [4, 5, 6]

The classification of conductivity depends on the band gap. Conductors have no gap. Semiconductor have narrow band gap, while insulators have large band gap. [7, 8]

MICA is a group of silicate minerals with a layered structure. Its general formula is $(K, Na)X_nALSi_3o_{10}\text{-}(OH, F)_2$ where X may be AI^{3+}, Mn^{2+}, Mn^{3+}, Fe^{2+},Fe^{3+}, Mg^{2+}, Ti^{4+}, or Li^{+}

There are a variety of uses of this mineral such as:

- It is used in paints as a pigment extender and also helps to brighten the tone of colored pigments.
- In the electrical industry the same as thermal insulation, and electrical insulators in electronic equipment.
- Its shiny and glittery appearance makes it ultimate for toothpaste and cosmetics.
- The high thermal resistance allows it to be used as an insulator in various electronics.
- MICA SHIELDS or Gauge Glass Mica can be used to secure the liquid level gauges from corrosive and acidic solutions. [9,10]

2.3.1 Properties of Mica

Mica belongs to a very important and rather large group of minerals that are highly suitable for several applications. However, its advanced properties make it highly suitable for use in various places. These are

Physical: Mica is translucent, easily split into thin films along its cleavage, optically flat, colorless in thin sheets, elastic and incompressible

Chemical: It is a compound hydrous silicate of aluminum, which also contains iron, magnesium, potassium, sodium fluorine, lithium and also few traces of numerous other elements. It is constant and entirely static to the action of water, acids (except for hydrofluoric and concentrated sulphur, alkalies, conventional solvents, bases, and oil. It remains almost unchanged by atmospheric action.

Electrical: Mica has the exclusive combination of uniform dielectric steadiness, capacitance stability, enormous dielectric power, high Q factor and lower power loss, high electrical resistance and low temperature coefficient. It is highly regarded for its resistances to arc and corona discharge without causing any lasting injury.

Thermal: It is highly fire proof, incombustible, non- flammable, infusible, and also can resist temperatures of up to 1000 degrees Celsius/1832 degrees Fahrenheit. However this depends on the type and variety of Mica used. It has excellent thermal stability, lower heat conductivity, and can be easily exposed to high temperatures without visible effect.

Mechanical: Mica is highly tough, having high tensile strength, elastic, and along with being flexible. It has immense compression power and can be machined, die-punched, or hand cut. [11]

1.2 Research Problem

The problem of the research is to find the relationship between absorption coefficient and the transmission coefficient with the wave length of light and therefore to study the optical properties of the material of mica.

1.3 Literature Review

Optical reflection and transmission measurements have been made between 6 eV and 13 eV on specimens of natural muscovite, phlogopite, biotite and a synthetic fluorphlogopite. Reflectivity peaks are observed near 9.9 eV and 11.8 eV and are thought to be due to the silicate structure of mica. An absorption edge occurs near 7.85 eV in synthetic mica. Additional structure is observed above 7.8 eV in the magnesium micas but not in the aluminium micas. The absorption of phlogopite mica is unusually low in the high energy region. Below 7.8 eV absorption is believed to depend on transition metal impurities in the mica. [12, 13]

1.4 Aim of the Work

The objective of this research is to study the optical properties of mica using UV analysis.

1.5 Thesis Layout

We took three slices of mica with a fixed thickness and we did UV analysis to know the properties of transmission and absorption and we knew the concentration of certain elements in the mica and we got shapes, this research came as follows, Chapter One: Historical background, Chapter

Two: Electromagnetic wave and light, Chapter There: light and its interaction with matter, Chapter Four: material and method.

Chapter Two

Electromagnetic Waves

2.1 Introduction

Electromagnetic wave are widely used in many application, therefore this chapter is devote to study Electromagnetic wave properties.

2.2 Maxwell’s Equations

In the 1860s James Clerk Maxwell published equations that describe how charged particles give rise to electric and magnetic force per unit charge. The force per unit charge is called a field. The particles could be stationary or moving. These, together with the Lorentz force equation, provide everything you need to calculate the motion of particles in electric and magnetic fields.

Maxwell’s equations describe how electric charges and electric currents create electric and magnetic fields. Further, they describe how an electric field can generate a magnetic field, and vice versa. The first equation allows you to calculate the electric field created by a charge. The second allows you to calculate the magnetic field. The other two describe how fields ‘circulate’ around their sources. Magnetic fields ‘circulate’ around electric currents and time varying electric fields, Ampere’s law with Maxwell’s correction, while electric fields ‘circulate' around time varying magnetic fields, Faraday’s law.

2.3 Maxwell’s Equations in the Classical Forms

Where the following table provides the meaning of each symbol and the SI unit of measure and $\nabla \cdot$ is the divergence operator (SI unit: 1 per meter),

$\nabla \times$ is the curl operator (SI unit: 1 per meter).

The Meaning of the Equations

Charge density and the electric field

$$\nabla . D = \rho \qquad 2.3.1$$

Where ρ is the free electric charge density (in units of C/m3), not counting the dipole charges bound in a material, and D is the electric displacement field (in units of C/m2). This equation is like Coulomb’s law for nonmoving charges in vacuum. The next integral form (by the divergence theorem), also known as Gauss’ law, says the same thing:

$$\oint_A D . dA = Q_{\text{enclosed}} \qquad 2.3.2$$

dA is the area of a differential square on the closed surface A. The surface normal pointing out is the direction, and Q enclosed is the free charge that is inside the surface. In a linear material, D is directly related to the electric field E with a constant called the permittivity, " (This constant is different for different materials)

$$\mathrm{D} = \varepsilon \mathrm{E} \qquad 2.3.3$$

You can pretend a material is linear, if the electric field is not very strong. The permittivity of free space is called ε and is used in this equation

$$\nabla . \mathrm{E} = \frac{\rho_t}{\varepsilon_o} \qquad 2.3.4$$

Here E is the electric field again (in units of V/m), ρ_t is the total charge density (including the bound charges), and ε_o(approximately 8.854 pF/m) is the permittivity of free space. One can also write ε as ε_o ,ε_r,Here ε_r is the permittivity of the material when compared to the permittivity of free space. This is called the relative permittivity or dielectric constant.

The Structure of the Magnetic Field

$$\nabla . B = 0 \qquad 2.3.5$$

B is the magnetic flux density (in units of teslas, T), also called the magnetic induction. This next integral form says the same thing

$$\oint_A B . dA = 0 \qquad 2.3.6$$

The area of dA is the area of a differential square on the surface A .

The direction of dA is the surface normal pointing outwards on the surface of A . This equation only works if the integral is done over a closed surface. This equation says, that in every volume the sum of the magnetic field lines that go in equals the sum of the magnetical field lines that go out. This means that the magnetic field lines must be closed loops. Another way of saying this is that the field lines cannot start from somewhere. This is the mathematical way of saying: “There are no magnetic monopoles".

A changing Magnetic Flux and the Electric Field

$$\nabla \times E = -\frac{\partial B}{\partial t} \qquad 2.3.7$$

This next integral form says the same thing:

$$\oint_s E . ds = -\frac{d\emptyset B}{dt} \qquad 2.3.8$$

$$\text{Here } \emptyset_B = \oint_{\mathrm{A}} \mathrm{B.\,ds}$$

This is what the symbols mean:

$\emptyset B$ is the magnetic flux that goes through the area A that the second equation describes, E is the electric field that the magnetic flux causes, s is a closed path in which current is induced, for example a wire, v is the instantaneous velocity of the line element (for moving circuits). The electromotive force is equal to the value of this integral. Sometimes this symbol is used for the electromotive force: $\boldsymbol{\varepsilon}$ do not confuse it with the symbol for permittivity that was used before. This law is like Faraday's law of electromagnetic induction. Some textbooks show the right hand sign of the integral form with an N (N is the number of coils of wire that are around the edge of A) in front of the flux derivative. The N can be taken care of in calculating A (multiple wire coils means multiple surfaces for the flux to go through), and it is an engineering detail so it's left out here. The negative sign is needed for conservation of energy. It is so important that it even has its own name, Lenz's law. This equation shows how the electric and magnetic fields have to do with each other. For example, this equation explains how electric motors and electric generators work. In a motor or generator, the field circuit has a fixed electric field that causes a magnetic field. This is called fixed excitation. The varying voltage is measured across the armature circuit. Maxwell's equations are used in a right handed coordinate system. To use them in a left-handed system, without having to change the equations, the polarity of magnetic fields has to made opposite (this is not wrong, but it is confusing because it is not usually done like this).

The Source of the Magnetic Field

$$\nabla \times \mathrm{H} = \mathrm{J} + \frac{\partial \mathrm{D}}{\partial \mathrm{t}} \qquad 2.3.9$$

H is the magnetic field strength (in units of A/m), which you can get by dividing the magnetic flux B by a constant called the permeability μ

$\mathrm{B} = \mu\mathrm{H}$ and J is the current density, defined by:

$$J = \int \rho_q \mathrm{v} d\mathrm{v} \qquad 2.3.10$$

v is a vector field called the drift velocity. It describes the speeds of the charge carriers that have a density described by the scalar function ρ_v in free space, the permeability μ is the permeability of free space μ_0 which is exactly $4\pi\times10^{-7}$ W/A·m, by definition. Also, the permittivity is the permittivity of free space ε_0 . So, in free space, the equation is:

$$\nabla \times B = \mu_0 J + \mu_o \varepsilon_0 \frac{\partial E}{\partial t} \qquad 2.3.11$$

The next integral form says the same thing:

$$\oint_s \mathrm{B.ds} = \mu_0 \mathrm{I}_{\mathrm{encircled}} + \mu_0 \varepsilon_0 \oint_A \frac{\partial \mathrm{E}}{\partial \mathrm{t}}.\mathrm{dA} \qquad 2.3.12$$

s is the edge of the open surface A (any surface with the curve s as its edge is okay here), and $\mathrm{I}_{\mathrm{encircled}}$ is the current encircled by the curve s (the current through any surface is defined by the equation.

$$\mathrm{I}_{\mathrm{thought}}\mathrm{A} = \int \mathrm{AJ.dA} \qquad 2.3.13$$

If the electric flux density does not change very fast, the second term on the right hand side (the displacement flux) is very small and can be left out, and then the equation is the same as Ampere's law. [14]

2.4 Electromagnetic Wave and Light

Electromagnetic wave is considered one of the most important kind of energy that spreads all own world, which have many benefit for the man being for example the media depends on the electromagnetic wave either by FM , UF, On the other hand laser and light are defined by electromagnetic wave, which leads us to understand and study the characteristics of this kind of energy through it is movement across the vacuum mid and variation of media , in other hand the essential characteristic of electromagnetic which we need it to deal with this energy a cross , how to study these characteristic of the reflection , absorption and deflection which occur to these wave mid to another

Suppose there is a wave that that moves towards position axis (z) this case it described as electrical vehicle

$$\mathrm{E}_x^+ = \mathrm{E}^+ x_0 e^{-\gamma_z} e^{jwt} \hat{\mathrm{I}}$$

$$E^{+}_{xo} = E^{+}e^{jwt}\hat{I} = E^{+}x_{0}e^{-\gamma_z}e^{jwt} \qquad 2.4.1$$

Use the same process we found that the magnetic vehicle that represents the magnetic field intensity which move at the same (z) axis

$$H^{+}_{y} = H^{+}_{0}\ \ _{\gamma x}\ e^{-\gamma_z}e^{+jwt}$$

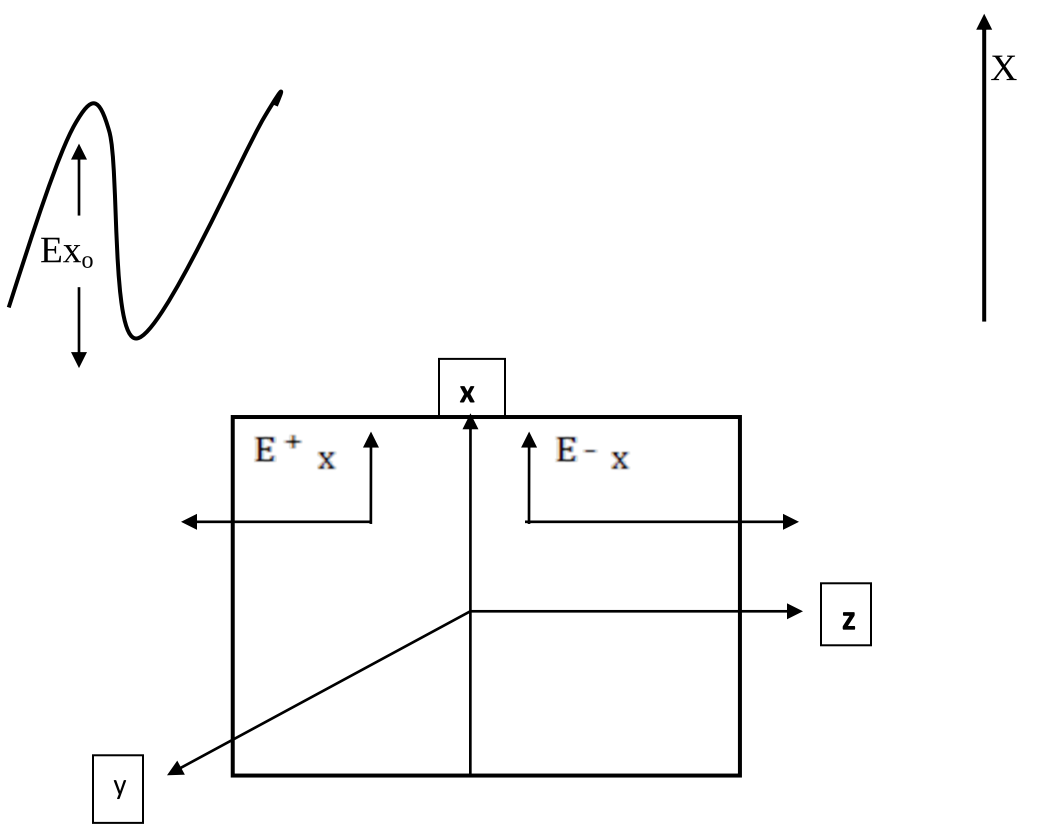
$$Hyc^{+} = H^{+}y\ e^{+jwt} = H^{+}_{0}\ _{\gamma}e^{-\gamma_z}\ e^{j\omega t} \qquad 2.4.2$$

When there is a magnetic wave that moves toward (-ve) axis (z) then in this case the electrical field represents by function

$$E^{-}_{x} = E^{-}_{xo}e^{\gamma_z}e^{jwt}$$

$$E^{-}_{xo} = E^{-}_{xo}e^{\gamma_z}e^{jwt} \qquad 2.4.3$$

Figure 2.4.1: there are two wave move toward the positive and negative (z) axis



Then the result of the electric wave in both direction given by:

$$E_x = E_x^+ + E_x^- \qquad 2.4.4$$

With same approach we find resultant magnetic component equal

$$H_y = H_y^+ + H_y^- \qquad 2.4.5$$

To know how these electromagnetic wave moves through the specific medium we must know the factor formula in the medium

$$\gamma = \sqrt{j\omega\mu(\sigma + j\omega\varepsilon)} \qquad 2.4.6$$

This factor can be written in real part α describe the absorption of medium for wave while the imaginary part describe wave number

$$\beta = K = 2\pi/\lambda$$

then

$$\gamma = \alpha + J\beta \qquad 2.4.7$$

To know the factors formula we use that the relationship between electric and magnetic field where

$$\frac{\partial E_X}{\partial_Z} = -j\omega\mu H_y \qquad 2.4.8$$

$$\alpha \neq 0$$

Substitute the equation (2.4. 2), (2.4.3), (2.4.4), (2.4.5), (2.4.6),(2.4.7) in 2.4.8 we find the equation 2.4.8 become

$$-\gamma . E_{ox}^+ . e^{-\gamma_z} + \gamma . E_{ox}^+ . e^{-\gamma_z} = j\omega\mu(H_{oy}^+ . e^{-\gamma_z} + H_{oy}^- . e^{-\gamma_z}) \qquad 2.4.9$$

By compare the factor $e^{-\gamma_z}, e^{\gamma_z}$ insides of equation 2.4.9 we find

$$-\gamma . \mathrm{E}_{\mathrm{ox}}^{+} = -j\omega\mu \mathrm{H}_{\mathrm{oy}}^{+}$$

Then we can define the quantity that called impedance in formula

$$\eta = \frac{\mathrm{E}_{\mathrm{ox}}^{+}}{\mathrm{H}_{\mathrm{oy}}^{+}} = \frac{J\omega\mu}{\gamma} \qquad 2.4.10$$

The η it is called the internal impedance for the medium, by compare the factor $e^{-\gamma_z}$, e^{γ_z}

$$\gamma \mathrm{E}_{\mathrm{ox}}^{-} = -J\omega\mu\, \mathrm{H}_{\mathrm{oy}}^{+} \quad \text{then we find}$$

$$\frac{\mathrm{E}_{\mathrm{ox}}^{-}}{\mathrm{H}_{\mathrm{o\gamma}}^{-}} = \frac{Jw\mu}{\gamma} = -\eta \qquad 2.4.11$$

By substitute a formula of γ of equation 2.4.6 in the equation 2.4.10 we find that

$$\eta = \frac{\mathrm{J}\omega\mu}{\sqrt{(\mathrm{J}\omega\mu(\sigma - \mathrm{J}\omega\varepsilon)}} = \sqrt{\frac{\mathrm{J}\omega\mu}{\sigma + \mathrm{J}\omega\varepsilon)}}$$

And by summaries the common factor we find that

$$\eta = \sqrt{\frac{\mathrm{J}w\mu(\sigma - \mathrm{J}\omega\varepsilon)}{(\sigma + \mathrm{J}\omega\varepsilon)(\sigma - \mathrm{J}\omega\varepsilon)}} = \sqrt{\frac{\omega^2\mu\varepsilon + \mathrm{J}\omega\mu\sigma}{(\sigma^2 + \omega^2\varepsilon^2)}} \qquad 2.4.12$$

η called the self-internal resistance it unit ohm (Ω) which is represent constant ratio the magnitude of electrical wave to the amputated , as the equation shows (2.4.11) to know what is going to happen of incidence wave from medium 1 $\mu_1\varepsilon_1$ into medium 2 $\mu_2\varepsilon_2$, in this case we can write $\gamma_1\gamma_2$ in medium 1 and 2 as :

$$\gamma_1 = \alpha_1 + JB_1 = \sqrt{J\omega\mu_1}\,(\,\sigma_1 + j\omega\varepsilon_1\,)\,)$$

$$\gamma_2 = \alpha_2 + JB_2 \ = \sqrt{J\omega\mu_2(\ \sigma_2 + Jw\varepsilon_2\ )} \qquad 2.4.13$$

In this case as the intensity electrical and magnetic field incident can be written

$$\mathrm{E_i} = \mathrm{E_{io}} \mathrm{e}^{-\alpha_{1z}} \mathrm{e}^{-\beta_{1z}}$$

$$H_\mathrm{i} = \mathrm{H_{io}} \mathrm{e}^{-\alpha_{1z}} \mathrm{e}^{-\beta_{1z}} \qquad 2.4.14$$

Which is α1 represents the decay coefficient in which is β1 the wave number (β_1=2π/) in medium 1 , the wave and the electrical and magnetic intensity are full in the formula

$$\mathrm{E_{ic}} = \mathrm{E_i} \mathrm{e}^{\mathrm{j}\omega\mathrm{t}}$$

$$\mathrm{H_{ic}} = \mathrm{H_i} \mathrm{e}^{\mathrm{j}\omega\mathrm{t}} \qquad 2.4.15$$

The equation 2.4.15 Is a move wave equation that fluctuates which time and position, given the equation 2.4.15 We found that the wave amplitude constant and magnetic intensity can be written in terms of impedance in the formula

$$\mathrm{H_{oi}^{+}} = \frac{\mathrm{E_{oi}^{+}}}{\eta_1} \text{ ‘ } H_{oi} = \frac{E\ _{oi}}{\eta_1} \text{ ‘} H_i = \frac{E\ _{oi}}{\eta_1} e^{-\alpha_{1z}}. e^{-\beta_{1z}} \qquad 2.4.16$$

In this respect, we have to distinguish completely between the electric amplitude E_m and electrical constant amplitude E_{ox} Which generally represents a decay wave or amplified in this formula

$$\mathrm{E_m} = \mathrm{E_{oi}} \mathrm{e}^{-\alpha_{1z}} \qquad 2.4.17$$

The wave decay by decay the amplitude E_m when it is $\alpha \neq 0$ and does not decay when it is $\alpha = 0$ And gives the impedance of two medium 1,2 In the formula

$$\eta_1 = \sqrt{\frac{J\omega\mu_1}{\sigma_1 + J\omega\varepsilon_1}} \quad , \; \eta_2 = \sqrt{\frac{J\omega\mu_2}{\sigma_2 + J\omega\varepsilon_2}} \qquad 2.4.18$$

When we deal with reflected beam with passes in the direction of the Z axis, we use equation 2.4.13 and 2.4.11 the reflected beam is denoted by E_r(r=reflected)

$$E_r = E_X^-$$

$$\frac{E_{or}}{H_{or}} = \frac{E_{orx}}{H_{ory}} = -\eta_1 \qquad 2.4.19$$

The reflected wave becomes in this formula

$$E_r = E_{or}\; e^{\alpha_{1z}}\; e^{J\beta_{1z}} = E_{or}\; e^{\gamma_{1z}} \qquad 2.4.20$$

It is represented the electrical intensity of the reflected wave where the reflection occurs in the medium (1)

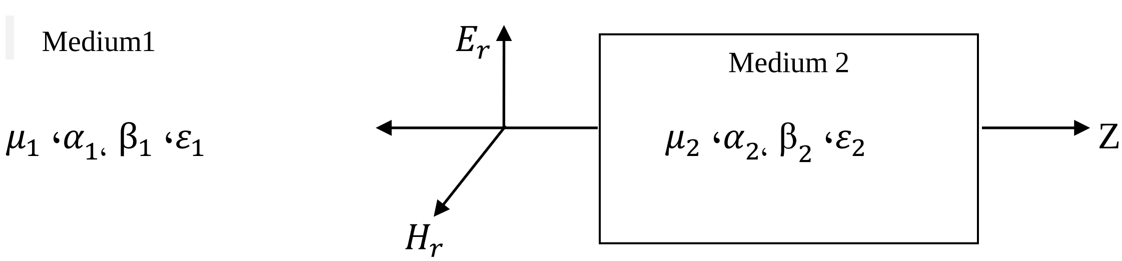


Figure 2.4.2: shows the wave

By the same way we find that magnetic field intensity is equal.

$$H_r = H_{or}\ e^{\alpha_{1z}}\ e^{J\beta_{1z}} = \frac{E_{or}}{\eta_1}\ e^{\alpha 1}\ e^{j\beta 1z} \qquad 2.4.21$$

It is represented the magnetic field intensity which is reflected in the medium (1), we used the relation 2.4.19 to replace E_{or} by H_{or}

$$H_{or} = -\frac{E_{or}}{\eta_1}\ ،\ H_r = -\frac{E_{or}}{\eta_1}\ .\ e^{z\gamma_1} \qquad 2.4.22$$

At incident ray E_1 from the medium (1) to the medium (2) then a part of E_R will be reflect in the medium (1) while a part of the radiation transit inside the medium (2) and denoted by E_1

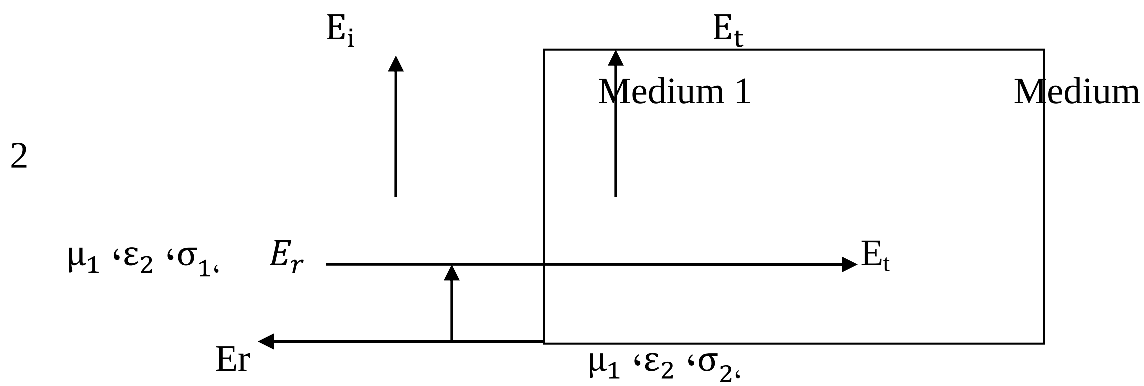


Figure 2.4.3: shows incidence and reflection and refraction of wave

Substitute equation 2.4.7 in 2.4.2 we get

$$E_t = E_{ot}\ e^{-\alpha_2 z}\ e^{-j\beta_2 z} \qquad 2.4.23$$

We substitute

$$\beta = \beta_2, \alpha = \alpha_2\ , \gamma = \gamma_2 \qquad 2.4.24$$

To find relation between amplitude constants for the waves incident and reflect and transmission, we use that fact the algebraic sum of these waves satisfies the relation

$$E_i + E_r = E_t \qquad 2.4.25$$

This relation is precisely achieved at the point Z= 0 which here wave of the same time (i.e)

$$E_i(z = 0) + E_r(z = 0) = E_t(z = 0) \qquad 2.4.26$$

Refer to equation (2.1.4), (2.1.3), (2.4.20) we find that

$$E_{oi} + E_{or} = E_{ot} \qquad 2.4.27$$

The magnetic field intensity also can be written by using equation

(2.4.2) (2.4.7) and (2.4.10) it to be in this formula

$$H_{Ot} = \frac{E_{ot}}{\eta_2} \text{ ‘ } H_t = H_{ot}\ e^{-\gamma_2 t} = \frac{E_{ot}}{\eta_2}\ e^{-\alpha_2 z}\ e^{-j\beta_2 z} \qquad 2.4.28$$

To find relation between amplitude constants of the magnetic wave the fact can sum of displacement of incident and reflect wave equal displacement of transit wave at Z = 0, then $H_i(z = o) + H_r(z = o) = H_i(z = o)$

$$H_{oi} + H_{or} = H_{ot}$$

$$\frac{E_{oi}}{\eta_1} - \frac{E_{or}}{\eta_1} = \frac{E_{o1}}{\eta_2} \qquad 2.4.29$$

This equation represented relation of amplitude of magnetic wave radiation which we wrote in term of amplitude constant of the electric wave in additional to the resistance for two mediums the first medium and the second medium.

By multiply both side of equation 2.4.29 by $\eta_1\eta_2$ we get

$$\eta_2\ E_{oi} - \eta_2\ E_{or} = \eta_1\ E_{ot} \qquad 2.4.30$$

By multiply both side by $\frac{1}{\eta_2}$ we get

$$E_{oi} - E_{or} = \frac{\eta_1}{\eta_2} E_{ot} \qquad 2.4.31$$

To refer to equation 2.4.25 we get

$$E_{0i} + E_{or} = E_{ot} \qquad 2.4.32$$

To delete E_{or} we all equation 2.4.31 to 2.4.32 to obtain the relation between E_{oi} and E_{ot} in this formula

$$2E_{oi} = \left(\frac{\eta_1}{\eta_2} + 1\right) E_{ot} = \left(\frac{\eta_{1+\eta_2}}{\eta_2}\right) E_{ot}$$

Therefore the coefficient of transmission (T) which represented the rate of amplitude constant of the transmission wave to amplitude constant of the incident wave it can be found in this formula

$$T = \frac{E_{0t}}{E_{oi}} = \frac{2\eta_2}{\eta_1+\eta_2} \qquad 2.4.33$$

To refer to equation (2.4.11) we get

$$\eta_1 = \sqrt{\frac{j\omega\mu_1}{\sigma_1+j\omega\varepsilon_1}} \quad \eta_2 = \sqrt{\frac{j\omega\mu_2}{\sigma_2+j\omega\varepsilon_2}} \qquad 2.4.34$$

Where η_1 and η_2 Represented self-disability for the medium (1) and medium (2), where consider the medium (1) most of time air or vacuum .To know how to change properties of two mediums the first and the second to control the reflection process must be we know the reflection index , by the same previous to find reflection index Γ.

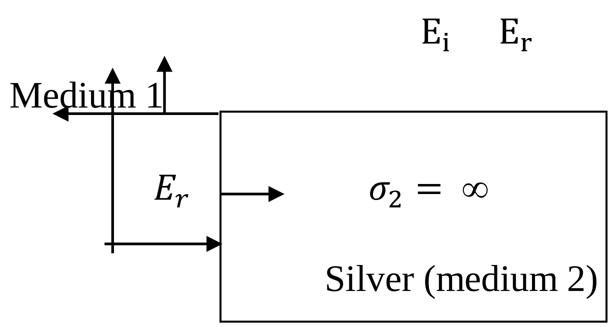
Which represented rate of amplitude constant of reflected wave E_{or} to amplitude constant of incident waveE_{oi}

$$\Gamma = \frac{E_{or}}{E_{oi}} \qquad 2.4.35$$

To find reflection index the terms of the self-disability for the two medium.

$$\eta_1 = \sqrt{\frac{j\omega\mu_1}{\sigma_1 + j\omega\varepsilon_1}}$$

$$\eta_2 = \sqrt{\frac{j\omega\mu_2}{\sigma_2 + j\omega\varepsilon_2}} \qquad 2.4.36$$



$\sigma_1 = 0$ air

Figure 2.4.4

$$\alpha_2 = \infty \qquad 2.4.37$$

Figure 2.4.4 illustrate A ray falls from the air on perfect conductor such as silver metal , if a wave falls from air on good and perfect conductive medium such as silver , the conductivity of air = 0 and silver conductivity $\sigma_2 = \infty$ 2.4.37, therefore silver resistance from equation 2.4.37.

$$\eta_2 = 0$$

Substitute the equation (2.4.37) (2.4.33) we get

$$\Gamma = \left(\frac{\eta_2 - \eta_1}{\eta_2 + \eta_1}\right) = -1,,,, \mathrm{T} = \left(\frac{2\eta_2}{\eta_1 + \eta_2}\right) = \mathbf{0} \qquad 2.4.38$$

Then

$$\Gamma = \frac{E_{0r}}{E_{oi}} = -1 \qquad T = \frac{E_{0t}}{E_{oi}} = o$$

$$E_{or} = -E_{oi}$$

$$E_{oi} = 0 \qquad 2.4.39$$

Which mean that the silver material reflects the light and does not allow it enter, so it is used in the manufacture of mirrors

2.5 Characteristic of the Fallen Rays at an Angle on the Separated Surfaces:

In the previous section, we studied what happens to the rays that hall perpendicular from medium to medium, we will now look at what happens to rays that have incident at angle of ϑi An are reflected at an angle ϑr and transmit with an angle ϑr in specific medium, where we will indicate of the intensity of the incident ray under the symbol E_i , while we will indicate the intensity of the reflected beam with the symbol E_r and the transmitted beam E_t in $\underline{r}$.

$$E_i = E_{oi}\, e^{-\gamma_1 z'} = E_{oi} e^{-r_1 \hat{n}_{i}.\underline{r}} \qquad 2.5.1$$

Vector $\underline{r}$ by written as $\underline{r} = x\hat{\imath} + z\hat{k}$ and it represent vector $\underline{r}$ at xz coordinates, while n̂i the unit vector in E_i coordinate.

Then we get

$\hat{n}_i . r = x\hat{n}_i . \hat{\imath} + z\hat{n}_i . \hat{k}$

$\hat{n}_i . r = \cos \emptyset_i \; = \cos(90 - \theta_i) = \sin \theta_i$

$\hat{n}_i . \hat{k} = \cos \theta_i$

$\acute{z} = \hat{n}_i . r = x sin\theta_i + z cos\theta_i$ 2.5.2

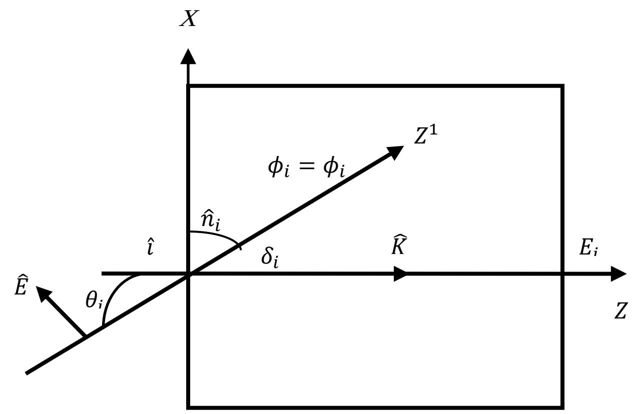


Figure 2.5.1: beam incident by θ_i angle

Equation (2.5.1) (2.5.2) can be used to write the electrical field strength of incident wave in terms of the falling angle θ_i , and the X coordinate, which expresses the parallel direction of the dividing and Z coordinate surface of the vertical on the separator

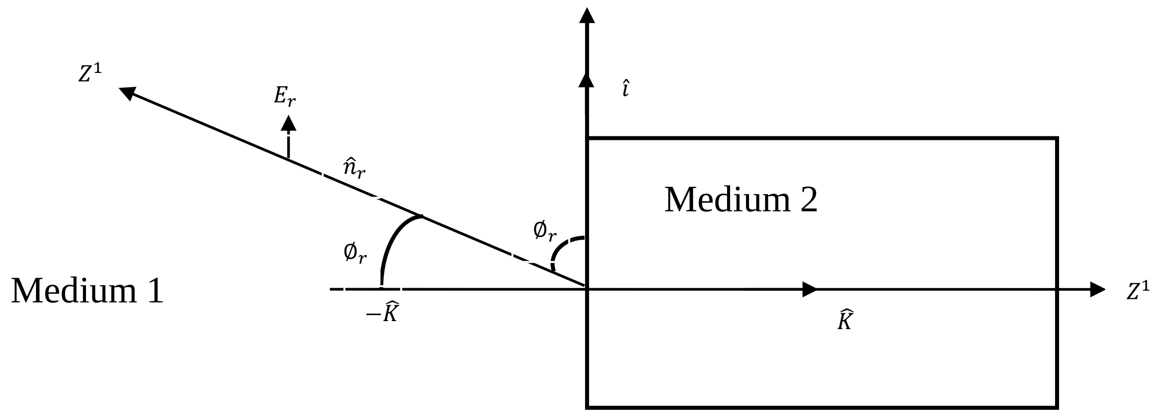
$$z' = x\sin\theta_i + z\cos\theta_i$$

$E_{ic} = E_i \, e^{j\omega t} \quad = E_{oi} \, . \; e^{-\gamma_1 (x\sin\theta_i + z\cos\theta_i)}$

$$E_i = E_{oi} \; e^{-\gamma_1} \, (x sin\theta_i + z cos\theta_i) \qquad 2.5.3$$

As the known the part of the falling been E_i will be reflected in the form of a beam reflected in the form of a beam reflected in the intensity of the electric wave E_r and it is written in the formula

$$E_r = E_{or} \, e^{-\gamma_1 (\hat{n}_i . r)} \qquad 2.5.4$$



$\hat{n}_r.\left(-\hat{k}\right) = \cos\theta_r \qquad \hat{n}_r.\hat{\imath} = \cos\emptyset_r$

$\hat{n}_r.\left(-\hat{k}\right) = \cos\theta_r \ldots\ldots.. \quad \hat{n}_r.\hat{\imath} = \cos\theta_r \qquad -\hat{n}_r.\hat{k} = \cos\theta_r$

$-\hat{n}_r.\hat{k} = \cos\theta_r \ldots\ldots.\hat{n}_r.\hat{\imath} = \cos(90-\theta_r) = \sin\theta_r \qquad \hat{n}_r.\hat{\imath} = \cos(90-\theta_r) = \sin\theta_r$

$\hat{n}_r.\hat{k} = -\cos\theta_r,, \hat{n}_r.\hat{\imath} = \sin\theta_r \qquad \hat{n}_r.\hat{k} = -\cos\theta_r,, \hat{n}_r.\hat{\imath} = \sin\theta_r$

θ_r Represent the reflection angle, the intensity of the refection wave wrote as

$$E_{rc} = E_{ro}\, e^{j\omega t} = E_{or}\, e^{-\gamma_1 \hat{n}.\underline{r}} = E_{or}\, e^{-\gamma_1 \hat{n}.\underline{r}}$$

$$E_{rc} = E_{ro}\, e^{-\gamma_1 \hat{n}.\underline{r}} \qquad 2.5.5$$

Figure 8 shows the relationship of the unit vector $\hat{n}_r$ into the direction of the reflected beam

$$\hat{n}_r.\underline{r} = x\hat{n}_r.\hat{\imath} + z\hat{n}_r.\hat{k} = x\sin\theta_r - z\cos\theta_r \qquad 2.5.6$$

By substitute (2.45) in (2.44) we get

$$E_r = E_{or}\ \ e^{-\gamma_1(x\,\sin\theta_r - z\cos\theta_r)} = E_{0r}\ \ e^{-\gamma_1(x\,\sin\theta_r - z\cos\theta_r)}$$

Equation 2-5-7 represent the electric field strength (non-temporal part) of the reflected wave ,where the equation shows that his intensity depends on the angle of reflection θ_r and performs part of beam falling in the medium 2 with θ_t (t = transmit ion)

E_t represents the non-time part of the intensity of transmitted field , where as the unit vector at the direction of the transmitted ray is denoted by $\hat{n}_t$, usually the electrical field intensity of the transmitted wave is written in this form

$$E_t = E_{ot}\ e^{-\gamma_2 \hat{n}_t . \underline{r}} \qquad 2.5.8$$

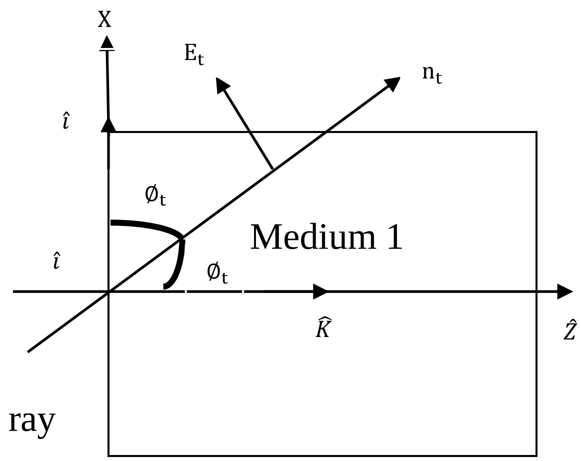


Figure 2.5.2 Transmitted ray

$$\hat{n}_t . \underline{r} = x\hat{n}_t . \hat{\imath} + z\hat{n}_t . \hat{k}$$

$$\hat{n}_t . \underline{r} = x[\cos\emptyset_t] + z[\cos\theta_t]$$

$$\hat{n}_t . \underline{r} = x[\cos(90 - \theta_t)] + z[\cos\theta_t]$$

$$\hat{n}_t . \underline{r} = x\sin\theta_t + z\cos\theta_t$$

$$\hat{n}_t . \underline{r} = x\cos(90 - \theta_t)] + z\cos\theta_t = x\sin\theta_t + z\cos\theta_t \qquad 2.5.9$$

Substituting equation (2.5.9) in equation (2.5.8) we get

$$E_t = E_{ot}\ e^{-\gamma_2} \quad (x\sin\theta_t + z\cos\theta_t) \qquad 2.5.10$$

This equation represents the intensity of the transmitted wave field, it depends on the angle of transmission θ_t

To know the relation between the incidence angle, the reflection angle and the transmission ray, we use the boundary condition that gives us the relation of the rays at point $Z = 0$ at it state that algebraic sum of the intensities of the incident ray and the reflected ray equals the intensity of the transmission ray at the point zero (i.e)

$$E_i (z = 0) + E_r (z = 0) E_t (z = 0) \qquad 2.5.11$$

Substituting the equation (2.5,10,11) as E_i, E_r, E_t we find the following

$$E_{oi}\, e^{-\gamma_1} \mathrm{xsin}\theta_i + E_{or}\, e^{-\gamma_1} \mathrm{xsin}\theta_r = E_{ot}\, e^{-\gamma_1} \mathrm{xsin}\theta_t \qquad 2.5.12$$

$$E_{oi}\, e^{-\gamma_1 \mathrm{xsin}\theta_i} + E_{or} e^{-\gamma_1 \mathrm{xsin}\theta_r} = E_{ot}\, e^{-\gamma_1 \mathrm{xsin}\theta_t} \qquad 2.5.13$$

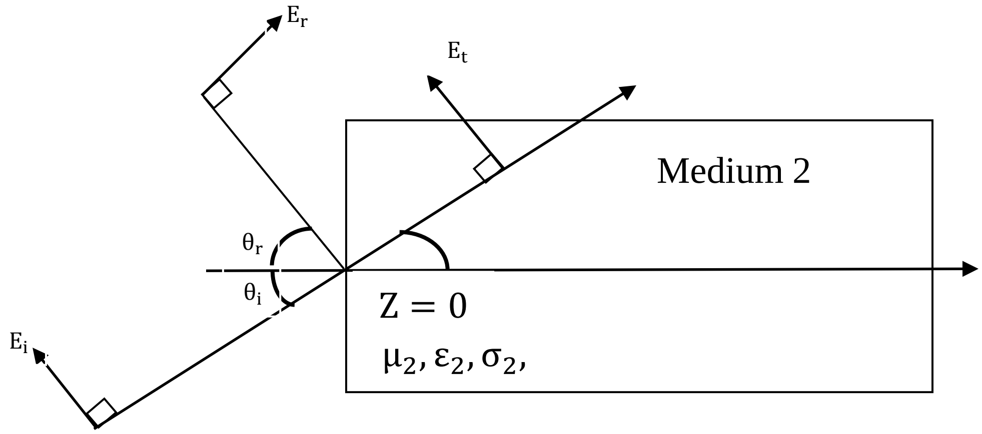
This equation is true when

$$-\gamma_1\, \mathrm{xsin}\theta_i = -\gamma_1\, \mathrm{xsin}\theta_r = -\gamma_2\, \mathrm{xsin}\theta_t \qquad 2.5.14$$

This mean that

$$\gamma_1\, \mathrm{xsin}\theta_i = \gamma_1\, \mathrm{xsin}\theta_r, \sin\theta_i = \sin\theta_r$$

Figure 2.5.3 shows that the incident ray until reflect and transmit at the point Z=0



Medium 1

$\mu_1, \varepsilon_1, \sigma_1$

Considering the 1st and the 2st terms of equation (2.4.14) we find that

$$\gamma_1 \text{ xsin}\theta_i = \gamma_1 \text{ xsin}\theta_r, \sin\theta_i = \sin\theta_r \qquad 2.5.15$$

$$\theta_i = \theta_r \qquad 2.5.16$$

This equation represent the reflection law that states (the incidence angle θ_i equals to the reflection angle θ_r , equation 2.5.16 can also be used to describe Snell's equation that gives the relation between the incidence ray and the transmitted ray.

$$\gamma_1 \sin\theta_i = \gamma_2 \sin\theta_t \qquad 2.5.17$$

The term γ can be known in the two medium 1 and 2 using equation 2.5.17 we find that

$$\gamma_1 = \sqrt{(j\omega\mu_1(\sigma_1 + j\omega\varepsilon_1)} \qquad \gamma_2 = \sqrt{(jw\mu_2(\sigma_2 + j\omega\varepsilon_2\,)} \qquad 2.5.18$$

If a ray from the air with conductivity $\sigma_1 = 0$ strikes on the a rainspout insulator like a glass with conductivity $\sigma_2 = 0$ then

$$[\sigma_1 = 0, \sigma_2 = 0]$$

$$\gamma_1 = j\omega\sqrt{\mu_1 \varepsilon_1} = \frac{j(2\pi f)}{\upsilon_1} \quad , \quad \gamma_2 = j\omega\sqrt{\mu_2 \varepsilon_2)} = \frac{j\omega}{\upsilon_2}$$

$$\gamma_1 = \frac{j\omega}{\upsilon_1} \quad ,\gamma_2 = \frac{j\omega}{\upsilon_1} \qquad 2.5.19$$

Given the velocity of light thought any medium equal

$$\upsilon = \frac{1}{\sqrt{\mu_1 e_1)}} \qquad 2.5.20$$

Substitute equation 2.5.20 in 2.5.17 and multiply sides by c we get

$$j\omega = \frac{c}{\upsilon_1}\sin\theta_i \quad = j\omega = \frac{c}{v_2}\sin\theta_t$$

$$n_1 \sin\theta_i = n_2 \sin\theta_t \qquad 2.5.21$$

$$n_1 = \frac{c}{\upsilon_1}, \qquad n_2 = \frac{c}{\upsilon_2} \qquad 2.5.22$$

Reflective index (n) is given in term of speed of light in the medium υ, and speed of light in air c.

n_1, n_2 are reflection index for the medium (1) and (2).

Equation 2.5.22 is called Snell's law for the reflection, it describe the deviation and reflection of a ray when it passes from one medium to another [15].

Chapter Three

Interaction of Light with Matter

3.1 Introduction

The behavior of light when it travels through space and when it interacts with matter play a central role in the two main paradigms of twentieth century physics; relativity and quantum physics

3.2 Atomic Interaction with Light

Electrons and their interactions with electromagnetic fields are important in our understanding of chemistry and physics. In the classical view, the energy of an electron orbiting an atomic nucleus is larger for orbits further from the nucleus of an atom. However, quantum mechanical effects force electrons to take on discrete positions in orbitals. Thus, electrons are found in specific energy levels of an atom, two of which are shown below

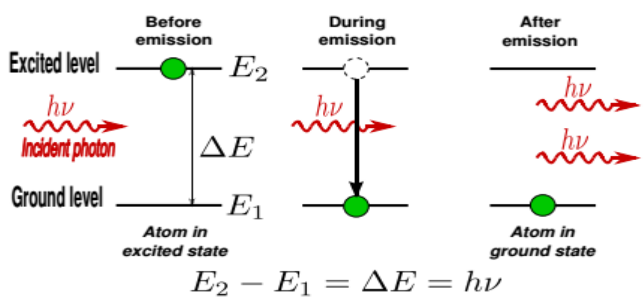


Figure 3.2.1: Stimulated Emission

When an electron absorbs energy either from light (photons) or heat (phonons), it receives that incident quantum of energy. But transitions are only allowed between discrete energy levels such as the two shown above. This leads to emission lines and absorption lines when an electron is excited from a lower to a higher energy level, it will not stay that way forever. An electron in an excited state may decay to a lower energy state which is not occupied, according to a particular time constant characterizing that transition. When such an electron decays without external influence, emitting a photon, that is called "spontaneous emission". The phase and direction associated with the photon that is emitted is random. A material with many atoms in such an excited state may thus result in radiation which has a narrow spectrum (centered around one wavelength of light), but the individual photons would have no common phase relationship and would also emanate in random directions. This is the mechanism of fluorescence and thermal emission. An external electromagnetic field at a frequency associated with a transition can affect the quantum mechanical state of the atom without being absorbed. As the electron in the atom makes a transition between two stationary states (neither of which shows a dipole field), it enters a transition state which does have a dipole field, and which acts like a small electric dipole, and this dipole oscillates at a characteristic frequency. In response to the external electric field at this frequency, the probability of the electron's entering this transition state is greatly increased. Thus, the rate of transitions between two stationary states is increased beyond that of spontaneous emission. A transition from the higher to a lower energy state produces an additional photon with the same phase and direction as the incident photon; this is the process of stimulated emission. [16]

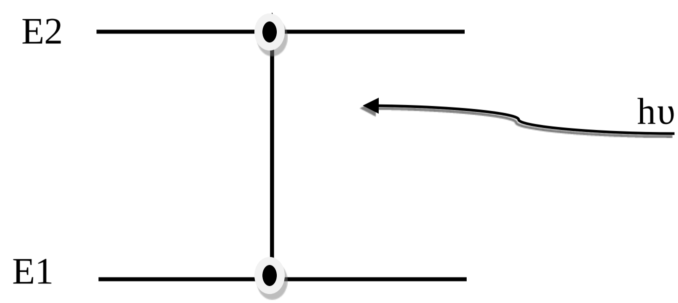
3.3 Absorption

Absorption is the process by which a photon is absorbed by atom, causing an electron to jump from a lower energy level to a higher one as seen in figure

3.3.1, the process is described by the Einstein coefficient B_{12} which gives the probability per unit time per unit energy density of the radiation field, that an electron in state 1 with energy E_1 will absorb a photon with energy $E_2 - E_1$ as seen in figure 3.3.1, And jump to state 2 with energy E_2 . The change in the number density of atoms in state 1 per unit time due to absorption will be:

$$\frac{d_{n_1}}{d_t} = B_{12} n_1 p = -B_{12}\, n_{12} \qquad 3.3.1$$

Where, n_2 describe the number of atoms in state 2 and 1 (υ) stands for intensity of radiation.



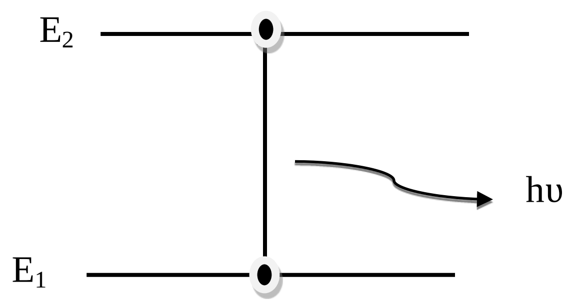
Figurer 3.3.1 the Atomic absorption

Where $E_1 - E_2 = h\,\upsilon$

3.4 Spontaneous Emission of Light

The atoms in level state E_2 reach the ground state E_1 by means of a single transition from E_2 to E_1 . The amount of energy equal the difference in two levels must be released by atom. Spontaneous emission is the process by which a electron “spontaneously”, i.e without any outside influence decays from a high energy level to lower one. The process is described by the Einstein coefficient A_{21} which gives the probability per unit time than an electron in state 2 energy E_2 will decay spontaneously to ground state with energy E_1 , emitted photon with energy as in equation blew as seen in fig.

$$\frac{d_n}{d_t} = A_{21} n_2 \qquad 3.4.1$$



Figurer 3.4.1: shown the Spontaneous Emission of light

3.5 Stimulated Emission of Light

The process by which an electron is induced to jump from a higher energy level to a lower one by the presence of a photon at (or near) the frequency of the transition emission of a photon. The process is described by the Einstein coefficient of a photon B_{21}which gives the probability per unit time per unit energy density of the radiation field. That an electron in state 2 with energy E_2 will decay to state 1 with energy E_1 , emitting a photon with energy $E_2 - E_1$ as seen in fig. The change in the number density of atoms in state one per unit time due to induced emission will be

$$\frac{d_{n_2}}{d_t} = B_{21} n_2 \, \rho \qquad 3.5.1$$

Stimulated emission is one of fundamental processes that led to the development of the laser [15].

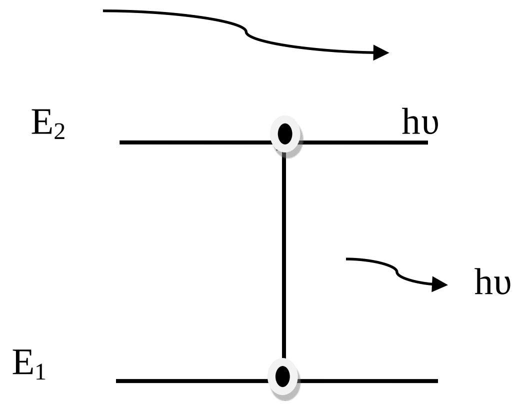


Figure 3.5.1: The stimulated emission of light

3.6 Transmission Coefficient

The transmission coefficient is used in physics and electrical engineering when wave propagation in a medium containing discontinuities is considered. A transmission coefficient describes the amplitude, intensity, or total power of a transmitted wave relative to an incident wave.

3.7 Absorption Coefficient

The absorption coefficient determines how far into a material light of a particular wavelength can penetrate before it is absorbed. In a material with a low absorption coefficient, light is only poorly absorbed, and if the material is thin enough, it will appear transparent to that wavelength. The absorption coefficient depends on the material and also on the wavelength of light which is being absorbed. Semiconductor materials have a sharp edge in their absorption coefficient, since light which has energy below the band gap does not have sufficient energy to excite an electron into the conduction band from the valence band. Consequently this light is not absorbed.

Chapter four

Material and Method

4.1 UV-Visible Spectroscopy

Spectroscopy is the study of interaction between matter and Electromagnetic radiation. Spectroscopy means study of the interaction between matter and radiated energy and it used to refer to the measurement of radiation intensity as a function of wavelength. Spectroscopy is basically an experimental subject and is concerned with the absorption, emission or scattering of electromagnetic radiation by atoms or Molecules.

UV-Vis spectroscopy is absorption spectroscopy or reflectance spectroscopy in the ultraviolet-visible spectral region. This means it uses light in the visible and adjacent (near-UV and near-infrared [NIR]) ranges. The absorption or reflectance in the visible range directly affects the perceived color of the chemicals involved. In this region of the electromagnetic spectrum, molecules undergo electronic transitions. This technique is complementary to fluorescence spectroscopy, in that fluorescence deals with transitions from the excited state to the ground state, while absorption measures transitions from the ground state to the excited state .

A hydrogen, deuterium or discharge lamp covers the ultraviolet range, and a tungsten filament (usually tungsten \halogen lamp) covers the visible range. The radiation is separated according to its frequency\wavelength by a diffraction grating followed by a narrow slit. The slit ensures that the radiation is of a very narrow waveband it is monochromatic.

The cells in the spectrometer must be made of pure silica. Detection of the radiation passing through the sample or reference cell can be achieved by either photomultiplier or photo diode, that converts photons of radiation into tiny electrical currents; or semiconducting cell (that emits electrons when radiation is incident on it) followed by an electron multiplier similar to those used in mass spectrometers. The spectrum is produced by comparing the currents generated by the sample and the reference beams

4.2 Basic components UV-Visible

1. Light source Sample.
2. Sample cell.
3. Uniform wave length (Monochromatic).
4. Scout (detector).

Optical sources are two types of photovoltaic sources: a tungsten bulb (Lamp Tungsten)for the measurement of visible rays(Visible)in the range (350 - 800).The light source is a deuterium bulb(Lamp D2)It is a light bulb Seeing it with the naked eye because it can cause temporary blindness due to the strength of its radiation. This for the measurement of ultraviolet radiation in the range (200 - 350).

The sample cells are either to be made from Glass or quartz (figure 4.1.1), and quartz are best made because the cell is made of glass Among its components is sodium synthesis which is absorbed in the field UV Therefore, it is preferable to use cells made Of quartz these cells are not among the components made by sodium and the prices of cells Quartz between 300 - 1000 SR depending on the quality of the cell and its thickness.

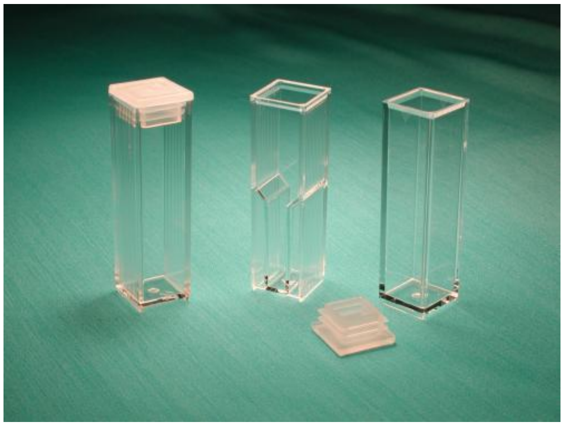


Figure 4.2.1: Sample Cell

Uniform wave length (Monochromatic) is a glass publication and this publication was used in old machines Currently, in the modern instruments of spectroscopy, there is a so-called reserve and function It scans the sample to determine the wavelength at which the highest catch occurred when it was shed Light whether the light of the tungsten bulb to measure the visible rays or from the deuterium bulb to measure The ultraviolet rays produce a uniform wavelength of many beams of light based Monochromatic The reception of the beam whose angle of fall is appropriate on the uniform wavelength and then The wavelength uniformly reverses the ray of radiation on it and directs it to a filter This filter selects the appropriate package very accurately and then continues to move The packet to a reflective mirror sends the fallen optical beam to the sample cell and then To the Scouts.

Scouts (Detector) that shows the amount of light coming out of the sample cell and explains what the quantity is The light outside the sample cell is equal to the amount of light inside the sample if it happens The amount of light inside the sample is equal to the amount of light outside the sample that did not absorb And therefore to get only a straight line does not have any absorption.

If the opposite happened the light outside the sample cell is less than the light inside the sample.

Diffraction grating is an optical component with a periodic structure, which splits and diffracts light into several beams travelling in different directions. The emerging coloration is a form of structural coloration.

The directions of these beams depend on the spacing of the grating and the wavelength of the light so that the grating acts as the dispersive element. Because of this, gratings are commonly used in monochromators and spectrometers.

For practical applications, gratings generally have ridges or rulings on their surface rather than dark lines. Such gratings can be either transmissive or reflective. Gratings which modulate the phase rather than the amplitude of the incident light are also produced, frequently using holography.

The principles of diffraction gratings were discovered by James Gregory, about a year after Newton's prism experiments, initially with items such as bird feathers. The first man-made diffraction grating was made around 1785 by Philadelphia inventor David Rittenhouse, who strung hairs between two finely threaded screws. This was similar to notable German physicist Joseph von Fraunhofer's wire diffraction grating in 1821, figure 2.6 shows the basic components UV-Visible spectrometer.

4.3 Applications of UV-Vis Spectroscopy

UV-VIS spectroscopy is routinely used in analytical chemistry for the quantities determination of different analyses, such a transition metal ions, highly conjugated organic compounds, and biological macromolecules. Spectroscopic analysis is commonly carried out in solutions but solids and gases may also be studied.

Solutions of transition metal ions can be colored (i.e. absorb visible light) because electrons within the metal atoms can be excited from one electronic state to another. The color of metal ion solutions is strongly affected by the presence of other species, such as certain anions or ligands. For instance, the color of a dilute solution of copper sulfate is a very light blue; adding ammonia intensifies the color and changes the wavelength of maximum absorption (λ_{max}) [17].

4.5 Results

This article contains a graphs and information on the optical properties of Mica. The graphs contains information about the relationship between absorption and wavelength and absorption coefficient and wavelength and Transmission and wavelength and the energy gap of Mica by using UV-VIS SPECTROPHOTOMETER (mini) at Al-Neelain University . And we have the concentration of mica by using (X-MET 5000) at Petroleum Technical Center (PTC).

Table 4.5.1: Concentration of Impurities in Mica

Element	C	STD	Elem	C	STD
Fe	38.60	52.258	W	7.30	10.317
Mo	2.05	2.901	V	0.98	1.379
Cr	0.81	1.114	Ni	0.73	1.027
Zn	(0.01)	0.009	Pb	0.00	0.006

C= concentration

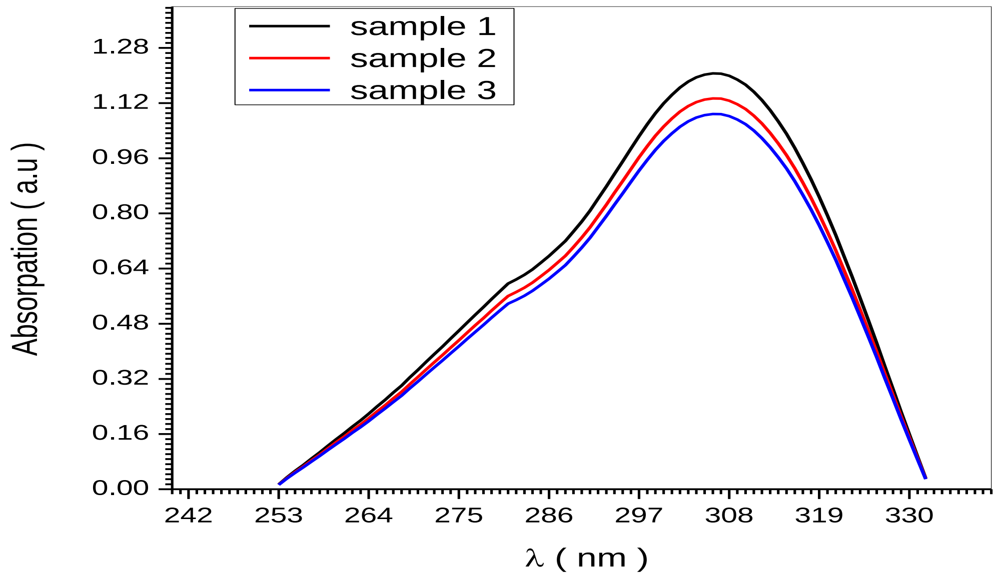


Figure 4.5.1: Relationship Between Absorption and Wavelength

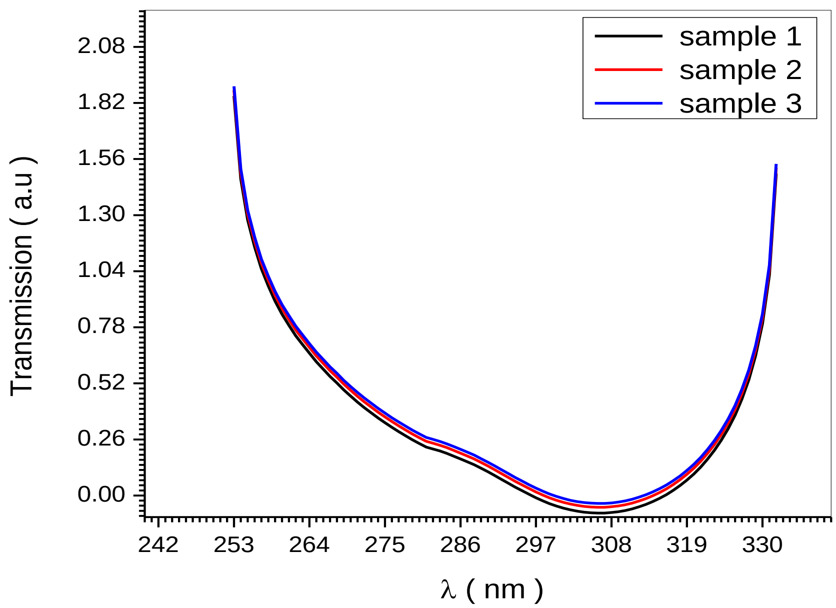


Figure 4.5.2: Relationship Between Transmission and Wavelength

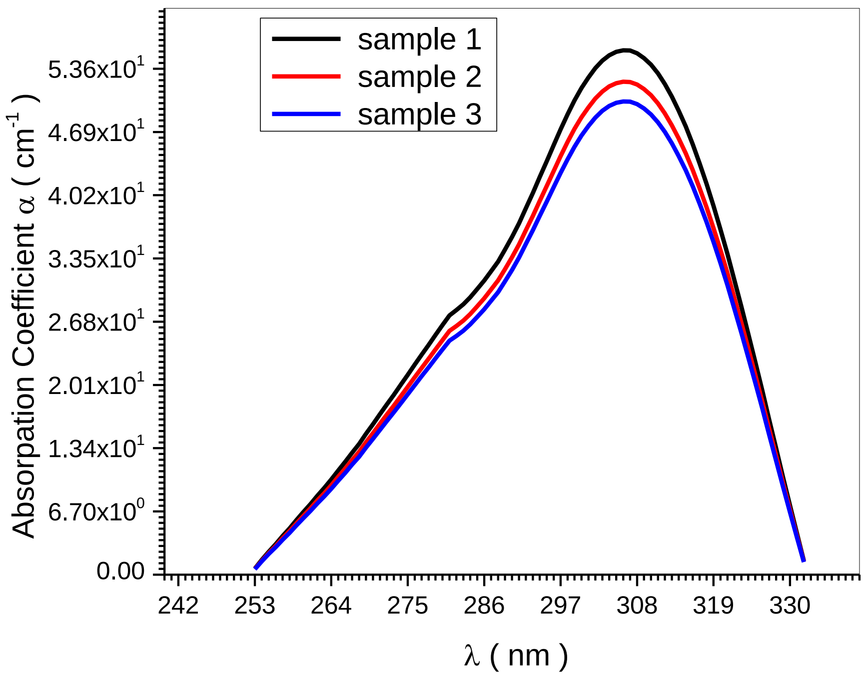


Figure 4.5.3: Relationship Between Absorption Coefficient and Wavelength

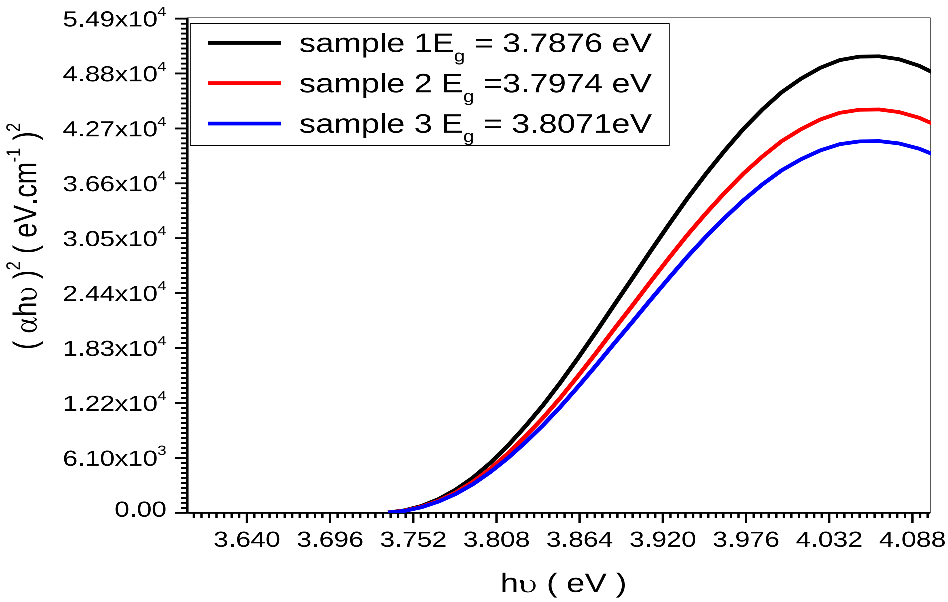


Figure 4.5.4: The Energy Gap of Mica

Discussion

The absorption spectra in figure 4.5.1 of the three samples shows absorption in maximum at the wave length $\lambda \approx 310$ nm

This corresponds to the photon energy

$$E = \frac{hc}{\lambda} \approx \frac{6.6 \times 10^{-34} \times 3 \times 10^{8}}{310 \times 10^{-9}} \approx \frac{6.6 \times 10^{-19}}{1.6 \times 10^{-19}} \approx 4.1\text{eV}$$

The transmission spectra in figure 4.5.2 shows the same results, which indicates that the absorption is maximum at this photon energy ($E = 4.1$eV).

This is in agreement with the result obtained in figure 4.5.4 where the energy gap is $E_g \approx$ 3.8eV thus one expect photon having energy just above E_g to be absorbed efficiently.

The sight a bit narrow band gap of mica may be due to the presence of high concentration of ($F_e \sim 38\%$) in it.

This indicate that mica act a semiconductor

Conclusion

The optical properties of mica show that it acts as a semiconductor.

This may be related to the fact that concentration of Fe is high.

References

[1] Charles Kittel , introduction to solid state physic, John Wiley November 2004, 8th Edition, the University of Michigan

[2] N.M. Ashcroft and N.D Mermin ,Solid state physics, Holt Rinehart and Winston, 1976, the University of California

[3] M. Ali omer, Elementary Solid state physics, Addison-Wesley Pub. Co, 1975, the University of California

[4] Gerald Burns ,Solid state physics , Academic Press ,August 11, 1985

[5] A. Hart – Davis ,Solids: An Introduction, McGraw-Hill, 1975, the University of Wisconsin - Madison

[6] R .A. Levy , Principles of Solid state physics, Academic Press (November 14, 2012),

[7] H .M. Rosenberg ,The Solid state, OUP Higher Education Division, 10 March 1988

[8] T. S. Hutchison and D. C. Barid, The physics of Engineering Solids,

, John Wiley and Sons.Inc , August 2004

[9] H. Ibach and H. Luth, Solid state physics,Springer Science & Business Media, 2013

[10] Ahmed Khojaly ,Principles of Solid State Physics,AZZA Center for publish and distribution , January 2002

[11] Ahmed Fouad Pasha ,Solid state physics, Arabic center publish Cairo,January 2010

[12] K. Lance Kelly,Eduardo Coronado,Lin Lin Zhao, andGeorge C. Schatz

,The Optical Properties of Metal Nanoparticles, December 21, 2002**,**

Department of Chemistry, Northwestern University

[13] A. T Davidson and A F Vickers **,The optical properties of mica in the vacuum ultraviolet**, Journal of Physics C: Solid State Physics, May 3, 2006, the university of Michigan

[14] Maxwell, J. Clerk ,A Dynamical Theory of the Electromagnetic Field, Philosophical Transactions of the Royal Society of London, January 1865

[15] Mubarak Dirar Abdallah ,Electromagnetic theory II ,textbook,Sudan University of science and Technology 2002

[16] Lars Olof Bjorn ,The nature of light and its interaction with matter

e-book, Springer link,London 2007

[17] Akihisa Nonoyama, Using multiwavelength UV- visible spectroscopy for the characterization of red blood cells: an Investiigation of hypochromism, Nov 2004