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EXP.NO: 4

Name of experiment: **Measurement the optical properties of the material**

Purpose of experiment: To find the absorption coefficient of the glass.

Apparatus: • Glass container. • (He-Ne) laser. • optical bench. • optical Rail. • Ink. • Water. • Detector. • Dense material (mud)

Theory:

Attenuation of a light beam:

When a beam of light traveling through a piece of optical material. Some of the light energy is absorbed by the material, and some is transmitted (fig. 1).

The transmission of the optical material is given by Eq. 1:

$$T = \frac{E}{E_0} \qquad (1)$$

Where: T = Transmission.

E_0 = Irradiance of light incident upon the material.

E = Irradiance of light transmitted through the material.

In some cases, almost no light is absorbed, and the transmission is almost 1.0. In others, there is no transmission at all (T = 0). Reflection and scattering of light together with absorption account for losses in all optical systems, but reflection and scattering are not considered in this experiment.

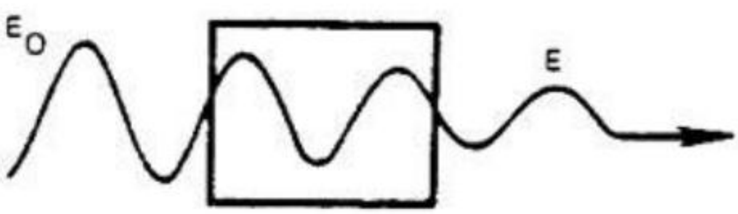

Figure (1): Attenuation of a light beam.

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The Exponential Law of Absorption:

Obviously, any increase in the thickness of the absorbing material will decrease the irradiance of the transmitted light. Fig. 2 depicts light traveling through four identical pieces of (filter) materials, each 1mm thick absorbing one – half the light incident upon it Fig. 3 is a plot the transmission this material as a function of thickness. Transmission in this case is based upon incident and transmitted power, rather than upon irradiance. The curve in fig. 3 is called an "exponential curve. "It begins at an initial value of 1.0 and approaches zero asymptotically as thickness increase.

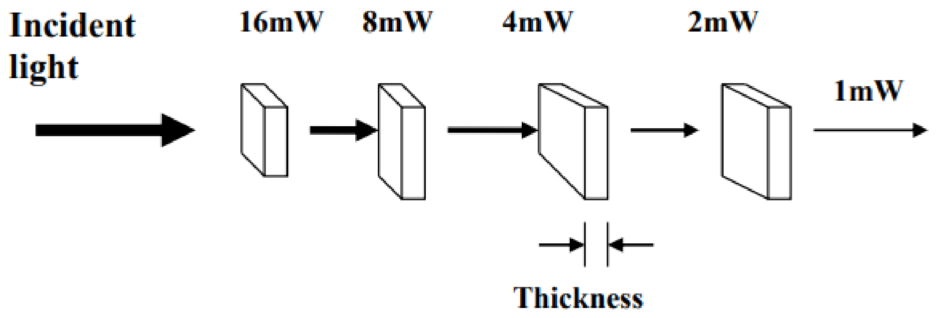

Figure (2): Transmission of light through a series of materials.

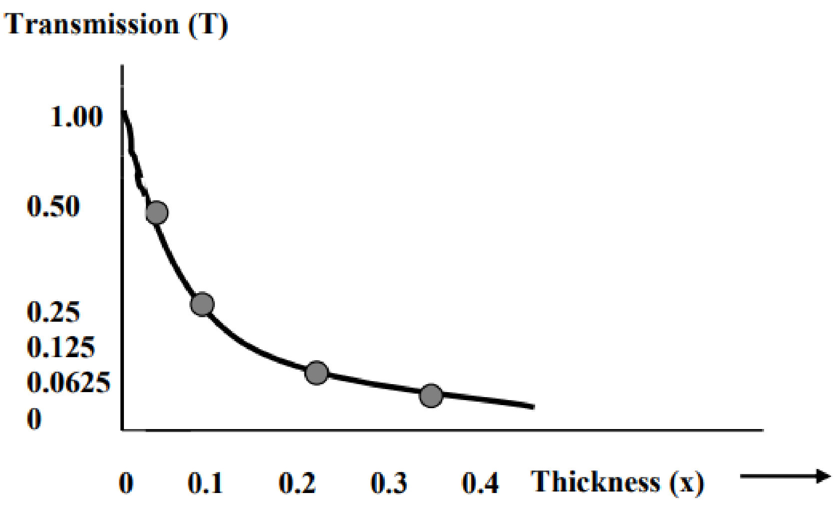

Figure (3): Transmission as a function of thickness.

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The degree of transmission for any thickness of a material is given by the exponential law of absorption, (fig. 3) as stated in Equation 2:

$$T = e^{-kx} \qquad (2)$$

Where:

T = Transmission

e = 2.718

k = The absorption coefficient of the material in cm^{-1} .

x = The thickness of the material in cm.

The absorption coefficient is numerically equal to the reciprocal of the thickness of a specific material that results in a transmission of 1/e (0.368) of the incident light. The units of thickness and absorption coefficient must be reciprocals of one another in order that their product, the exponent of e, will remain a dimensionless quantity. Rearrangement of terms yields Equation 2 for absorption coefficient.

$$k = \frac{1}{x}\ln\left(\frac{1}{T}\right) \qquad (3)$$

The absorption coefficient of any material is a function of the wavelength of the light striking that material.

Procedure

1. Arrange the set up shown above:

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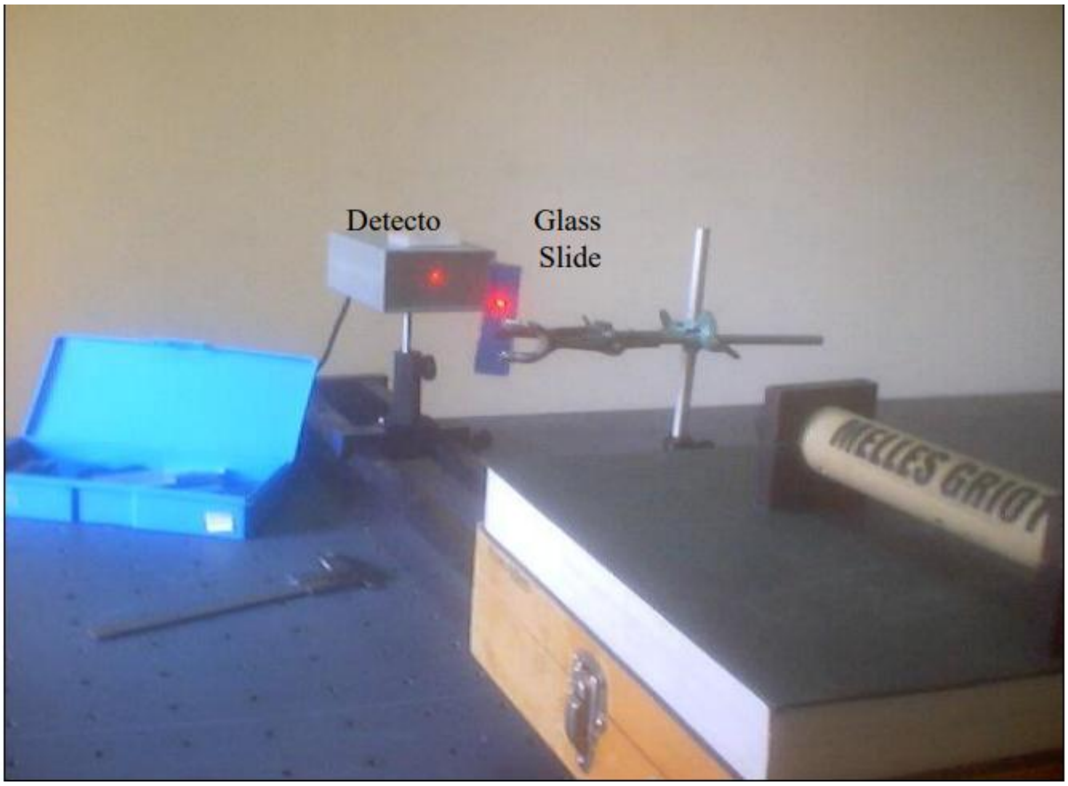

Figure (4): Experimental Photograph.

2. Measure the intensity of laser source.

3. Measure the intensity of laser when it propagated through an

- Empty container
- Container that filled with water
- Container that filled with water and one drop of ink.
- Container filled with water and mud, with different densities (increased in 8– steps).

4. Plot a curve between density against intensity of light.

(Hint: stop the filly of mud when the light can't be propagated through the container).

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Discussion:

1. Discuss the effect of the density of material on the power intensity of laser source.

2. Discuss the relation between the absorption coefficient and intensity of light.

3. The light incident upon the material in Figure 1 has an irradiance of 2.5 W/cm2. The irradiance of the transmitted light is 0.50 mW/cm2.

Find: The transmission