Study the effect of colors on the optical properties of imported glass

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Abstract
Several models were chosen from imported glass in different colors (transparent, blue, bronze, green), and with different thicknesses (4-6-10mm) available in the Iraqi market. The intensity of the beam, the light transmitted with the thickness change, was measured to determine the permeability characteristics. Calculating the energy gap for direct and indirect transference allowed. It has been shown that the permeability change with the change in color and thickness of the sample. In addition, transparent glass has high permeability comparison with other types, and that the visual characteristics depend on the thickness of the sample.

Key words: imported glass, different colors, permeability characteristics.

1. Introduction
The study of raw materials for the glass industry has become of great importance to the quality of the glass as well as the economic importance of providing local sources of raw materials for this industry. The glass is called transparent material whose structure is similar to the fluid structure of random crystal structure [1]. The glass in its solid or liquid state does not contain crystals and its melting point cannot be determined because it is transferred from the solid state to the liquid passing through the ductility stage which is characterized by a high viscosity level [2]. Glass is an important material in our daily life, so we cannot do without it. It is produced by rapidly cooling the molten viscous material below its glass transfer temperature by rapid damping. The most common form of glass is the silica based material used in household things like light bulbs and windows. Glass is a biologically inactive substance that can be formed on smooth surfaces. Under tension, the glass is brittle and will split into sharp fragments. Under pressure, pure glass can withstand a great deal of strength. The properties of the glass can be modified or changed with the addition of other compounds or heat treatment. Most glass formulations contain about 70-72% by weight of silicon dioxide (SiO2). The most common form of glass is lime soda glass, which contains approximately 30% sodium oxides, calcium or carbonate [3]. The main raw material for glass is sand that contains approximately 100% of crystalline silica in the form of quartz. Although it is almost pure quartz, it may contain a small amount (Less than 1%) of iron oxides that color the glass. [4].

2. The practical side
Initially, our selection of samples was different from imported glass of different colors from the Iraqi market. Then we cut the samples with a special device to cut the glass so that they were cut in the form of circles with diameters of 3 cm, and finally the samples were cleaned in three stages

1- The glass was placed in the cleaning liquid for 3 minutes in a bowl.

2- The glass was taken out and put in pure water for 15 minutes.

3- The glass was placed in acetone liquid for 10 minutes.

Then it was dried with cotton fabric and air blower. After cleaning all the samples, the measurements started. We measured the optical properties of the representative samples (absorbance, reflectivity, and permeability) for all samples.

Where the permeability was calculated using the following relationship [5].

\[ T = \frac{I}{I_0} \] ……… (1)

Where: T: permeability, I: penetrating ray, I_0: falling beam Calculate the absorbance using the following relationship:

\[ A = \frac{I_A}{I_0} \] ……… (2)

If that A: absorbance, I_A: Absorbed beam, I_0: falling beam

From the absorbance we calculate the absorption coefficient:

\[ \alpha = 2.303 \frac{A}{t} \] ……… (3)

As: \( \alpha \): Absorption coefficient; \( \alpha \), t: thickness

And through the relationship between reflectivity, permeability and absorbance:

\[ T + A + R = 1 \] ……… (4)

Where the reflectivity was calculated:

\[ R = 1 - (T + A) \] ……… (5)

The energy gap for all permissible direct transfer glass types was also calculated using the following equation ( Tauc’s relation)

\[ \alpha h \nu = B_\nu (h \nu - E_g)^r \] ……… (6)

Where: exponential coefficient determining the type of transition, \( B_\nu \): A constant that depends on the type of material, h\( \nu \): incident photon energy in eV units, \( E_g \): power gap in eV units.

3. Results and discussion

3-1 Permeability:
Figure 1 represents the change in permeability as a function of the wavelength with the same thickness of 4 mm glass and of colors (transparent, green, blue and bronze). The permeability changes depending on the wavelength that increases from 300 nanometers to 1100 nm, where the permeability of transparent glass at the wavelength (300) nm is (0.018), while its greatest value is at the wavelength (370) nm is (0.455). We note that between the wavelength (370-650) nanometers, the permeability is constant with a change in wavelength and after that it begins to decrease gradually. As for the blue glass, its permeability is at the wavelength of (300) nm. Not fixed between the wavelength (390-640) nm, then it starts with a gradual increase until the wavelength (730) nm. The permeability becomes at this length (0.4119), and then it starts with a gradual decrease, and we also notice the presence of its peak at the wavelength (355) with permeability (0.3199), while green glass, we notice that it has two peaks at the wavelength (395) nm, whose value is (0.3564), and the second peak at the wavelength (550) nm, whose value is (0.3807), where its greatest permeability is at the second peak. While the bronze whose permeability is at the wavelength (300) nm, it is (0.05016) It also contains one peak that has the greatest permeability at the wavelength (705) nm and its permeability (0.3494), and immediately after it decreases by increasing the wavelength, by what We note that clear glass has the highest permeability in relation to the rest of the colors, and this result is logical in relation to the composition of samples and is similar to the general behavior. This result is consistent with the results of researchers in the source [6].

![Figure 1: The relationship between wavelength and permeability for 4mm glasses](image)

Figure 2 represents the change in permeability as a result of a change in the wavelength from 300 to 1100 nm for glass samples of various colors and measuring 6 mm. where the permeability of transparent glass at the wavelength (300) nm is (0.018), while its greatest value is at the wavelength (370) nm is (0.455). We note that between the wavelength (370-650) nanometers, the permeability is constant with a change in wavelength and after that it begins to decrease gradually.

Blue glass at the wavelength (300) nm has a permeability (0.01828). We note from the drawing that there is a regular height until it reaches the length The wavelength (370) nm whose permeability is (0.41195) and then it starts waving, and as we note that there are two peaks at the wavelength (400) nm
which have the greatest permeability (0.411954) and the second peak at the wavelength (720) nm and after that it decreases Permeability with increasing wavelength. As for bronze glass, we notice that at the wavelength of (320) nm, its value is (0.01828), the permeability begins with a gradual increase with increasing wave length, we notice the presence of one peak at the wavelength (400) nm, at which the transmittance is (0.357949), and we notice that there are two points where the wavelength from (370) to (700) ripples with permeability, and then we find a gradual decrease with increasing wavelength. For green glass at the wavelength (300) nm, the permeability is (0.11002), and we notice the presence of the first three peaks at the wavelength (400) nm with a value of (0.4423877) and the second peak at the wavelength (550) nm with transmittance (0.448970) and the last summit It is at the wavelength (740) nm, after which we notice a gradual decrease with increasing wavelength.

Figure 2: The relationship between wavelength and permeability of 6 mm thickness

Figure(3) represents the relationship between the wavelength and the permeability of glass with a thickness of 10 mm. where the permeability of transparent glass at the wavelength (300) nm is (0.018), while its greatest value is at the wavelength (370) nm is (0.455). We note that between the wavelength (370-650) nanometers, the permeability is constant with a change in wavelength and after that it begins to decrease gradually. Where the blue glass has permeability at the wavelength (300) nm is (0.014497) with a gradual increase being observed with increasing wavelength. We also notice the presence of two peaks at the longest wavelength (400) in which the blue glass has the greatest value (0.400514) and the second peak at the wavelength (725) with transmittance (0.33082) and after that suffers a gradual decrease with increasing wavelength.

As for bronze glass, its permeability is at the wavelength (300) nm (0.103634) and it starts with the gradual height from the wavelength (320 to 370) and there is one peak at the wavelength (400) whose permeability is (0.291872).

As for green glass, it has less permeability, at the wavelength (320) nm, where its permeability is (0.0012009), and then we notice a gradual increase in permeability by increasing the wavelength, and its greatest value is at the wavelength (510) nm which it is has a value (0.44897) and then suffers a gradual decrease with increasing wavelength. While the transparent glass at the wavelength (300), the
permeability is (0.024227), and then we notice an increase in its permeability until it reaches its highest peak at the wavelength (395), where we notice the permeability of the permeability of the wavelength (395 to 585) with an increase in the wavelength, and after that it suffers Decrease in transmittance gradually by increasing wavelength. Through the results, I showed that the permeability value increases with increasing wavelength, as the increase and decrease in the permeability of the samples depend on the retinal distortions, scattering centers and photon incident energy [7, 8].

![Figure 3: The relationship between wavelength and permeability for 10 mm glasses](image)

### 3-2 Energy gap

The energy gap gap is one of the most important physical constants for optical properties and is based on determining the value of this constant in the manufacture of many electronic devices such as solar cells and detectors. The energy gap for permissible direct transmission was calculated by plotting the graphical relationship between \((\alpha h\nu)^2\) and photon energy \((h\nu)\), as we get a graph showing the straight line span that crosses the axis \((h\nu)\).
Figure (4) represents the energy gap for the permissible direct transmission of clear, blue, green and bronze glass of 4 mm thickness.
The energy gap for the permissible indirect transmission was calculated by plotting the graphical relationship between \((\alpha h \nu)^{1/2}\) and the photon energy \((h \nu)\) as we get a graph showing the straight line span that crosses the axis \((h \nu)\).

![Graph of clear 4mm](image1)

![Graph of blue 4mm](image2)

![Graph of brown 4mm](image3)
Figure 5: represents the energy gap for the permissible indirect transmission of glass in different colors

Through the results of the samples in the previous forms of the energy gap values for the permissible and forbidden direct transmission, we note that the transparent, bronze, blue and green color have varying values of the energy gap that may be due to the random composition of the atoms as in Table 1, this is due to more electrons traveling from a beam Parity to the conduction beam, which leads to a decrease in the value of the energy gap, and this result is consistent with behavior in terms of change in values. [9,12]

The table represents the energy gap values for electronic transitions

| colors   | Thickness mm | Allow direct transmission | Indirect transmission is permitted |
|----------|--------------|---------------------------|-----------------------------------|
| Clear    | 4            | 3.9                       | 3.6                               |
| Blue     | 4            | 3.9                       | 3.5                               |
| Green    | 4            | 3.6                       | 3.4                               |
| Bronze   | 4            | 3.6                       | 3.4                               |

4 .Conclusion

In this work, the optical properties of imported transparent glass have been studied and compared with 4mm stained glass types. As the results showed that the permeability value increases with increasing wavelength in general, absorbance changes with color change and with difference in values and different behavior in some curves. As for the energy gap values for permissible and forbidden direct transmission, the results showed that the transparent and bronze color has varying values of the energy gap, As for blue and green, the gap value decreases.
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