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Preventive Conservation of Historic Textile from the Ultraviolet Degradation due to Light Exposure in Egyptian Museums

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Abstract: Historic Textiles are safer from light degradation when exposed to ultraviolet radiation emit from different kind of illumination either natural or artificial in uncontrolled and poor Egyptian museums. This article is present an experimental study of using different materials as coating in order to reduce the UV amount on display of historic textiles. Different kinds from glass of showcases in some Egyptian museum were tested against to UV. Transmittance of six samples of different thickness of Perspex that used in showcases at Egyptian museums was studied as will. Two compounds Titanium dioxide and zinc oxide are studied as coating materials on commercial glass with thinks 3mm and 5mm. Twenty four samples was prepared for each compound. Coated glass exposed to artificial Ultraviolet source to study their protection. Also, non-coated glass was used as a blank sample and assessments have been done. The transmittance of output of the samples obtained through the spectral transmittance of each sample, given that the maximum transmittance was for air.

Keywords: Historic, Textiles, Light, Ultraviolet, Museum, Display, Degradation, Exposure

1. Introduction

Textile collections can vary from large carpets and tapestries to delicate lace, embroideries and personal clothing. Because textiles are utilitarian and part of our everyday lives, antique textile survives often only by chance. Moreover, textiles, being organic by nature, are among the most fragile of all artifacts [1]. Museum textiles are extremely susceptible to damage from environmental factors such as humidity, dust, airborne pollutants, light, heat etc [2].

Many authors have studied the effect of light, temperature, humidity and washing on dyed silk with natural dyes. Light is the greatest enemy of textiles. Damage from light accumulates over time and is irreversible. Light causes fading, bleaching, and color changes, and can make materials dry and brittle. You may not notice deterioration at all until it's too late [3, 4, 5, 6, 7, 8]

Exposure to light is the chief concern when display is considered. Ideally, textiles should be displayed in an area where lighting can be removed or turned off when the objects are not being viewed, and textiles should never be displayed in an area where they will be exposed to sunlight of any kind. Fluorescent lights, because they emit UV light, should be fitted with UV filters or not used at all, and light sources should not be mounted close to the textile to prevent heat damage. In general, 50 lux is considered to be a safe amount of light for textile display. While it is hard to determine the lux of light sources without the proper equipment, this is light that is slightly brighter than twilight [9, 10, 11, 12]

To reduce harmful ultraviolet we should use coating materials on the glass of museums such as Titanium dioxide and zinc oxide [13, 14] or we can use prespex which is light weight and unbreakable [15] and Laminated glass is a sandwich made of one piece of plastic Poly Vinyl Butyral (PVB) between two or more glasses. The PVB sticks with the glass and forms chemical as well as mechanical bonds. It gives acoustic insulation as well as gives protection against damage caused due to UV radiation [16].

The article aims to:

- Survey of display methods of historic textiles and Light system in controlled and uncontrolled Egyptian museums.
- Measure the transmittance of ultraviolet for different thickness of laminated glass, Perspex and commercial glass that used in controlled and uncontrolled Egyptian museums.
- Apply protection coating materials such as Titanium Dioxide and Zinc Oxide on the surface of commercial glass and measure the transmittance of ultraviolet after the glass coating for poor and uncontrolled museums.

2. Materials and Methods

2.1. Materials

The following materials were used in this study:

- Perspex samples from Suez National Museum, Egypt.
- Laminated glass samples from the Islamic art museum in Cairo, Egypt.
- Commercial Glass samples from Museum of Faculty of Archeology, Cairo University, Egypt.
- Commercial Glass of thickness 3mm and 5mm from local market.
- Titanium dioxide and Zinc oxide from El-Gomhoria Company, Egypt.

2.2. Methods

- Application the coating materials by brush method.

Coating materials prepared by mixing 7 cm^3 acril 33 with 100cm^3 water in a bicker, then 0.5 g from titanium dioxide or zinc oxide added and mixed together. The coating materials were applied by brush "one, two and three layers of coating materials on glass samples" and one layer from each side of glass samples.

Table 1. *Shows the chemical composition of Titanium dioxide and Zinc oxide.*

Materials	Wight (g)	Acril 33(Brimal)	Water
Titanium dioxide	0.5 g	7 cm^3	100 cm^3
Zinc oxide	0.5 g	7 cm^3	100 cm^3

- Application the coating by the spray method.

Coating materials prepared by mixing 100cm^3 Acetone in a bicker with 0.5 g from titanium dioxide or zinc oxide added and mixed together, and glass samples was coated with Acril 33 at first and let it to dry then application the coating material with spray bottle (the distance between glass samples and the spray bottle was 15cm).

Table 2. *Shows the chemical composition of Titanium dioxide.*

Coating materials	Weight (g)	Acetone
Titanium dioxide	0.5 g	100 cm^3
Zinc oxide	0.5 g	100 cm^3

2.3. Transmittance Measurement

A system consists of

1. 30 Watt Deuterium lamp with its house and special power supply.
2. Sample holder.
3. Single monochromator with CCD detector.
4. Software displays the output spectrum on PC screen.

The emitted spectrum of the Deuterium lamp aligned and paralleled through optical components. The parallel beam passes through the samples and collected to focus on the input fiber. The input are dispersed inside the monochromator and detected by the built-in CCD detector. PC displays the resulted transmittance spectra.

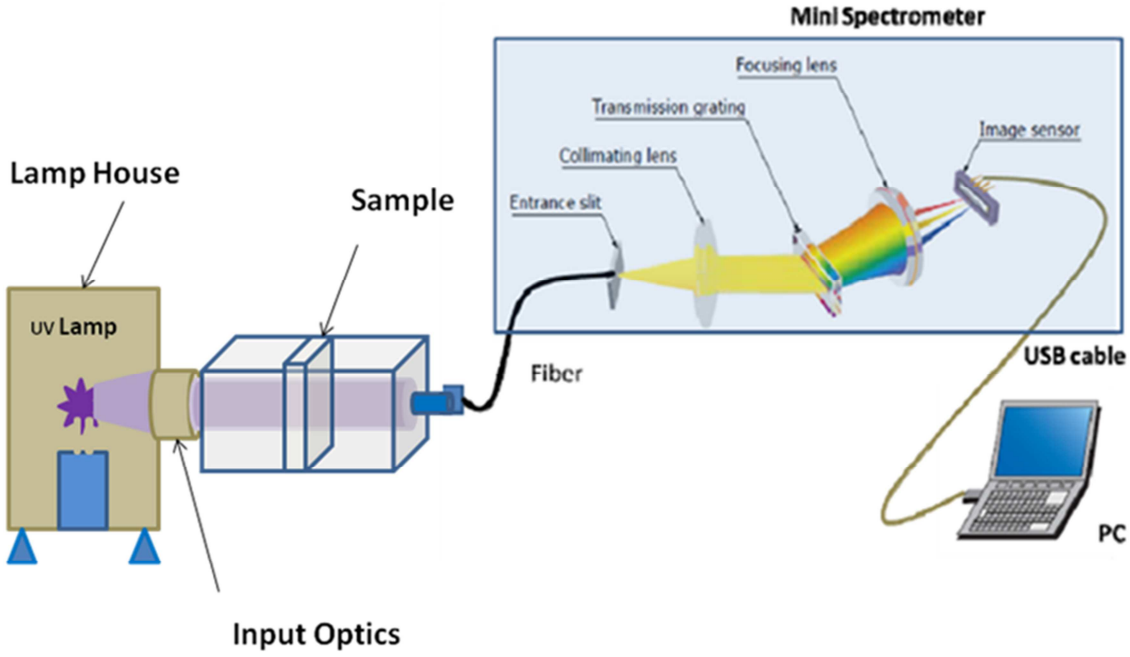

Fig. 1. *Show the UV transmittance measurement system.*

3. Results

3.1. Survey of Display Methods of Egyptian Museums

The study focused on survey of display methods of historic textiles and Light system in controlled and uncontrolled Egyptian museums. One can see the Fig the Coptic museum as the controlled museums sample. The images show the display methods with different type of showcases, and the light method. In Coptic museum the light system is LED light and the showcases were made from laminated glass and different sickness of Perspex. Fig. 2 show the average UV transmittance of laminated glass, all Perspex samples with different sickness (1mm, 2mm, 5mm, 7mm, and 10mm), and glass. The museum windows were covered by the thick curtains in order to prevent natural lighting. The temperature and relative humidity are under control.

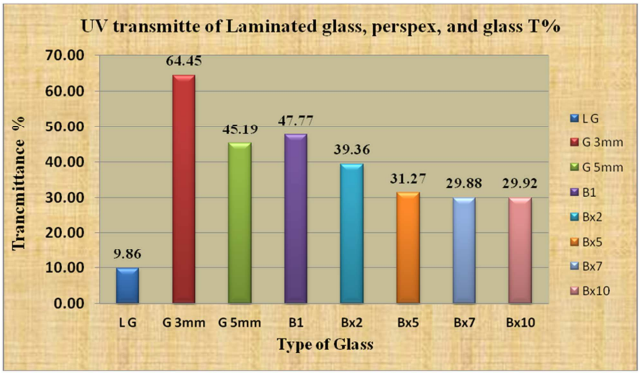

Fig. 2. *Show the average transmittance of laminated glass (LG), Perspex (B1, Bx2, Bx5, Bx7, Bx10), and glass (G 3mm, G 5mm) that used in the Egyptian museums.*

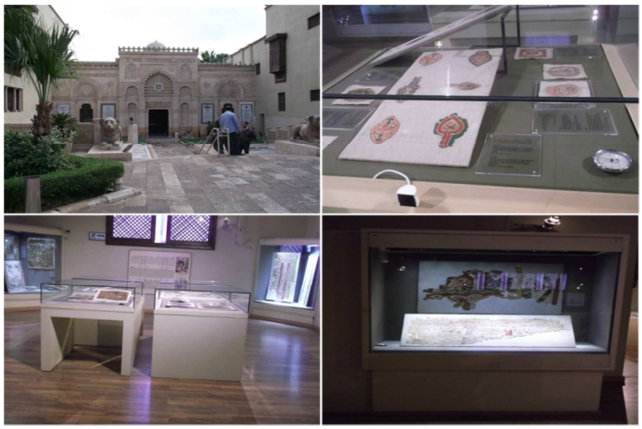

Fig. 3. *Show the display of historic textiles in Coptic museum, Cairo.*

While Fig. show Islamic art museum in Cairo as a controlled museum, it is noticed the different display methods and showcases that were made from laminated glass. Furthermore, one can see that the lighting system is optical fibers. The museum widows were covered by the thick curtains in order to prevent natural lighting. The temperature and relative humidity are under control. Fig. 2 show the average UV transmittance of laminated glass, all Perspex samples with different sickness (1mm, 2mm, 5mm, 7mm, and 10mm), and glass (3mm, 5mm).

Fig. 4. *Show the display of historic textiles in The Islamic Art museum, Cairo.*

While Fig. shows the Faculty of Archeology Museum in Cairo as an uncontrolled museum, it is noticed the different display methods and showcases that were made from unlamented glass from local marking with different sickness. Furthermore, one can see that the lighting system is fluorescent bulbs, as well as natural light (sunlight). It is noted that the curtains on the windows are very slight. Temperature and relative humidity are variable through the year. Fig. 2 show the average UV transmittance of laminated glass, all Perspex samples with different sickness (1mm, 2mm, 5mm, 7mm, and 10mm), and glass (3mm. 5mm). So, this study will focus on glass treatment in order to reduce the UV transmittance to save the historic textiles from UV effect.

Fig. 5. *Show the display of historic textiles in Faculty of Archaeology, Cairo University.*

3.2. Glass Treatment

In this section an experimental part was done by applying Titanium dioxide, Zinc Oxide, and mixture from Titanium dioxide and Zinc Oxide on glass in order to reduce the UV transmittance thought glass samples. The application of Titanium dioxide, and Zinc Oxide were done by using brush and spraying the materials on glass samples (3mm and 5mm). The samples measured from (200-400nm), it is noticed that transmittance at the range from (200-300) tending to zero. Transmittance percent (*T%*) are calculated from equation 1

$$T\% = \frac{I}{I_0} \times 100$$

I = the value of UV transmittance thought samples.
I_0 = the value of UV transmittance thought air.

3.3. Applying the Coated Materials on Glass by Using Brush

In this section the coated materials was applied by using brush from one side. One layer of coated materials was applied. The fig.6 show the result of the value of UV transmittance thought coated glass samples. It is noticed that the samples coated by using brush needs a lot of time to dry due to water as solvent in material components.

3.4. Average of Amount UV Transmittance of Brushed Glass (3mm)

After drying of samples the transmittance UV were measured as showed in fig 6. One can see that the amount of UV transmittance of glass 3 mm coated by titanium dioxide is less than 35%. While the amount of UV transmittance of samples coated by Zinc oxide is around 50%. By the other hand, the amount of UV transmittance of samples coated by mixture of Zinc oxide and is Titanium dioxide is around 40%. From Fig 2 It is noticed that the amount of UV transmittance of glass 3mm is around 65%. The coated materials reduce the amount of UV transmittance. Coated samples by titanium dioxide showed the better results in the previous experiment.

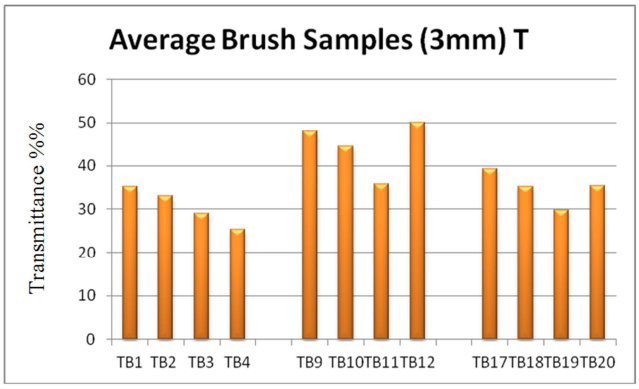

Fig. 6. *Shows the result of coating materials on glass samples 3mm, titanium dioxide (TB1:TB4), Zinc oxide (TB9:TB12), and mixture of titanium dioxide and zinc oxide (TB17:TB20).*

3.5. Average of Amount UV Transmittance of Brushed Glass (5 mm)

Fig. 7 show the result of amount of UV transmittance of glass 5 mm coated by Titanium dioxide (TB5:TB8). Zinc oxide (TB13:TB16). Mixing between titanium dioxide and zinc oxide (TB21:TB24). It is noticed the amount of UV transmittance of glass 5 mm coated by titanium dioxide is less than 30%. While the amount of UV transmittance of samples coated by Zinc oxide is less than 40%. By the other hand, the amount of UV transmittance of samples coated by mixture of Zinc oxide and is Titanium dioxide is around 25%. From Fig 2 It is noticed that the amount of UV transmittance of glass 5 mm is around 45%. The coated materials reduce the amount of UV transmittance. Coated samples by titanium dioxide showed the better results in the previous experiment.

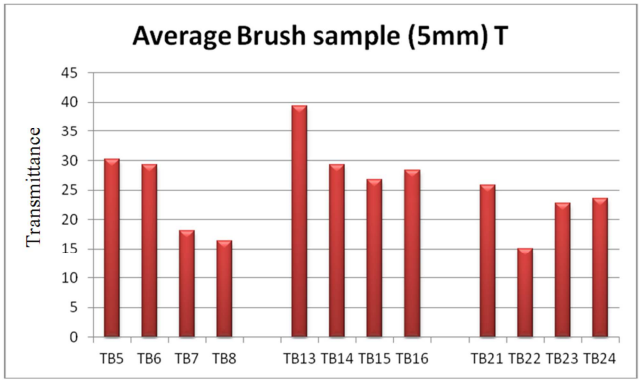

Fig. 7. *Shows the result of coating materials on glass samples 5mm, Titanium dioxide (TB5:TB8). Zinc oxide (TB13:TB16). Mixing between titanium dioxide and zinc oxide (TB21:TB24).*

3.6. Applying the Coated Materials on Glass by Using Spray

In this section the Titanium dioxide, Zinc oxide, and mixing between titanium dioxide and zinc oxide were applied on glass samples (3 mm and 5 mm) by spraying. This section will show if there are any change of results according to the Appling methods. The samples coated by spraying were dried faster than the samples coated by brush.

3.7. Average of Amount UV Transmittance of Sprayed Glass (3 mm)

Fig. 8 show the result of amount of UV transmittance of glass 3 mm coated by titanium dioxide (S1:S4), Zinc oxide (S9:S12), and mixture of titanium dioxide and zinc oxide (S17:S20). It is noticed the amount of UV transmittance of glass 5 mm coated by titanium dioxide is around 35%. While the amount of UV transmittance of samples coated by Zinc oxide is around 30%. The coated materials reduce the amount of UV transmittance.

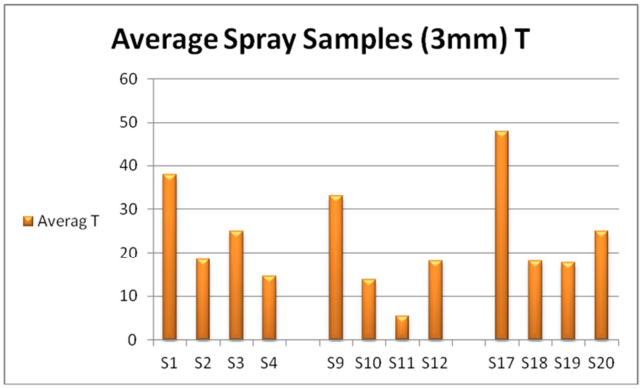

Fig. 8. *Shows the result of coating materials on glass samples 3mm, titanium dioxide (S1:S4), Zinc oxide (S9:S12), and mixture of titanium dioxide and zinc oxide (S17:S20).*

3.8. Average of Amount UV Transmittance of Sprayed Glass (5 mm)

Fig. 9 show the result of amount of UV transmittance of glass 3 mm coated by titanium dioxide (S1:S4), Zinc oxide (S9:S12), and mixture of titanium dioxide and zinc oxide (S17:S20). It is noticed the amount of UV transmittance of glass 5 mm coated by titanium dioxide is around 35%. While the amount of UV transmittance of samples coated by Zinc oxide is around 30%. The coated materials reduce the amount of UV transmittance.

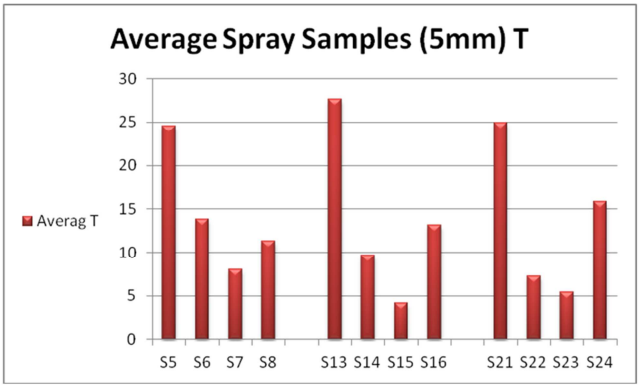

Fig. 9. *Shows the result of coating materials on glass samples 5mm, Titanium dioxide with one layer transmittance UV more than the other samples (S5: S8). Zinc oxide transmittance UV more than titanium dioxide (S13:S16). Mixing between titanium dioxide and zinc oxide better than zinc oxide (S21:S24).*

4. Conclusions

This study present survey of display system, light and other museum condition in both them the controlled and uncontrolled museum in Egypt. The glass samples that obtained from some Egyptian museum were useful to give us a clear idea of historic textiles protection from UV. Laminated glass is the best material we can use to block the transmittance of UV never ever. The treated glass by titanium dioxide and zinc oxide may be solution for poor museums. The sample coated by brush methods need more time to dry more than sample coated by spray method. It is noticed that samples coated by spray method become more homogenous than sample coated by brush. Titanium dioxide and Zinc oxide are effective materials in blocking ultraviolet transmittance partly. One can see that the Titanium dioxide is better than Zinc oxide in block ultraviolet transmittance. The glass without coating blocks UV up to nearly 300nm, and transmits the rest of UV band. The coated glass samples stop the UV at different wavelength depending on the coating material and its thickness. The protections of historic textiles from UV by using coated materials need further studies. Other materials that have more protection power with high transmittance at vision range must be studied. The study is recommending that using titanium dioxide and zinc oxide in storage area that is not visible to visitors.

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