Egyptian Journal of Archaeological and Restoration Studies "EJARS"
An International peer-reviewed journal published bi-annually

Volume 7, Issue 2, December - 2017: pp: 103-110 www. ejars.sohag-univ.edu.eg

Original article

A STUDY OF DEGRADATION PHENOMENA OF THE STAINED GLASS IN SOME CAIRO PALACES FROM 1850 TO 1950

Abdel Baky, N.
Conservation dept., Faculty of Archaeology, Sohag Univ., Sohag, Egypt.

E-mail: *n_sbae@yahoo.com*

Received 4/5/2017 Accepted 13/11/2017

Abstract

Egypt's palaces have various openings and architectures, the most significant of which were those openings containing stained glass. Due to the degradation of most stained-glass windows in the Egyptian palaces that are full of artistic works of high production quality and the increase of degradation factors, whether natural or artificial, they should be immediate conserved to keep this heritage from extinction. Thus, the study investigates, diagnoses, interprets the degradation phenomena of stained glass in some Cairo palaces from 1850 to 1950. It also investigates their relation to the internal degradation of most glass pieces. Furthermore, damage caused by humans due to negligence and ignorance of handling this type of monuments is studied. It proposes a plan of a national project to restore and maintain this heritage. Therefore, it utilizes the descriptive and analytical approach besides the comparative one to define and present degradation manifestations of stained glass in Sakakini palace (est. 1897), Prince Youssef Kamal Palace (est. 1908), Tahra palace (est. 1915), and Rustom pasha palace (est. 1927). The study recommends paying special interest to those windows and setting a national project to restore those palaces, in general, and their stained-glass, in particular.

Keywords: *Stained glass, Cairo palaces, Lead, Examination, Degradation manifestations.*

1. Introduction

With the passing of time, clear traces appear on the monuments, of different types and forms, especially rare ones. One of them, if not the most significant, is stained glass with various functional and colorful values. It creates harmony and diversity of colors and is characterized by aesthetics of the line, where the straight or curved lines of lead exist, as well as the beauty and glamor caused by the reflection of light on the internal structure. Such factors cooperate to create one of the most beautiful glass arts. From the 19th century to the middle of the 20th century, various architectural styles were introduced in Egypt. They were not an evolution of the prevailing architectural style at that time, but they were introduced to the foreign communities in Egypt and the attempts of some kings and princes to transfer the Eur-opean culture to Egypt. So, they recruited foreign architects to build palaces and gov-ernment facilities. Each community was keen on transfer its architectural and artistic style, whether in housing, places of worship, or facilities [1]. It evolved over time. In the beginning, it was related to Christianity and spread by representing the different topics of the Bible. Stained glass is small colored or painted glass pieces joined with lead and fixed in a wooden or metalized

frame [2]. There are various styles of stained glass. When the artist joins the colored pieces of glass using lead to create the desired design and to be fixed in a wooden frame to architectural openings, it is known as leaded glass. In a later stage, the artist utilizes tracing, shading color painting and silver stain to display the details on the colored glass to form the stained glass. Then, grisaille glass, known for its dec-orative units and neutral colors to some extent, was introduced. Each style reflects certain traditions, trends, and beliefs because the topics handled vary according to the architectural style and age circumstances [3]. That is, the appearance and architectural style of the building greatly affect the properties and forms of its openings. This, in turn, clearly influences stained glass, concerning the shape and size of the window, affecting the design's position. This is clearly manifested in the Gothic, rather than Byzantine windows. While the Byzantine architecture used to thick walls and few openings, Gothic was familiar with small-sized walls and increased number of openings with larger areas. Medieval Ages' architecture in Western Europe mainly utilized stained glass for its mural painting, while the Byzantine architecture used mosaic for it [4]. Consequently, it was more related to the Gothic style. That is, it evolved and flourished with the Gothic architecture in Europe [5]. In Egypt, especially in Cairo, there are many royal and Pasha's palaces holding marvelous stained glass works, known for their excellent design, execution, and high painted techniques. They were modeled after the Western architectural patterns because the Western culture dominated the architectural trends in Egypt. However, stained glass wasn't used for religious purposes, unlike that of the European churches [6].

2. Materials and Methods

2.1. *Materials*

The current study was conducted on 5 samples of the broken glass pieces collected from the palaces, as follows, fig. (1). **a)** *Sakakini Palace; a sample of blue glass*, **b&c)** *Prince Youssef Kamal Palace; samples of brown and red glass*, **d)** *Tahra Palace; a sample of green glass*. **e)** *Rustom Pasha Palace; a sample of dark brown glass with black tracing line*. They were used in the various examinations and analyses of the study.

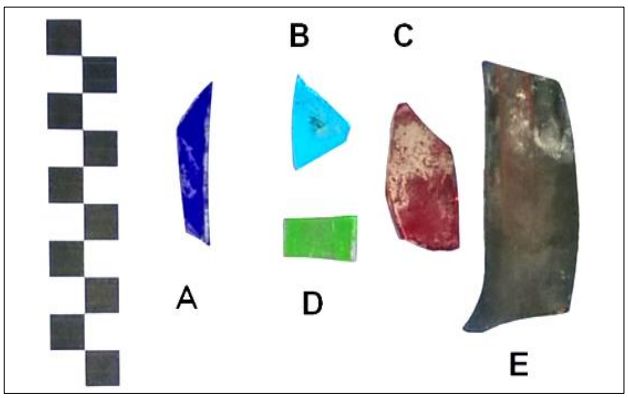


Figure (1) Shows the collected samples from different study areas.

2.2. *Methods*

Various methods of examination and analysis were utilized to investigate and interpret degradation manifestations in these panels. *Visual examination* is the first stage, where individual lenses are used. It is a quick and easy way to examine the surface and its degradation features, giving a good impression about the condition of the monument in hand [7]. Magnifying glasses (4:6 X) were also used to evaluate the conditions of the archeological panels, concerning their techno-

logical process or degradation. *Reflected light examination* is a procedure that helps explore the monument's surface because the reflection of light occurs when it bounces off a reflective surface beam in the same medium when it falls on a reflecting surface. This provides a good view of the surface and shows its degradation manifestations [8]. *Penetrating light examination*, this test is considered one of the best methods of examining the stained glass. It clearly shows the cracks and different optical holes affected glass objects. Furthermore, *SEM* was used for investigating the external surfaces stained glass. It gives many accurate details, e.g. scratches, pits, cracks, durability, and surface deposition layers. *EDX* analysis was adapted to obtain quantitative and qualitative data characterize the study samples [9]. In addition to identify the samples' elemental ratios. This greatly helps define their degradation because of the disorder in the main elements of the glass. Finally, *XRD* was used to analyze glass samples from the archeological panels to explore their crystal components, indicating any degradation because glass is non crystallized and does not give results except in the case of degradation, or crystallized phases of mineral oxides used in glass coloring, cataract factors, and previously used rest-oration materials [10].

3. Results

3.1. *Visual and reflected light examination*

Because light is the first means used in stained glass, natural light was used in the examination. Photography was utilized using a Sony camera (60 X magnification) to record the aspects of surface degradation, as follows:

3.1.1. Sakakini palace

The main window on the second floor consists of two movable panels. In the background we show horizontal and vertical lines are noticed. The viewer believes that they are part of the panel's artistic design. However, they are strips of adhesive tape, increasing glass degradation as it increases acidification on the surface. As a result, various carbonates or sulfate are accumulated in the form of layers causing surface degradation [8]. This tape is found behind all the panels of the window. In addition, in the right side breaking and losing of the glass appear beside lead rods. There is also the phenomenon of illumination. It is the space that results from losing the Cement and the consolidation of lead rods causing glass pieces to come out of the lead cavity. Consequently, light penetrates and affects the view of the panel. This indicates the beginning of panel degradation. As pressure increases on the panel, the piece of glass cracks and brakes. When this cavity widens, the piece falls and is lost [11]. This is clear in the upper part of the two movable panels. The falling of the panels from the wooden frame as a result of vibration. In addition, glass pieces were replaced with colored glass with no ornaments, as shown in fig. (2-a, b, c, d).

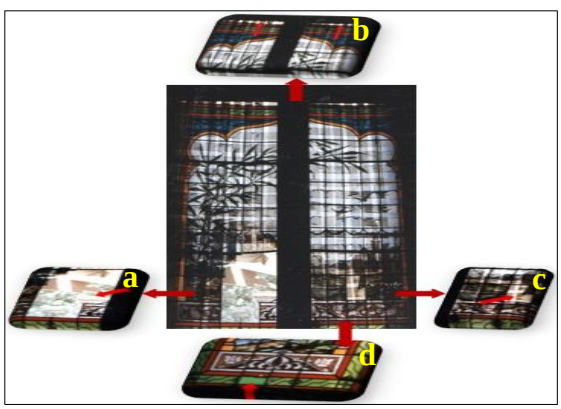


Figure (2) Shows **a**. breaking and losing of the glass, **b**. illumination, **c**. strips of adhesive tape, **d**. glass pieces were replaced with colored glass with no ornaments.

3.1.1. Prince Youssef Kamal palace

The main window of the dining room on the 2nd floor is divided into three parts. Generally, its lead net is weak because it is largely unable to keep the panel in the up-right position. This loses the cohesion of glass pieces in the lead frame and the cement is lost. Consequently, the panel falls. Such weakness clearly appears in the lower part caused by load increase [12]. As a result, the weight of the window is disturbed and its ability to hold the glass panel is lost. Glass pieces broke and a large part was lost. Accordingly, a change of the general appearance and dimensions of the panel occurred [12], causing breaking in the welding of the lead net, losing glass piece in many places, and cracks appeared in the glass, fig. (3-a, b, c).

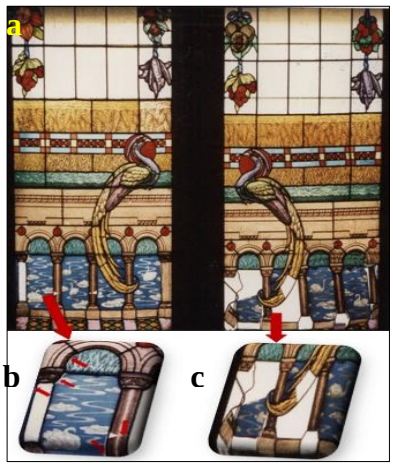


Figure (3) Shows **a**. lead net is weak as it is greatly unable to keep the panel in the up-right position, **b**. cracks and illumination of the glass, **c**. breaking the welding and losing of glass pieces as a result of the weakness of the lead net.

3.1.2. Tahra palace

The panels in Tahra Palace are the least (among those under study) regarding the exposure to damage because the palace was not used as a governmental institution; interacting with the public is one of the most significant degradation causes of most panels. One of the clearest degradation manifestations is the loss of the green color under the panel. In addition, there are dust and dirt behind the panel causing darkening. Furthermore, colored glass pieces were replaced with transparent ones, fig. (4-a, b, c).

Fig. (4) Shows **a**. colored glass pieces were replaced with transparent ones, **b**. dust and dirt behind the panel causing darkening, **c**. clearest degradation manifestations is the loss of the green color under the panel.

3.1.3. Rustom pasha palace

Degradation is manifested in a window of a room on the 2nd floor, as follows: There are dust and dirt in the back and front parts, creating a good environment for microorganisms to grow. Thus, glass corrosion is accelerated. Calcified deposits appear on the surface of the panel, indicating piling up of the alkaline components. In addition, the structure was affected and weakened because of the irregular cleaning of dust and drops of dew and rain, creating a humid environment on the surface which hastens degradation. Iron saddle bars were rusted braking their welding into the panel. Consequently, the specific gravity of the panel was disordered and the lead net was limped. The adhesive tape was also used to gather the glass pieces, increasing the acidification of the surface. As a result, the phenomenon of illumination occurred and then the glass came out of the lead frame, fig. (5-a-1-2-3, b-1).

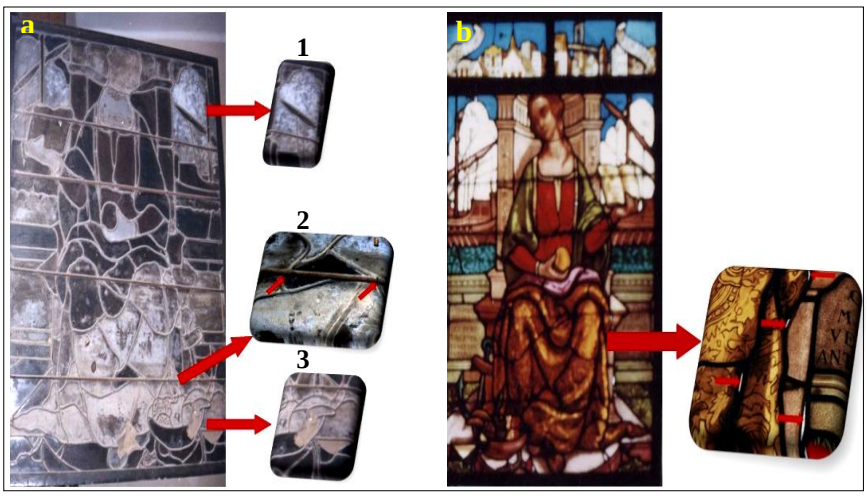


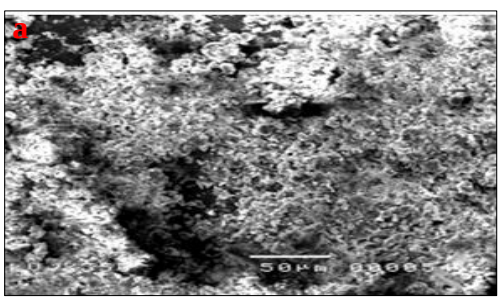
Fig. (5) Shows a. The back side of the window containing (**1**- *dust & dirt behind the panel,* **2**- *rust & breaking of iron saddle bars,* **3**-*improper adhesive tape to gather the glass pieces*) b. the front side of the window containing (*illumination*).

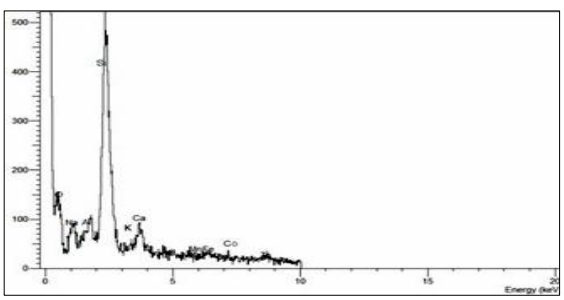
3.2. *SEM attached to EDX*

The results of SEM and EDX are listed in tab. (1), in addition, fig. (6- a, b, c, d, e) showing the charts and photo-microphotograph that illustrating the elements of the glass samples.

Table (1) results of EDX analysis of the various glass samples

Sample	Elemental Ratios (%)												
	O	***Na***	***Mg***	***Al***	***Si***	***K***	***Ca***	***Mn***	***Fe***	***Zn***	***Co***	***Cr***	***Cu***
A	19.8	3.7	0	6.4	54.7	1.7	8.9	0.9	1.7	0.2	1.3	0	0
B	13.5	10.4	0	7.2	55.1	3.6	5.2	0.5	1.1	0.7	0	0	1.2
C	18.5	3.7	1.2	5.3	48.4	2.5	15.4	1.6	0.9	0.8	0	0	1.7
D	12.3	6.4	2.1	7.5	58.3	5.3	3.7	0.9	1.2	0.5	0	1.8	0
E	22.9	2.8	1.2	5.4	46.7	0.9	14.6	1.9	2.8	0.8	0	0	0





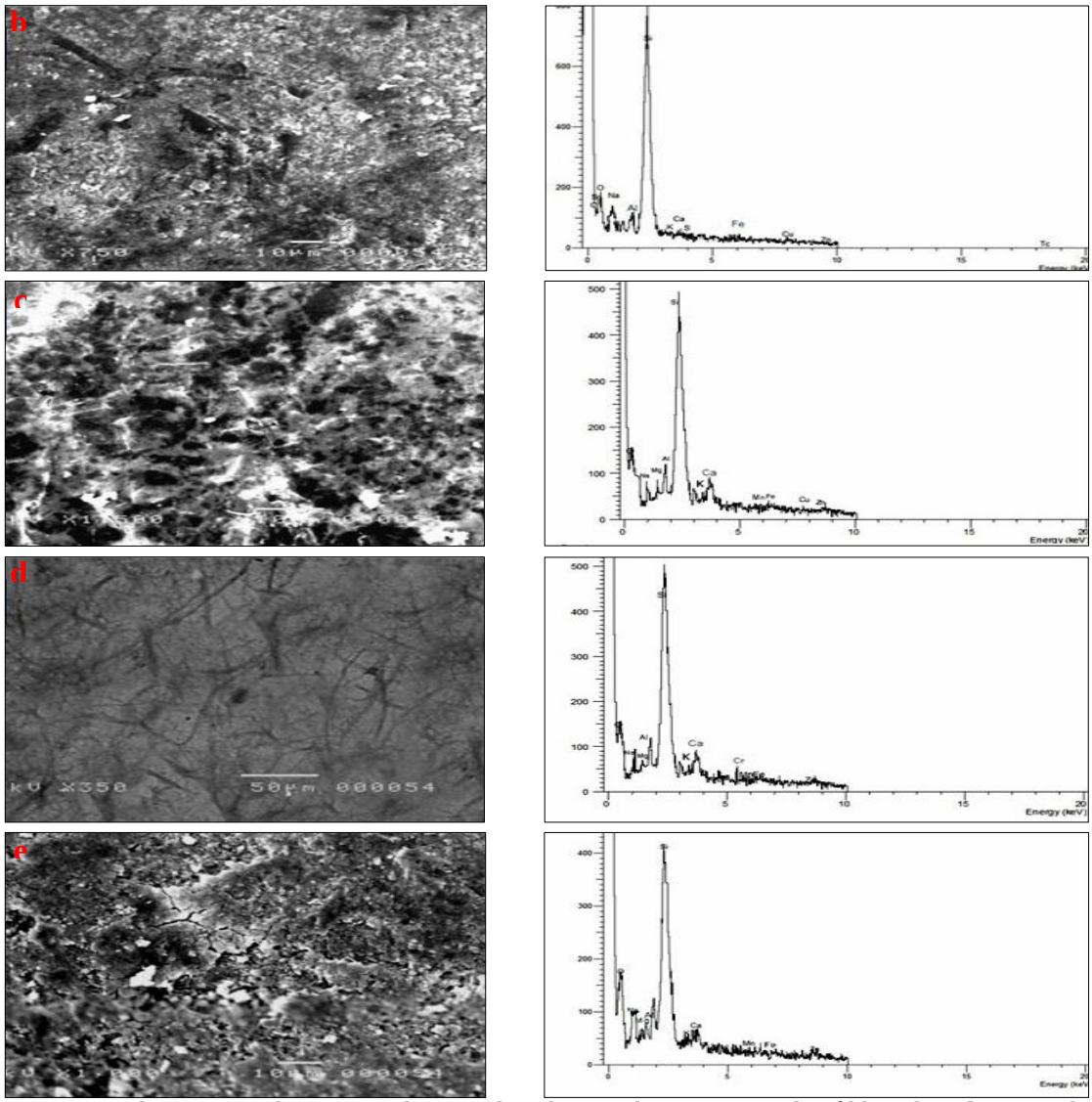
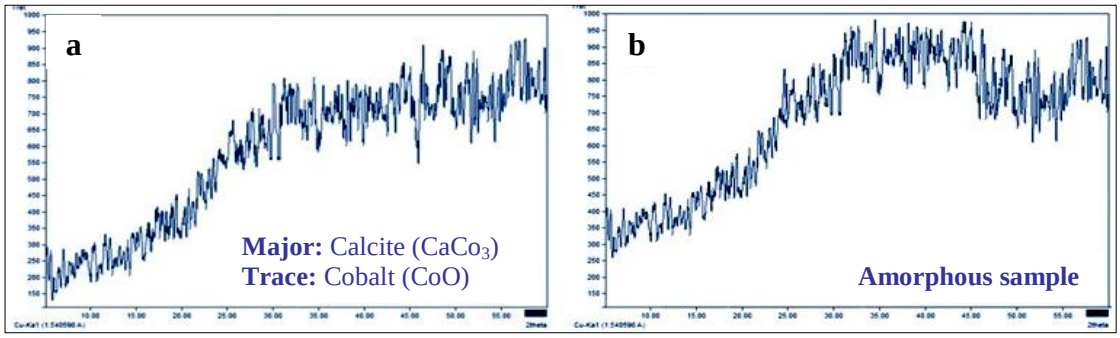


Figure. (6) Shows SEM photo-microphotograph and EDX charts **a**. a sample of blue glass, **b**. a sample of brown glass, **c**. a sample of red glass, **d**. a sample of green glass, **e**. a sample of dark brown glass with black tracing line

3.3. *XRD analysis*

The obtained results of X-ray diffraction, fig. (7-a, b, c, d) revealed that calcite ($CaCO_3$) appears as a major crystal phase and Cobalt appeared as traces in sample (a) of blue color. In addition, both of turquoise color in sample (b) and green color in sample (c) contained amorphous components. On the same context, Calcite ($CaCO_3$) and gypsum ($CaSO_4$) appeared as major crystal phases and hematite (Fe_2O_3) appeared as traces in sample (d) of the dark brown color.



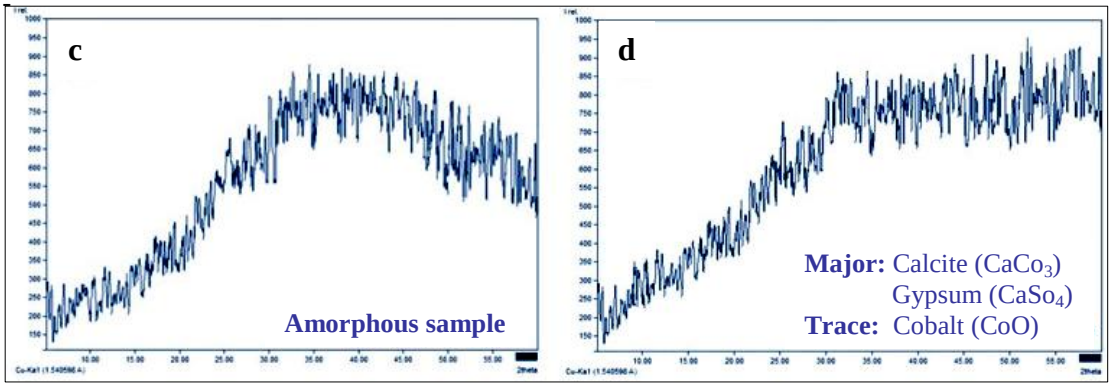


Figure (6) Shows XRD patterns **a**. a sample of blue glass, **b**. a sample of turquoise glass, **c**. a sample of green glass, **d**. a sample of dark brown glass.

4. Discussion

By comparing the resulted data of all samples collected from the four palaces (under study) it could be claimed that silica, in all the samples, was rated between 46.7 % and 58.3 %, indicating the beginning of the silicon frame's degradation. Sodium and potassium were low; the highest percentage of sodium was 10 % for the turquoise sample, indicating its good condition. The other samples achieved 2.8 % to 5.3 %. Potassium in all samples achieved 1.7 % to 5.3 %, showing that they were exposed to degradation by a source of moisture causing the movement of alkaline subst-ances from the inner parts of the glass to the surface [13]. Then, they were compl-etely lost or reacted with the gasses of air pollution into carbonates and sulfate. This interprets the layers of white degrade-ation on the surface of some panels. Calcium achieved 15.4 % in the red sample and 14.6 % in the dark brown one. Such percentages are high for calcium to be used as a stabilizing component in the mixture of glass manufacturing. Thus, it was a result of degradation processes due to the movement of calcium from the glass frame to be deposited on the surface and reacted with air pollutants to form calcium carbonates and sulfate [11]. This was reported by XRD examination where their crystal phases appear as gypsum is one of the most dangerous degradation because it's hard to be solved. It is a hygroscopic layer that absorbs and keeps water vapor. Consequently, water is always on the glass surface, causing the continuity of degradation and corrosion [14]. Figure (6-a, b, c, d, e) shows the degradation layers in a fragile and porous form containing corrosion pits. Additionally, calcified degradation layers appear on glass surface with simple pores. A net of microcracks and pits on glass surface, scratches on glass degradation and weak and fragile colors of tracing line with cracks also appear. Aluminum and magnesium appear in different rates in some samples. They are enhancing materials in glass mixture. Cobalt appears an oxidant of the blue color. Copper appears as an oxidant to both the turquoise and the red samples. It is used in a decreasing atmosphere to get the red color. Chrome appears as an oxidant of the green color, while iron and magnesium appear as the oxidant of the dark brown color.

5. Conclusion

The present study shows that the panels of stained glass are of high technology concerning their design and execution, especially using Vitreous Paints in glass ornaments. The panels of Youssef Kamal and Tahra Palaces share the same architectural features, e.g. setting the panels in semi-circular arches because they were built by the Italian architect "Antonio Lasciac", who also built many royal palaces and governmental institutions in Cairo. Tahra Palace is the best

concerning solidity and non-exposure to damage. In the other palaces, the panels have different degrees of degradation. The most significant stated aspects of degradation are the limpness of the lead net and the disturbance of the panel's specific gravity clearly manifested in Youssef Kamal Palace and phenomenon of illumination. There are many degradation manifestations, the most important of which is the human factor because using the palaces as governmental and scientific institutions causes degradation of stained glass windows. In addition, negligence causes a complete loss of original glass pieces in most of the panels. Finally, the institutions that contain archaeological openings with panels of stained glass should be counted, registered and studied. Conservators and archeologists should be motivated to do their best to repair and keep such heritage because it comprises rare artistic Egyptian monuments. Furthermore, these palaces should not be used as governmental buildings or scientific institutions, but should be used as museums.

Acknowledgments

I would like to express my special thanks to Prof. Salwa Gad EL-Karim Dawi, Professor of Conservation & Restoration, Faculty of Archaeology, Cairo Univ. for all the help and valuable information she provided. She was the first to study the conservation and restoration of stained glass at the Faculties of Archeology in Egypt.

References

[1] Elbayaa, S., (2011). *Churches of Elmanshea district, Alexandria in the 19th century*, Ph.D., Islamic Archeology dept., Faculty of Arts, Tanta Univ., Egypt.

[2] Morris, E., (1990). *Stained & décorative glass*, Tiger Books International, London.

[3] Wylie, E. & Cheek, S., (1997). *The art of stained and decorative glass*. Todtri Productions Limited, NY.

[4] Growhill, G., (1966). *Encyclopedia of world arts*, Vol. 3, J. Heraty & Associates, NY.

[5] Grodecki, L. & Brisac C., (1984). *Gothic stained glass: 1200-1300*, Office du Livre, Fribourg, Switzerland.

[6] Salem, A., (2002). *Palaces of princes and pashas of the 19th century in Cairo*, Part 1, Zahraa El Sharq Book Shop, Cairo.

[7] Davison, S., (2008). *Conservation and restoration of glass*, 2nd ed., Butterworth, UK.

[8] Melcher, M. & Schreiner, M., (2013). *Glass degradation by liquids and atmospheric agents: Modern methods for analyzing archaeological and historical glass*, in: Janssens, K. (ed.) John Wiley & Sons, Ltd., West Sussex.

[9] Goldstein, J., Newbury, D., Joy, D., Lyman, C., Echlin, P., Lifshi, E., Sawyer, L. C. & Michael, J., (2003). *Scanning electron microscopy and X-ray microanalysis*, 3rd ed., Springer, NY.

[10] Mass, J., (1999). *Instrumental methods of analysis applied to the conservation of ancient and historic glass in (the conservation of glass and ceramic)*, James & James Science Pub. Ltd., London.

[11] Schreiner, M., (1988). *Deterioration of stained medieval glass by atmospheric attack*, Part 1, Glastechnische Berichte, Germany.

[12] Valldeperez, P., (2001). *Stained glass: The craft, the art, and restoration techniques demonstrated and explained with step-by-step photos*, Barron`s Educational Series, NY.

[13] Newton, R., & Davison, S., (1997). *Conservation of glass*, Butterworth-Heinemann, London.

[14] Ronald, M., (1969). *Weathering effects and corrosion of stained glass*, CVMA, the British Academy by the Oxford University Press, London.