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Glass gilding process in medieval Syria and Egypt (13th–14th century)

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ABSTRACT

Twelve gilded and enamelled Islamic glass fragments, produced in Syria or Egypt during the Ayyubid or Mamluk period, were provided by the Louvre museum for complete non-destructive analysis. The enamelling process of similar objects has been extensively studied in the last decades, but the gilding process has never been investigated in details. This paper focuses on the understanding of both the gilding process and the gold/glass adhesion mechanism. The structure, composition and thickness of the gold flakes forming the gilding decoration are measured. The complete process combining gilding and enamelling is described and the local mechanism of adhesion of gold flakes on the glass body is discussed.

1. Introduction

Enamelled and gilded glass is one of the most outstanding artistic productions of the Islamic craft industry, especially during the Ayyubid and Mamluk dynasties (Syria and Egypt, 13th and 14th centuries) (Lamm, 1941). Islamic glassware was already widely distributed in the western world, but the scientific interest for Islamic glass production only started in the middle of the 19th century. The first studies were devoted to iconographic and stylistic aspects only (d'Avennes, 1877; Schmoranz, 1899). Scientific and technical investigations became possible with the emergence of non-destructive analysis methods, and gilded and enamelled objects have been extensively studied in the last decades. Two major publications (Carboni and Whitehouse, 2001; Ward, 1998) provide what may be considered as the most complete state-of-the-art of the current knowledge about fabrication techniques and materials as well as production centres and their trade diffusion. A large number of data is available on the composition and structure of both glass bodies and decorative enamels (Freestone and Stapleton, 1998; Freestone, 2002; Henderson, 1998; Verità, 1998). However, the enamelling process is not fully understood. In particular the temperatures and number of firing remain vaguely described.

The gilding process is rarely mentioned in the literature. Authors who mention it all admit that gold is ground into powder, mixed with a binder of gum Arabic kind and applied with a brush before firing (Carboni, 2001a; Gudenrath, 2001; du Pasquier, 2005). Also in ancient sources the descriptions of this specific glass gilding process are very rare or non-existant. The Abu'l Quasim treatise, written in 1301, (Allan, 1973) describes in detail the gilding of Islamic ceramics with gold foils but does not mention glass gilding process. A gold painting technique is described in the 12th century treatise by Théophilus (2000). That treatise refers to Byzantine techniques anterior to the Mamelouk period, but the Syrian glassmakers worked in the same tradition as the Byzantine artists.

This paper describes the result of a comprehensive laboratory study of 12 gilded and enamelled glassware fragments kindly selected and provided by the Department of Islamic Art of the Louvre museum. On the archaeological point of view, the purpose of this study is the understanding of the gilding technique: What tools and materials were used by the artisans? How was gold applied to the glass surface? Are there similarities between the glass and the ceramic productions?

On the scientific point of view, this paper brings new information on the adhesion mechanisms between gold and glass, which is a difficult and unsolved issue. Some publications recently offered

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physical models of the adhesion mechanism in very specific cases (Darque-Ceretti et al., 2002, 2008), but the question of adhesion between glass and ground gold was never considered.

2. Materials and techniques

2.1. Studied fragments

Twelve fragments were chosen amongst the collection of the Department of Islamic Arts of the Louvre museum, in agreement with the curator in chief, as representative of the production of gilded and enamelled glassware during the Ayyubid and Mamluk period (Syria and Egypt 13th–14th century) (Fig. 1). They cover all the range of enamel colours existing in that collection, except yellow. Most of them show typical dark-red enamelled lines surrounding enamels and gilded patterns. Two fragments made of coloured glass were chosen in order to identify the colouring agent and identify possible differences in composition with the uncoloured fragments. The fragments are in variable conservation state. Some fragments are in an excellent state, others are whitened or strongly weathered. Some gilded decorations are very dense and shining, others show large gaps.

2.2. Experimental techniques

Because of the cultural heritage value of the fragments, no sampling was allowed and the study had to be entirely conducted by non-invasive methods. The recent development of non-destructive analysis methods now allows obtaining very rich information on cultural heritage objects (Darque-Ceretti and Aucouturier, 2007).

First the objects were carefully observed by optical microscopy (binocular microscope) in both reflected and transmitted light.

Thanks to their limited size, they could be inserted into the chamber of a scanning electron microscope (SEM, Philips XL30CP), operated at 20 kV acceleration voltage and under limited vacuum (100 Pa) to avoid charging effects. In such a limited vacuum configuration, the magnification is limited to about $\times 1000$.

As no sampling was allowed, it was impossible to observe cross-sections. For most of the samples the observations were made on the surface only. Fortunately two fragments showed a very clean broken edge that could be observed without preparation.

An X-ray energy dispersive spectrometry (EDS) attachment allowed local microanalysis. In limited vacuum configuration, SEM-EDS microanalysis may be affected by the so-called "skirting effect"

Fig. 1. images of the studied objects. Egypt or Syria, 13th or 14th century. Musée du Louvre, Department of Islamic art. Photographs © C2RMF, D. Bagault. *"waq-waq" is a legendary tree whose fruits in shape of animal heads say "waq-waq" when they are gathered.