Investigation and analysis of three gilded wood samples from the tomb of Tutankhamun

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This paper describes the examination and documentation of three samples of gilded wood from the tomb of the pharaoh Tutankhamun. The samples were sent for identification at the Royal Botanic Gardens in Kew in 1932 and returned to Egypt for further examination in 1984. By studying these samples using techniques such as scanning electron microscopy–energy dispersive spectroscopy (SEM-EDS), X-ray diffraction (XRD), polarised light microscopy (PLM) and Fourier transform infrared spectroscopy (FTIR), variation in materials became evident. The composition of the gold leaf and the plaster layer varies, as does the type of wood used. Different imported coniferous wood species were used for the funerary furniture, such as Cedrus libani and Cupressus sempervirens. The difference in the colour of the gold leaf was due to a wide variation in the composition and concentration of the alloying elements. The rich red colour of one of the samples was originally considered to be due to the presence of cuprite but elemental analysis using EDX showed the presence of iron. The thickness and composition of the textile, gilding and gesso layers were investigated, and the condition of the wood, substrate and gilding was documented.

1 INTRODUCTION

The technology and materials of ancient Egyptian gilded wood are usually mentioned very briefly in the literature. For conservation purposes, it is important to know how gilded wood, a composite material, was prepared. Lucas and Harris (1962) give a fairly good indication of the materials used, but this is not sufficient to allow an understanding of the method by which the different layers adhered to each other and have remained intact for all these years.

This paper describes the examination and documentation of three samples of gilded wood from the tomb of the pharaoh Tutankhamun that were sent by the excavator, Howard Carter, for identification at the Royal Botanic Gardens in Kew in 1932. The samples, which were partly documented by Lucas and Harris (1962: 433–434), were returned to Egypt in 1984 for further examination. The returned samples were labelled only with numbers indicating the register number that Carter had given to the object from which the sample had been taken. The samples had a small label beside them with the Latin name of wood type, but it is difficult to tell who had written this identification. After extensive searches, it proved possible to identify these objects, as well as the location of each sample.

Sample 1 (original register number 239) was one of a number of wood chips taken from the fourth (innermost) shrine, now numbered je 60668 at the Egyptian Museum in Cairo. According to Carter’s handwritten object card number 239-07, the ancient workmen had cut away these chips from the inner surface of the top rail of the shrine’s west end panel because of an error in measurement (Carter 1963). The same cards noted that Mr L.A. Boodle, from the Royal Botanical Gardens in Kew, had identified these chips of gilded wood as being cedar, either Cedrus atlantica, Manetti or Cedrus libani, Barrelier. Lucas and Harris (1962: 433) mention that the specimens taken from the shrines had been examined microscopically by Dr L. Chalk, of the Imperial Forestry Institute, Oxford, and were identified as sidder (Ziziphus spinosa-christi) and cedar (he had examined both panels and wooden pegs). The identification of this sample (sample 1) was published and confirmed by Waly (1996) as Cedrus libani.

Sample 2 (original register number 253) was taken from the first (outermost) coffin. According to Carter’s handwritten object cards (card number 253-04), the top edge of the foot end of the coffin lid had been chipped off during burial with a sharp, adze-like instrument because it was too tall to allow the lid to be placed on the sarcophagus (Carter 1963). These chips, which were found at the bottom of the sarcophagus under the bier (register number 253a), were identified as Cupressus sempervirens (cypress). This identification was reconfirmed by Waly (1996). The first coffin (from which sample 2 had been chipped off) and the sarcophagus are the only two artefacts that remain in the tomb today (Davis 2003).

Sample 3 does not have a register number, but its wood was identified as Cedrus libani, and it may have come from the yellow-gold areas of the fourth (innermost) shrine (Waly 1996).

The structure of each sample is summarised in Table 1; the layers found in the samples are shown in Figure 1.

2 IDENTIFICATION AND ANALYSIS

The analytical tools used in the current study were:

- Optical and polarised microscopy;
- Scanning electron microscopy–energy dispersive spectroscopy (SEM-EDS): Philips XL30 ESEM (environmental scanning electron microscope) and JEOL JSM-5400 (low vacuum SEM-EDS);
- Fourier transform infrared spectroscopy (FTIR): JASCO FT-IR-460 plus spectrometer;
- X-ray powder diffraction (XRD): the mineral composition of the studied samples was determined using a Philips PW 3710/31 diffractometer, scintillation counter, Cu-target tube and Ni filter at 40 kV and 30 mA. This instrument is connected to a computer system using Philips’ APD diffraction software and the ASTM (American Society for Testing and Materials) card database for mineral identification.

2.1 WOOD

It was very common in ancient Egypt to use native woods such as acacia, tamarisk and sycomore fig covered with
<table>
<thead>
<tr>
<th>Sample 1</th>
<th>Sample 2</th>
<th>Sample 3</th>
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<tr>
<td>Carter registration number</td>
<td>239</td>
<td>239?</td>
</tr>
<tr>
<td>Original sample location</td>
<td>fourth (innermost) shrine</td>
<td>first (outermost) coffin</td>
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<tr>
<td>Wood substrate</td>
<td>Cedrus libani (cedar)</td>
<td>Cupressus sempervirens (cypress)</td>
</tr>
<tr>
<td>Animal glue</td>
<td>thick layer and droplets</td>
<td>thick layer</td>
</tr>
<tr>
<td></td>
<td>have penetrated ray</td>
<td>thick layer</td>
</tr>
<tr>
<td></td>
<td>parenchyma</td>
<td></td>
</tr>
<tr>
<td>Textile layer</td>
<td>Z-spun linen, tabby weave</td>
<td>Z-spun linen, tabby weave</td>
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<td>Gesso and binding medium</td>
<td>fine layer on top of</td>
<td>fine layer on top of</td>
</tr>
<tr>
<td></td>
<td>coarse layer</td>
<td>coarse layer</td>
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<tr>
<td>Pigment base layer</td>
<td>none</td>
<td>black pigment</td>
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<tr>
<td>Gilding</td>
<td>reddish surface coloration</td>
<td>bright yellow gold, thin</td>
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**Table 1** Summary of structure and materials for each sample

![Schematic drawing](image)

**Figure 1** Schematic drawing of the successive layers in samples 1, 2 and 3.

a gesso layer that concealed the flaws often found in these woods and that acted as a ground for decoration (Davies 1995: 148). Prestigious imported timbers such as cypress and cedar had fewer flaws and an attractive colour and texture. It was therefore rarer for these woods to be covered with thick layers of plaster (Davies 1995: 148). However, the woods in the samples discussed in this paper, taken from the gilded funerary furniture of Tutankhamun, had already been identified as the foreign timbers Cedrus libani and Cupressus sempervirens.

Examination using SEM showed that the wood appeared to be in good condition. No fungal decay was evident and the cells were intact, showing no signs of deterioration. Small cracks in the longitudinal and transverse directions were evident in the tracheids of sample 1. The presence of such microcracks can be easily explained: the samples studied had been chipped off the fourth shrine and first coffin during the burial, using sharp tools. Another reason could be the changes in temperature and relative humidity throughout the years, which may have caused slight movement in the wood, forming microcracks as a consequence.

In sample 1, which was made of cedar wood, the melted glue had penetrated the ray parenchyma during application. Glue droplets that made their way through the ray cells are visible in some parts inside the wood (Figure 2). The outer side of the wood of sample 2 was totally covered with a thick layer of glue, which had been used to adhere the layers that lay above it. The adhesive layer was distributed fairly evenly over the outer wood grain, and it was obvious that the bordered pits of the cypress wood (from the coffin) were completely covered and blocked with animal glue (Figure 3).

Scanning electron micrographs of sample 1 showed the ruptured parts of the upper surface of the wood, linen threads from a textile layer and some particles from the gesso layer that lay above the linen textile (Figure 4a). The tracheids and ray parenchyma of the cedar wood were presumably ruptured while the timber was prepared and smoothed for gluing.

### 2.2 Textile Layer

Lucas and Harris (1962) mention that, in some cases where gesso was applied to wood, a layer of coarsely woven linen fabric was adhered between the wood and the gesso layer to compensate for the instability of the multi-layered structure of the polychrome wood and mitigate damage from movement of the wood. In the gilded samples, this textile layer is present. The linen thread was finely Z-spun (clockwise), and typically contained 15 fibres per thread. The thickness of one linen fibre was approximately 7 μm and the thickness of the linen textile immersed in the glue with which it was attached to the wood and gesso was approximately 310 μm. The textile used in this multi-layered structure was of a simple tabby weave. The warp and weft threads were easily observed while studying the samples using SEM. Under the optical microscope the thread appears to have been immersed in the glue, its colour being slightly darker than that of the wood. The outer layers of both wood and textile are totally covered with glue, and this imparts a shiny appearance. The difference in texture makes it easy to differentiate between
Three gilded wood samples from the tomb of Tutankhamun

Figure 2  a) Transverse section of cedar wood from sample 1 showing tracheids and ray parenchyma. Fissures are seen in some of the tracheids. A small droplet of glue is clearly seen by the ray parenchyma (circled). SEM micrograph; bar = 50 µm. b) The FTIR spectra of the glue taken from the sample presents the typical features of a proteinaceous material, presumably animal glue.

Figure 3  Transverse section of Cypress wood from sample 2, showing tracheids and bordered pits that were covered with the adhesive material used for binding the wood support to the remaining layers. SEM micrograph; bar = 50 µm. Elemental analysis of the adhesive layer proved that it contained sulphur, which is present in proteinaceous materials.

Examination of the gesso layers using polarised and optical microscopy and SEM revealed a double-structure of coarse and fine gesso layers in samples 1 and 3 and a single, coarse layer in sample 2. The coarse layers were packed with crushed angular grains which could be explained by the hand crushing of calcite for the formation of coarsely divided grains. XRD analysis indicated the presence of calcite (5-586) in all of the samples, in addition to some quartz (4-784). The results of EDX analysis of the gesso layers is given in Table 2 (see also Figures 6–8).

2.4 BINDING MEDIUM AND ADHESIVE

A number of natural products were used in ancient Egypt as adhesives or paint binders. On current evidence, animal glue and plant gums appear to have been the most common paint binders (Newman and Halpine 2001). In circumstances where there is no significant interference from inorganic materials, FTIR spectrometry may be used to indicate the presence of plant gum or glue (Newman and Serpico 2000). In all three samples, the binding materials and adhesives were investigated using FTIR, taking into consideration the fact that the gesso layer was mainly calcite, and that the presence of the carbonate group caused a slight shift in the absorption bands (Centeno et al. 2004). The FTIR spectra of the glue sample taken from underneath and around the textile layer from the shrine sample (sample 1) gave typical features of the proteinaceous material in animal glue (Figure 2b). In the case of sample 2 it was difficult to separate the glue layer and therefore the sample used for FTIR analysis was taken from the gesso layer. The results obtained from sample 2 were very difficult to interpret, but the elemental analysis of this sample revealed the presence of traces of sulphur, which is found in proteinaceous materials.

2.5 BLACK BASE LAYER

An additional layer, black in colour, was found between the gilding and the coarse gesso layer in sample 2. This may have been applied as a base coat for the gilding. Different colours of base coat have been mentioned in previous research. A ‘layer of yellow ochre between the plaster and gold leaf’ was recorded by Laurie (Lucas and Harris 1962: 232); it may have been applied to enhance the colour of the gold. Additionally, the base colour

wood grain and the interlocking structure formed by the linen thread (Figure 4b and Figure 5). In areas where the textile had been pulled out, voids are visible between the wood and the gesso layer (Figure 6b).

2.3 GESSO LAYER

Wood substrates in ancient Egyptian objects are often covered with either a single-structured layer of gesso or layers of coarse and fine gesso. Hatchfield and Newman’s analyses of Egyptian gessoes have shown that they usually consist of a calcium carbonate or calcium sulphate filler mixed with an organic binder (Hatchfield and Newman 1991). This layer may be modelled in bas-relief, incised or stamped with any desired design and, when dry, gilded.

Cardoso (2006: 75–76) mentions that ‘the use of several differently textured gesso layers mitigates the destructive effect of the natural movement of the wood because the coarse and uneven particles of calcium carbonate prevent shrinkage of the gesso’. Moreover, the binding medium imparts greater strength and flexibility to the layers of coarse gesso, allowing them to accommodate the natural movements of the wood without cracking (Cardoso 2006).
Figure 4  a) Parts of the ruptured ray parenchyma and other wood cells from the Cedrus libani substrate of sample 1. Clearly visible is the linen textile that had been glued on to this wood and coated with gesso.  SEM micrograph; bar = 50 µm. b) Woven linen textile showing warp and weft threads passing over and under each other.  SEM micrograph; bar = 50 µm.

Figure 5  a) Linen thread adjacent to the cypress wood in sample 2.  SEM micrograph; bar = 100 µm. b) the three layers: wood, textile, gesso (photomicrograph). c) Linen thread, consisting of several spun fibres adhering to the coarse gesso layer in sample 2.  SEM micrograph; bar = 50 µm.

Figure 6  a) The gesso layer in sample 1, showing the structure of calcite grains, evidently coated with an adhesive/binding material.  SEM micrograph; bar = 10 µm. b) Coarse gesso layer in sample 1, showing the structure of calcite grains and some fossilised remains. The voids between the gesso layer and the wood core are due to the missing thread from the textile layer. The vertical crack in the gesso layer and the presence of part of a loose tracheid could be due to the use of tools while chipping off the samples.  SEM micrograph; bar = 50 µm.
Three gilded wood samples from the Tomb of Tutankhamun

<table>
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<tr>
<th>Sample</th>
<th>Ca</th>
<th>Cu</th>
<th>Si</th>
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<th>K</th>
<th>S</th>
<th>Na</th>
<th>Cl</th>
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<td></td>
</tr>
<tr>
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<td></td>
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</table>

Table 2 Elemental analysis of the gesso layers using EDS

Figure 7  a) A single, coarse gesso layer in sample 2, showing the structure of calcite grains evidently coated with an adhesive/binding material. SEM micrograph; bar = 5µm. b) showing the crushed angular grains/inclusions in the coarse layer. SEM micrograph; bar = 10µm.

Figure 8 Sample 3. A double-structured layer of coarse and fine gesso layers; the coarse layer showing the crushed angular grains/inclusions. SEM micrograph; bar = 200µm.

Figure 9 The gold foil was partially removed from sample 2, revealing a black layer underneath that was made up mainly of carbon and nitrogen. PLM micrograph.

would show through any cracks in the leaf once it had been applied, creating an effect much like the veins of colour in marble. Grimm (1999) records another instance, where a layer of Egyptian blue was applied under gilding to some areas of the headdress of a wooden coffin mask found in Thebes and dating to Dynasty 17. Hatchfield and Newman (1991) also mention ‘thin colored layers (bole) applied over gessos [that] consist of earth pigments or ochres that contain clay’ in ten different objects made of stone, metal and plaster.

Many examples of black pigment on Egyptian objects have been analysed and most consist of some form of carbon (Lee and Quirke 2000). The black colour that lay underneath the gold leaf on sample 2 was totally opaque and could be seen underneath the gilding in those areas where the gold leaf had been scratched or removed (Figure 9). In cross-section, it was evident that the black layer is not uniform in thickness and it was almost non-existent in some areas. Elemental analysis of the black pigment showed that it was made up mainly of carbon and nitrogen. The presence of carbon conforms with what was published by Lee and Quirke (2000: 108) and Middleton and Humphrey (2001: 12). The presence of nitrogen in the sample could be due to the use of glue as a binding material. This contains collagen, a natural polymer formed from nitrogen-containing amino acids (Newman and Serpico 2000: 481).

2.6 Gilding Layer

Gilding is the technique whereby thin sheets of gold are applied onto a firm support to achieve the rich appearance of solid gold.
Gold leaf was made by hammering thin sheets of pure gold, or gold alloyed with small amounts of silver, copper or other metal (Hodges 1981: 95). The wide range of variation in the composition of gold leaf is unrelated to date of manufacture in ancient Egypt, moreover, the ‘production of extremely thin gold leaf was not dependent on the availability of extremely pure gold, whether from native or refined sources’ (Hatfield and Newman 1991: 30). There is a wide variation in the use of the terms gold foil and gold leaf but, following Lucas and Harris’ definition of the latter as a sheet that has a thickness of 0.01–0.09 mm (10–90 µm) (Lucas and Harris 1962), the term ‘gold leaf’ will be used to describe the samples discussed in this paper.

Parts of the samples were prepared for surface examination and as cross-sections for metallographic examination. The cross-sections were mounted in polyester resin and polished with a graded sequence of diamond pastes. These sections were examined under a polarising microscope, photographed and analysed using ESEM-EDS. They were etched using Aqua Regia (60% nitric acid (HNO₃), 40% hydrochloric acid (HCl)) but no microstructure was revealed, even when the etching time was extended up to one minute. The set of unmounted samples was sputtered with gold so that both the gilded and the non-gilded areas could be studied using low-vacuum SEM.

The colour of the gold layer is different in each of the three samples. Sample 1 shows a distinctive dull, reddish-brown layer that was originally thought to be either a cuprite layer (due to selective corrosion of copper in the gold) or due to the presence of iron. During the mounting of sample 1, the gold layer was detached and adhered to the base of the mounting cup, thus allowing the examination of the reverse side of the leaf. The considerable difference in colour between the two sides of the foil was studied using EDS analysis; the results indicate that the main components of the gold alloy – reverse side – are gold, silver and platinum. The analysis of the red-gold surface, on the other hand, revealed enrichment in silver and sulphur (Figures 10 and 11, Table 3).

This red-gold surface, however, does not resemble a corrosion layer. We suggest that it may result from an intentionally applied coating rich in silver and sulphur.

Sample 2 has a yellow-gold colour. EDS analysis indicated that the main component of the alloy is gold, with a small amount of silver in the core that increases in quantity at the surface. The variation in composition between the inner core and outer surface in sample 2 may be due to the selective corrosion of silver and this is further confirmed by the presence of sulphur and chlorides on the surface (Table 3). The gold leaf ranges from 14.1 µm to 19.5 µm in thickness (Figure 12).

Sample 3 has a bright, yellow-gold colour and is nearly pure gold. The thickness of the gold leaf is not uniform and ranges from 23.1 µm to 47.9 µm (Figure 13).

3 DISCUSSION

Gilding was a popular means of finishing or decorating timber in ancient Egypt, dating back as far as c. 2900 BC (Gale et al. 2000: 366). It was usually applied on top of a gesso layer, so the quality of the timber core was less important than for objects where the wood surface was visible. As a result one would expect gilding to be found on poor quality local wood rather than on the better quality imported timber, even for high-status objects. For example, the woods used for a Dynasty 17 gilded coffin mask that belonged to a woman of royal descent were identified as tamarisk and sycomore fig (Grimm 1999). However, the Tutankhamun samples discussed here were made from the foreign timbers cypress and cedar of Lebanon, even though they were subsequently gessoed and gilded.

All wood samples were found to be in a fairly good state, and Waly (1996) managed to prepare transverse and longitudinal sections at 30–50 µm for light microscopy. Often the preparation of such sections is not possible in archaeological, dry wood. The SEM micrographs clearly show that there was no sign of microbial attack at any stage during burial and there is no evidence of hyphae or microbial spores in the wood cells. The only problem observed in the wood is the presence of microcracks and fissures along the tracheids, which may be attributed to the temperature and humidity changes that Carter (1963) mentioned. The wood cell walls are intact, showing none of the signs of collapse or separation of cell wall layers that are usually found in archaeological wood. The horizontal cracks in the tracheids are probably due to the use of sharp tools. The buckling and loosening of the gesso layer that Carter (1963) mentions are natural phenomena in all polychrome wood, due to expansion and contraction of the wood. These phenomena cannot be prevented unless the object is placed in a controlled and stable environment. Certainly, the textile and gesso may partly absorb some of the movement of the wood, and thereby lessen the cracking and flaking of the gold leaf, but the gesso layer itself may also suffer from the continuous changes and separate from the wood over time.

It was not clear why a black layer had been applied underneath the gilding in sample 2. Several sources mention the use of other colours, such as yellow and red ochres and Egyptian blue, as a base for gilding (Hatfield and Newman 1991; Grimm 1999; Taylor 2001). The black found in this sample consisted of a form of carbon, which confirms the findings and analysis of black colours, in general, from earlier studies (Green 1995, 2001; Middleton and Humphrey 2001). Carter (1963: 181) mentioned that ‘black pigment used in this tomb was not in sufficiently fine state of division to be soot unless in a very impure condition and was probably powdered charcoal’.

Research has been conducted into the red surface colorations found on ancient Egyptian objects (Frantz and Schorsch 1990). Different hypotheses have been suggested. Lucas and Harris (1962: 233) mentioned that ‘the colours of gold whether sheet or gilt varied sometimes in patches and sometimes over the whole surface. The colours comprised bright yellow, dull yellow, green, grey and various shades of red, including reddish brown, light brick colour, blood colour, dull purple and a very remarkable rose colour.’ They add that all the colours except rose gold are due to chemical changes that had taken place while the objects were in the tomb. Possible reasons are tarnishing or selective corrosion of base metals intentionally or unintentionally alloyed with gold, or staining of the gold with an organic matter, while the rose gold colour is attributed to an applied translucent coating of iron oxide. The samples studied in the current research displayed a wide variation in colour from reddish brown to yellow and bright yellow colours. The yellow gold (sample 2) proved to be almost pure gold, while the
Figure 10  Sample 1, showing the difference in the appearance and colour between the surface (exhibiting red colour) and the reverse side: a) red surface (optical microscope × 10); b) reverse side (polarising microscope × 50).

Figure 11  a) The surface of the red gold layer in sample 1, showing the structure of what appears to be an intentionally applied coating. SEM micrograph; bar = 10 µm. b) Magnified detail of the “coating”. SEM micrograph; bar = 10 µm.

Figure 12  a) A cross-section of sample 2, showing the single gesso layer with gilding on top. SEM micrograph; bar = 1 mm. b) Thickness of gold leaf, ranging from 14.1 µm to 19.5 µm. SEM micrograph; bar = 50 µm.

<table>
<thead>
<tr>
<th>Sample</th>
<th>Au</th>
<th>Pt</th>
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<th>Fe</th>
<th>Cu</th>
<th>S</th>
<th>Ca</th>
<th>Cl</th>
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<td></td>
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<td>7.44</td>
<td>12.30</td>
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<td>4.27</td>
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Table 3  Elemental analysis of the gilding layer using EDS
Therefore, the elemental composition of the total variation observed in all investigated gold artefacts does not provide any reliable information on the provenance of the gold.

Ogden (2000: 169) indicates that ‘Platinoid inclusions have been noted in Egyptian gold work as early as the Old Kingdom. The inclusions are seen in many gold objects from Egypt and are typically primarily iridium, osmium, ruthenium alloys. Platinum metal grains occur mainly in alluvial deposits. However, a combination of gold and platinum metals is found in some secondary deposits and it is not unusual for gold and platinum metal bearing rocks to occur in proximity’. Junk and Pernicka (2003: 313) mentioned that although ‘...it was hoped that [platinum-group mineral (PGM)] inclusions could be characteristic for a certain deposit ... the compositional variation within a single gold object can be as large as the total variation observed in all investigated gold artefacts. Therefore, the elemental composition of the PGMs in gold artefacts does not provide any reliable information on the provenance of the gold.’

The composition of the reddish-gold surface colour on sample 1 was studied, and EDS analysis revealed the presence of silver and sulphur. These results agree with those of Frantz and Schorsch (1990), who identified the species responsible for the predominant reddish-purple coloration as silver–gold sulphide (AgAuS), a compound sometimes found in nature as the mineral petrovskite. They suggest that these tarnishes reflect the high sulphide ion activity associated with the typical contexts of sealed burial chambers, as well as the naturally occurring gold–silver alloys used in antiquity. A similar phenomenon has been noted on modern gold coins: Gusmano et al. (2004) analysed red stains on a collection of Austrian coins using multi-technique surface analysis. From X-ray photoelectron spectroscopy (XPS) results, it was concluded that the coloured stains consist of silver sulphide (Ag₂S). However, the SEM micrographs of sample 1 in the current study show a layer that resembles an applied coating and not a corrosion product or tarnish. Another possibility is the presence of modern ‘melted paraffin wax used in order to consolidate and preserve the gilt plaster’ (Lucas and Harris 1962: 433) that may have remained on the surface and discoloured the gilding; however, the surface of the sample was unaffected when tested for solubility.

4 CONCLUSION

In the samples studied, two important layers were applied between the wood and gold leaf. On each sample, linen textile had been glued onto the wood. This was then covered by a second layer of gesso. In samples 1 and 3, rough gesso was overlain by fine gesso. In sample 2, a rough gesso layer was overlain by a layer of black pigment, applied between the gesso layer and the gold leaf. It is interesting to note that, although the samples come from the same group of objects in a single, undisturbed tomb, the materials used varied widely. It is common to find different types of wood in one object, due to the scarcity of wood in Egypt, and it is possible to find differently coloured gold leaves on one artefact but it comes as a surprise to find that the techniques and materials were so varied and different in the chosen gilded samples.

REFERENCES


