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The Recessed Apertures of the Holy Crown

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Abstract

One of the most important questions in the study of the Holy Crown concerns the technique of making the enamel cloisonné. The importance of this is that the manufacture of cloisonné enamel reached its peak in the 10th and 11th centuries in Byzantium and Western Europe. The figural enamels of the Holy Crown are all images of top-quality products of this process. Archaeometric analysis of the Holy Crown has not been carried out. My work attempts to fill this gap. The knowledge of the techniques used will help to determine the place and time of the various parts. For the time being, the aim is to recognise the techniques only from the colour side, but if possible from both sides. With this tutorial I would like to describe what I have learned so far.

Keywords: *Holy Crown, diaphragm making, archeaometry.*

1. Technical evolution of the émail cloisonné

The enamel itself, known in French as émail cloisonné, is made of glass. It is not crystalline like ceramics, but amorphous. The enamel is made by fusing several layers of different coloured glass powder into a recess delimited by metal walls – the recipient. The different coloured parts of the image are separated by strips.

The study deals exclusively with gold recipes made using the sunken sandwich technique, which were used in Byzantium and Western Europe from the 10th to middle of the 11th centuries. All the figural enamel works on the Holy Crown (a total of 19) were made using this technique. The sandwich construction of the recipient is due to the fact that they are typically made of two layers of plates soldered together, and the lower plate is often recessed.

Figure 1. *Vollschmelz (full) enamel on the main panel of the Martvili Triptych, Tbilis.*

1.1. The Vollschmelz (full melt) enamel

By definition, the Vollschmelz of full enamel fills the entire surface of the plate. To achieve this, the edge of the plate was folded up or, alternatively, a thicker sub-plate was framed around it. This was necessary to prevent the molten glass from flowing over the edge; this can be observed in **Figure1**

1.2. Recipient with cut-out, sandwich structure

In this case, two plates were soldered together. A piece of the upper one was cut out where the enamel is visible and then soldered on top of each other. The depth of the recipient is thus equal to the thickness of the upper plate. This method of making the recipient evolved naturally from the solution shown in **Figure 2.** If the recipient is created by soldering two plates together, I call it the sandwich technique.

1.3. Sandwich technique combined with sinking

In my opinion, it was realised early on that considerable savings in gold could be made in the production of enamel images if the required depth of the recipient was not achieved by using a thick and a thin plate, but by sinking the lower of the two thin plates.

The same procedure was used for all the figurative pictures of the Holy Crown, regardless of where they were made - in Western Europe or Byzantium. The present study focuses on this type of technical realisation. The aim is to formulate criteria that will allow us to identify, from the colour side only, the way in which the recipient was executed. By defining the recipient created, we can obtain important information for determining the date and place of the Holy Crown's creation. Still, the use of chronology justifies the presentation of this technique alongside the practice of the earlier (full melt) and subsequent ages, the Limoges and the „only" sinking techniques.

1.4. Recessed recipients

By the turn of the 10th and 11th centuries, gold was running out in the West as well as in Byzantium. In Byzantium, from the second third of the 11th century onwards, recipients were not made using the sandwich technique, but simply by sinking a thin gold plate. The earliest compartment enamel I know of made using this technique is the Monomachos Crown (1045-1050) from the Hungarian National Museum (MNM).

One of the reasons why this work of art was described as a technical forgery by Nicolas Oikonomides was precisely because of the simple technique of sinking [1]. Other enamel paintings made with a similar technique were identified later, as shown in Figure 5 (c. 1100). By this time, Byzantine enamel was already used mainly in opalescent (not translucent, similar to polished marble) enamel. Another striking feature is the denser walls of the compartment strips.

1.5. Limoges or champlevé enamels

From the middle of the 11th century until the second half of the 12th century, there were no gold compartment enamels made. This may have been partly due to changing fashions, and partly to the extreme shortage of gold in the German-Roman Empire (no gold coins were minted for a long time after 1000), while in Byzantium (mainly due to warfare) the gold stock was extremely low. In the 12th century, gold enamels were replaced in

Figure 2. *Christ on enamel medallion, Cleveland.*

Figure 3. *11th century medal, Metropolitan Museum of Art (MET) (colour side-on left; back side-on right).*

Figure 4. *Image of Christ with sandwich recipient, British Museum, London.*

Figure 5. *Byzantine Christ, enamel c. 1100, Metropolitan Museum of Art (MET).*

the west by so-called champlevé enamels. In this case, recesses were made in the copper or bronze (sometimes silver and very rarely gold) plates by engraving ‚pits'. Importantly, the enamel they used was light-absorbing, opalescent, so it did not glitter like the earlier diaphragm enamels (German: Grubenschmelz; hence the term „pit enamel".

2. The technique of the sandwich recessed diaphragm recipient

From the 10th century onwards, the relationship between Byzantium and the German-Roman Empire became very strong. This was thanks to the efforts of Princess Theophanu, who arrived in Italy on 14 April 972, thanks to the efforts of Otto I (the Great), who did everything he could to re-establish the Roman Empire, but Byzantium considered itself the heir to the Roman Empire, and in fact despised the Frankish Empire. The result of Otto's long and intense efforts was that Otto II was eventually able to bring a wealthy, high-ranking princess from Byzantium, but not from the narrow imperial family. Theophanu arrived with a huge court and dowry, and was married to Otto II. From then on, countless documents have survived confirming the strong Byzantine influence. A bilingual hymn-book, codices, clothing, carpets, textiles and, last but not least, importantly for us, Byzantine-style gold enamels belonging to strict Christian religious artefacts, relics or depicting saints. In 983, after the death of Otto II, Theophanu reached the height of his power as regent of the German-Roman Empire. The Greek language and style was mixed with Latin on countless works of art produced at this time. Numerous works of art from this period mix Greek language and style with Latin. The first Byzantine enamel I know of and date, made using the recessed-sandwich technique, is the Preslav hoard, dating from the first third of the 10th century. The treasure, which was restored in Mainz, was described by Antje Bosselmann-Ruickbie [2]. The lower plate of the two-layer recipient is about 0.1 mm thick and is pure gold, while the upper plate, from which the contour was cut, is 0.2 -0.3 mm thick. The lower plate was deepened by trébing. It is probable that the technique of recessed sandwiching in enamel was first used in Byzantium. I do not know of any enamels made in Western Europe using this technique from the first half of the 10th century.

As can be seen from the above, enamel making is a multi-phase process and it is therefore necessary to examine the process, the advantages and the time of use of the solutions. In Theophanu's time, enamel works became widespread in Western Europe, north of the Alps. The enamel paintings created at this time were of two styles.

The first, with the previously known full-enamel technique, and the second with the recessed sandwich technique. In this period, the recessed sandwich technique was more common. This was also verifiably in use in the art workshops that Egbert managed.

Since all the figural enamel paintings of the Holy Crown are made using the recessed sandwich technique, a thorough knowledge of this technique is required. Latin and Byzantine languages are also mixed on the Holy Crown, which was more common in the late 10th and early 11th century artefacts, in the Saxon Liudolfinger period, and even characteristic of Ottonian objects, so much so, that until the end of the last century many decorative enamel plates in Western Europe were believed to be of Byzantine origin.

Among the mixed Byzantine and Eastern Frankish monuments of the Ottoman period, the Pericope of Henry II (Bible fragment) and the Morgengabe cross stand out, but we must not forget

Figure 6. *The Death of Thomas Becket, Limoges enamel, c. 1180. V&A, foto: Marie-Lan Nguyen.*

Figure 7. *Enamel pulp on the Preslav site, Bulgarian National Museum.*

the Relic of St. Marius, the most outstanding piece in the Essen treasury, which was unfortunately destroyed during the secularisation (**Figures 8–9**).

It is scientifically certain that the ring of the tyre on the Holy Crown was aligned with the cross-strap, and that the pediment, the pendilias and other parts were mounted on the hoop according to the cross-strap. It is also likely that the integral cross-strap was made in the Egbert workshop. Consequently, if it can be shown that the six definitely original enamel figures on the hoop are from the 10th century, then the greatest likelihood that the Western and Eastern enamels, created at almost the same time at the end of the 10th century, were on the same artefact is precisely in the Ottoman Empire. Although I have searched through some 2,000 enamels, relics and other artefacts from Byzantium and West of it, I have not found any artefacts, certainly made around 1,000 AD, which would have featured enamels from the two geographical areas in question at the same time, anywhere other than in the German-Roman Empire. This fact is confirmed by the similarity of the strap widths and the two Pantocrator images of the same size and appearance.

To determine the age of enamel works, it may be important to know the materials and technology used. To this end, we have set ourselves the goal of investigating whether it is even possible to identify this technique of making the recipients from the colour side (front side) of the images.

The recognition of the recessed sandwich enamel images is not always easy, since it involves the combined use of two different recipient-making techniques. The first is the sandwich (subsection 1.2), the second is the embossing (subsection 1.4). To understand this complex technique, they are first discussed separately.

2.1. The sandwich recipient

A pure sandwich recipient, which consists of two sheets of gold soldered together, is often impossible to recognise. Sometimes it cannot be distinguished from engraving. The question is, how can one tell that the medallion in **Figure 3** is not engraved? In this case, the fact that the top left side of the head has a damaged plate (**Figure 10.** and **11**). is helpful. In this case, a damage on the edge of the enamelling will help us to recognise it from the colour side. At the time of the damage, the edge of the recipient is turned out and it is possible to see well into the bottom of the recipient. The fact that it is turned out is evidence that the bottom plate is much thinner than the top plate. This is confirmed by the injury shown in the image on the back. High quality images are needed to identify it, but even then it is difficult. It is also advisable to examine the edge of the plate carefully. This requires either a high-resolution 3D digital model nor a stereo microscope. In the

Figure 8. *Prayer book of Henry II Pericope (Munich).*

Figure 9. *Henry II, detail of the Morgengabe cross, after P. Schramm.*

Figure 10. *Detail from Figure 3.*

Figure 11. *Detail from Figure 3.*

case of the Holy Crown, as the crown cannot be examined, it is essential to have a 3D computer-processable model.

In the 10th and 11th centuries, the sandwich recipient was used not very often, but it was used. The fact is that until the end of the 20th century, we knew too little about the types of recipient used or even how to recognise them. In Hungary, D. Buckton was the first to draw attention to the variations of recipients when he described the „Latin crown **[3]**. From the 12th century onwards, when cloisonné enamels were replaced by champlevé enamels, the recesses in the copper plates were already engraved, and it was even necessary to vary the depth of the engravings for stylistic reasons. The depth of the recipient of the gold diaphragm enamel is constant. Another aspect is that engraving creates chips of variable size, which have a greater loss than cutting, and this is an important consideration for gold. It is therefore easy to understand why the sandwich technique was preferred to the kidney technique for cloisonné enamels. This idea should also be considered in the light of a more recent and thorough examination of the Reichskrone enamel plates, which are considered to have been made by engraving **[4].**

In summary: the upper plate is thick, the cut edges of the contour are intact, sharp and defined. From the reverse side, the lower plate is not completely smooth. This is often due to heating.

2.2. The sandwich recessed recipients

Recognition of the sandwich technique is much easier if the reverse side of the enamel plate is known. Note **Figure 4.** What is immediately noticeable are the recesses of the letters. These are not visible on the reverse side, whereas where the Christ image is visible, the recesses are also visible on the reverse side. So, in similar cases, where the front and back can be examined, there is no particular difficulty in recognising them. The aim of this study is to identify features that will allow us to determine the process from the colour side of the enamel (front side).

Before demonstrating, by means of concrete examples, the processes used in different workshops, it is necessary to assess the possibilities. From an engineering point of view, the possible technological sequence is as follows:

1. the outline of the enamel image is drawn on a thin plate, the upper one. This is then cut out.

Two options are then possible:

a) 1.a. First the two plates are soldered together, and then the countersinking.
- 2.a. The lower plate and the upper plate are welded together.
- 3.a. The lower plate is recessed where the upper plate is cut out. The advantage of this procedure is that the recess will often be within a few tenths of a millimetre of the cut contour.
- 4.a. The compartment strips are then placed in the recess and soldered in place.
- 5.a. Enamelling follows in several steps.

b) 1.b. First the recessing and then the soldering.
- 2.b. The contour is also drawn on the bottom plate.
- 3.b. The drawn contour is recessed. In this case, in most cases the upper edge of the resulting recess is larger than the cut-out of the upper plate. This may often have been intentional.
- 4.b. The compartment strips are inserted into the bottom sheet and soldered to the top plate at the same time. In this case, the compartment strips are often intentionally placed under the top plate, and often the strips are inserted under the edge of the top plate in the same direction as the top plate. In this way, the strips may be in contact with the edge of the contour.
- 4.c. An alternative to the previous solution is to solder the joints one after the other, rather than all at once. This can be done by soldering the compartment strips first and then the top plate. The result is as above, so the strip can be placed under the top plate. But it is also possible to solder the two plates together and then press the strips under the top plate.

Before we go any further, let us first examine **Figure 4.** The most characteristic descriptive signs of the technique in question:
- 1. the relatively low gold consumption,
- 2. the recipient is cornered, forming a precise transition at the junction of the gold and glass at the face of the plate.
- 3. The „b” or „”c” versions have a more closed edge at the corners and are therefore much less sensitive to contours.

The simplest technological process of the recessed sandwich process is to solder immediately after cutting the top plate and then to recess it. In other words, the recipient is formed according to procedure ‚a’ above.

The countersunk sandwich process is the result of a clear process that started with the full enamel, continued with the sandwich technique and reached the highest level of enamel art with the recessed sandwich recipient. I believe it started in

Byzantium and was carried over into the practice of the Egbert workshop. Now let us look again at **Figure 4.** What stands out is the nimbus of Christ, and within it the cross belonging to the nimbus. The two horizontal cross stems belong to the upper plate, but the vertical stem is separate, separated from the upper plate.

So, if you look at the back of the plate, you can see that the nimbus of Christ is completely recessed, even where the cross-bars are.

This means that they were recessed before the two plates were welded together. This procedure offers several possibilities. If the recessing is done before the two plates are welded together, it is possible to extend the recessing beyond the contour. The reverse side of **Figure 13.** shows that the sandwich design has been made with the bottom plate smaller than the face plate. This also occurs so that even less gold is needed. The point, however, is that Peter's right hand is much more graceful than it appears on the reverse.

It follows that a wider recess than that shown in the enamelled image was intentionally used. But further special solutions were also possible, namely to allow the partitions to reach the edge of the cut-out contour without obstruction, and even to intentionally push it underneath. In the case of letter designs, such as the letters O, P, A, etc., it was necessary to replace the part that had fallen out, which, when the partitions were soldered, were also inserted. Letters were not usually countersunk, but they were often not countersunk for staves, cross stems, spears, etc., which were outside the figure. In these cases, the enamel layer is of small thickness and therefore the enamel has often fallen out as shown in **Figure 13**.

In **Figure 12** are some examples from the Trier-Essen workshop to illustrate this procedure. The noteworthy specialities are shown with arrows. All of the examples shown are from the Trier-Essen workshop and are all from before 1000.

3. Recognising the sandwich technique from the colour side

A way to create a recess in a thin plate other than a sandwich technique is to create a recess in it by embossing: **Figure 14**. The recessing by embossing involves the sheet hardening at the point of plastic deformation, and the resulting near-vertical recess wall supporting the part of the sheet that has not been embossed. Therefore, when later pressed from the face of the enamel picture, as on a decorative book cover, the con-

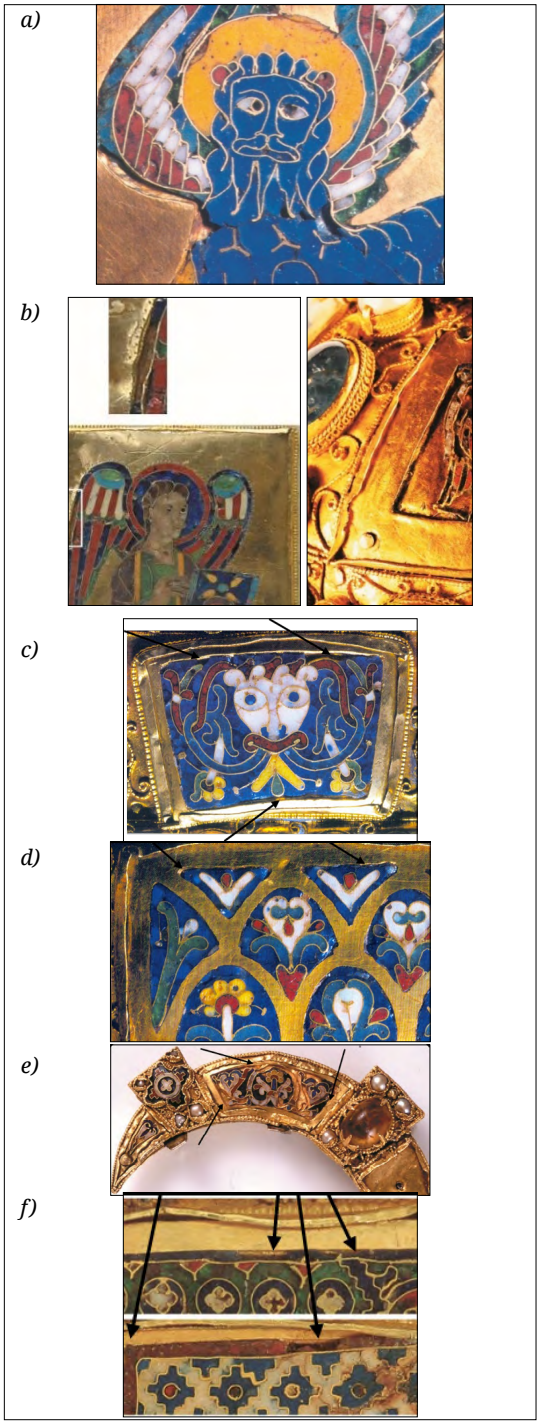

Figure 12. *a) Cross with the large countersunk melts, Dom Essen; b) Peter's staff, Dom Limburg; c) Egbert shrine, Dom Trier; d) Cross nail reliquary, Dom Essen; e) Theophanu cross, Dom Essen; f) Chris nimbus, Dom Essen; g) Images of the apostles from the Holy Crown.*

tour is accentuated. The features that emerge from the colour side (front side) in the case of simple recessing are as follows.

– The edge of the outline, which is visible from the colour side, is rounded, smooth and blunt along its entire length. This is unavoidable, but is particularly noticeable on thin gold plates. One can assume that for the more demanding enamel designs, this was precisely the reason for choosing the more complex sandwich construction. In the latter case, the transition between enamel and gold is much more perfect.
– If this enamel plate has been subjected to pressure from the colour side, then, as in the case of the image in **Figure 14**, a pronounced bend is visible from the colour side.

Colour-side characteristics of recessed sandwich enamel plates:

1. The top plate had to be cut out where the enamel was placed. The cut is clearly distinguishable from the rounded edge at a higher resolution. The edge is sharp. The cut was usually made with a sharp tool.
2. In this case, the cutting edge is left with burrs, material that is often applied to the enamel surface by post-grinding: **Figures 15** *c.* and *e.*
3. The cutting out of the letters, because of their size and the absence of a tool specially designed for this operation, is rather irregular in contour: **Figure 15** *b.*
4. If the upper plate is damaged during cutting, the recipient is enlarged there **Figure 15.** *k.*
5. In the case where the enamel and often the diaphragm go under the top plate, the top plate and diaphragm may also fuse together during soldering; creating thickening and special shapes that are unique to the recessed sandwich construction **Figure 16.** *h.* and **Figure 17.** *h.* or **Figure 4.**
6. The diaphragm wall must not go under the top plate if the recessing has been made after the two plates have been welded together. Therefore, this technique can only be detected if enamel has fallen out at the already thin edges. In this case, it is notable that the beginning of the sinking of the lower plate becomes visible below the thickness of the upper plate: **Figures 12.** *a–g.*
7. Often the upper plate is damaged and peeling occurs. See under details **Figures 15.** *c; f; g; i; j.*
8. It is interesting to note that the technique of the recessed sandwich has been known to almost all enamel experts since the last third

Figure 13. *Enamelled image of St Peter, MET.*

Figure 14. *Enamelled image of St Nicholas, MET.*

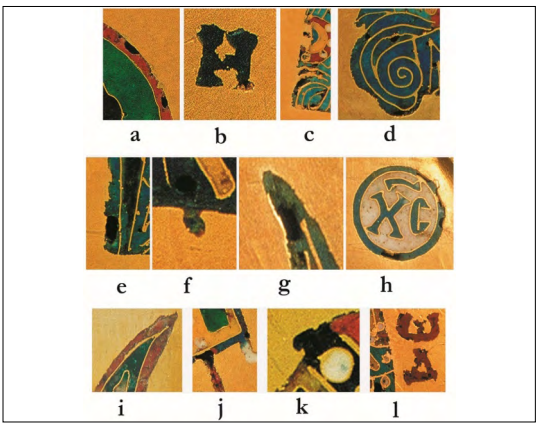

Figure 15. *Recognising the sandwich technique from the colour of the Holy Crown enamel images.*

Figure 16. *Recognising the sandwich technique from the colour of the Holy Crown enamel images.*

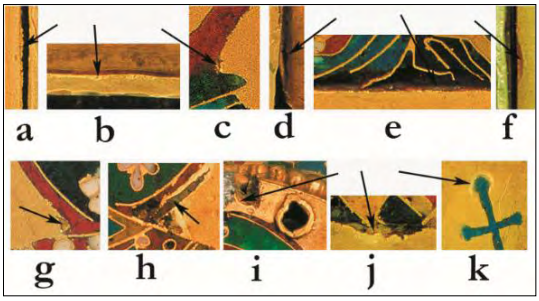

Figure 17. *Recognising the sandwich technique from the colour sides of the Holy Crown enamel images.*

Figure 18. *Recognising the sandwich technique from the colour side, Bibliotheca Marciana, Venice.*

of the 20th century, but unfortunately it is ignored in Hungary. My own observation is that the Byzantine enamel workshops were characterised by the technique of recessing the plates first and then soldering them together. I detect the same thing on the lower part of the Holy Crown. As an example, here are some Byzantine enamel plates of the Bibliotheca Marciana book cover in Venice: (**Figure 18**).

The features described above are also clearly visible in Byzantine enamel paintings from the 10th century. I have marked them with arrows.

In the case of the enamel medallions in the Cathedral of San Marco, it is noticeable that the enamel wall is smeared in many places on the enamel. Typically, this is very noticeable when there are defects or air bubbles left in the enamel.

4. Recognise the sandwich technique if both sides of the enamel picture are known

Recognising the sandwiching from the side is not always possible. If the enamel is intact and the edge is covered, the sandwich technique can be recognised from the colour side, but the countersinking can only be determined from indirect signs. Such a sign could be, for example, the recognition of the edge of the letters. As you know, the unevenness of the edges of the letters is characteristic of soft and thin plates. Thick plate usually provides better edges. Backside characteristics: not all the colour-side enamel elements appear to be bulged on the backside. Think here of the letters or parts that fall outside the body, such as the stick, cross, spear, etc.

It is also advisable to use a computer. Take a photograph of the front and the undersides. In the computer, we make a vertical mirror image of the back and superimpose the colour side and the mirror image. We align them exactly according to the edges. If the recessed contour on the back is larger than the enamelled surface then this is obviously a sandwich technique, and the one I have seen above in the Greek enamelling technique, and in addition it is of better quality. If the recessed contour is everywhere less than or equal to the size of the enamel, then you must first ascertain from the colour side whether you are dealing with the sandwich or direct recessing technique, as per the properties listed above. If we are satisfied that it is, then it was probably made according to technique 3.2.a, i.e. the sandwich plate pair was created first and then countersunk.

Figure 19. *Recognition of the technique from the colour: St. George and St. Cosmas, San Marco, Venice*

5. A summary of the recessed sandwich technique

The technique is most often clearly recognisable from the colour side of the enamel picture. This technique was used around the first millennium in Western Europe and also in Byzantium for gold recipients. There is a difference between the processes used north of the Alps and those used in Byzantium, so it can be an important reference for the location and time when the enamel was made. Thus, the enamel pictures on the Holy Crown could not have been made at any other time than this period. After this period, the production of gold enamel stopped north of the Alps, while in Byzantium they returned to full enamel or simple recessing and switched to the use of opaline glass. There was no other way of soldering the two plates together than the so-called reaction soldering, which had been forgotten for centuries and which allowed for repeated soldering in several steps. It is thus possible that the figural enamel images of the crown could have been made by a later forgery.

References

[1] N. Oikonomides: *La couronne dite de Constantin Monomaque, in Travaux et Mémoires.* Centre de Recherche d' Histoire et Civilisation de Byzance, 12, 1994, 241–262.

[2] A. Bosselmann-Ruichbie: *Byzantinischer Schmuck des 9. bis frühen 13. Jahrhunderts*. Reichert, Wiesbaden, 2011, 88.

[3] Buckton David: *Vorläufige Ergebnisse einer optischen Untersuchung des Emails der Krone*. In Ferenc Fülep – Éva Kovács – Lovag Zsuzsa: *Insignia Regni Hungarie. Studien zur Machtsimbolik des mittelalterlichen Ungarn.* MNM, Budapest, 1983. 129–144.

[4] S. E. Eckenfels-Kunst: *Goldemails*. Pro Business, Berlin, 2008, 135.