

## LOCATION AND DEVELOPMENT OF FINGERPRINTS ON EURO BANKNOTES. PRELIMINARY REPORT

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**ABSTRACT:** Introduction, Information on the production of Euro-notes, Luminescence properties of Euro-notes, Specimen fingerprinted surfaces, Selection of fingerprint development methods, Application and evaluation of fingerprints, Results, 5-day old fingerprint residues, 20-day old fingerprint residues, 3-month old fingerprint residues, Recommended procedure for locating and developing fingerprints, Summary. Fluorescence photographs of € 100 banknotes. The cover picture shows the obverse of a € 100 note under UV light illumination.

**KEY WORDS:** Fingerprints on Euro banknotes; Development methods.

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### INTRODUCTION

The process known as “frontloading” – distributing the Euro currency to credit institutions and businesses – has been under way since 01.09.2001, and on 01.01.2002 the Euro will become legal tender.

The first Euro banknotes lost due to criminal activity (robbery from a security van on September 6, 2001 in Lich, Hessen) have now been recovered.

Thus the topical question arises as to which methods are suitable for locating and developing fingerprints on Euro banknotes. Due to, perhaps, a different type of paper, special printing techniques or surface treatment, the possibility exists that the tried and tested methods suitable for DM banknotes can no longer be used with the requisite prospect of success.

It is questionable whether the new banknotes can still be regarded as “porous” substrates or, on the contrary, as “non-porous” substrates and therefore whether different fingerprint development methods have to be employed.

The Departments KI 24 (Fingerprint Development Methods, Operational Technology and Support) and ZD 12 (General Scene of Crime Unit) of the Federal Bureau of Criminal Investigation (BKA) therefore carried out

a series of experiments with the aim of determining the most effective method of locating and developing fingerprints.

#### INFORMATION ON THE PRODUCTION OF EURO-NOTES

The paper for the Euro banknotes is manufactured according to the ECB (European Central Bank) specifications. There are narrow tolerances for the products from the various manufacturers, although the tolerances can only be determined with special instruments.

In Germany, the paper is manufactured at the Louisenthal Paper Factory in Gmund on the Tegernsee.

The paper concerned is the same as for the DM-notes, which consists of shortened and split cotton fibres. Various security features (for example, fluorescent fibres) are incorporated into the paper during manufacture. Once dried, the surface is sized with a synthetic resin dispersion in order to increase water and abrasion resistance.

A whole range of techniques (e.g. intaglio printing, offset printing, screen printing, letterpress printing) is employed for their printing. One security feature is the use of a fluorescent ink for certain motifs on the banknotes.

In the case of the 50–500 notes, a foil patch bearing a hologram (kinogram) is applied using pressure and heat. There is no longer any surface finishing treatment.

#### LUMINESCENCE PROPERTIES

As the UV fluorescence of the banknotes may interfere with certain fingerprint development techniques (for example, UV stains, DFO), the different banknotes were first illuminated with light of different wavelengths (Polilight) and examined both with and without inspection filters. A digital camera (Kodak DCS 420) was used to produce a photographic record (see Appendix).

The strongest fluorescence was obtained with an excitation wavelength of 350 nm (long wave UV light), and therefore the use of DFO with an excitation wavelength of 450–570 nm should not be excluded. However, it is not possible to use fluorescent powders or stains such as basic yellow 40 (BY 40) which are excited by long wave UV light.

## SPECIMEN FINGERPRINTED SURFACES

The German Federal Bank provided the BKA with genuine Euro banknotes (specimen sets marked as invalid) for its experiments. The notes originated from different national banks and were therefore produced by different printing works.

The fingerprinted surfaces were Euro banknotes in denominations of € 5, € 10, € 20, € 50, € 100, € 200 and € 500. As it was not necessary to have a complete note for the experiments, all the notes were cut lengthwise into three equal-sized pieces.

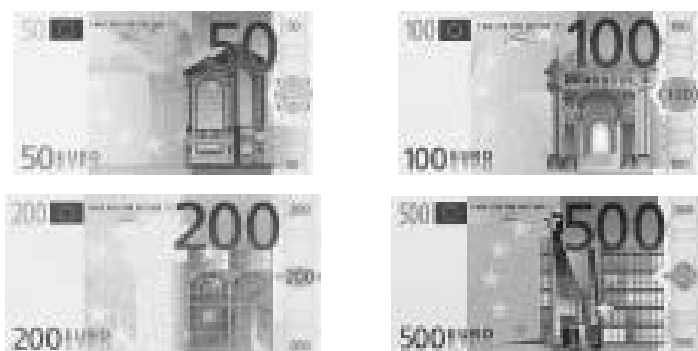


Fig. 1. € 50, € 100, € 200 and € 500 banknotes.

## CHOICE OF THE PROTOCOL FOR FINGERPRINT ENHANCEMENT

In accordance with our remit of finding the simplest possible method, the following fingerprint development methods (for descriptions see LF 385) were chosen for this series of experiments:

1. magnabrush brush and powder;
2. iodine fumes;
3. cyanoacrylate fuming (followed by vacuum metal deposition);
4. ninhydrin – dipping method (ninhydrin-petroleum-benzene NPB).

In addition, we included:

5. sequence DFO-/Ninhydrin-dip;  
and the new technique currently under trial:
6. ninhydrin sublimation.

For the sequential methods of cyanoacrylate/vacuum metal deposition and DFO/ninhydrin dip, the development of fingerprints was checked after each individual technique.

The samples treated with both the ninhydrin dip and sublimation methods were then placed in a humidity chamber at 50% RH and 50°C for 20 min.

On account of the deadlines set for this series of experiments, we omitted any other fingerprint development methods for this study.

## DEPOSITION AND EVALUATION OF FINGERPRINTS

Fingerprints were collected from two colleagues, who are usually regarded as “good donors”. To do this, they held the banknotes firmly between index finger and thumb. In this way, the prints were left in each of the three areas of the specimen surfaces: unprinted, printed and foil.

In this investigation, 5-day, 20-day and 3-month old fingerprints were considered.

Only visualisation of the fingerprints was of relevance for evaluation purposes, i.e. whether they could be rendered visible and whether ridges were then clearly visible and well contrasted with the background. We ignored any evaluation of the fingerprints in respect of their basic pattern and number of features.

## RESULTS

### 5-day old fingerprints

#### *Magna brush*

Magna brush powder was applied to the fingerprinted surfaces with a magnetic rod. Fragments of ridges were rendered visible on only some of the banknotes on the foil areas.

The method is fundamentally unsuitable (Figure 2).

#### *Iodine fuming*

This method is suitable only for fresh prints. In this study, only fragmentary ridge detail was developed from a few banknotes.

The method is fundamentally unsuitable (Figure 3).

#### *Cyanoacrylate fuming (followed by vacuum metal deposition)*

Cyanoacrylate fuming only rendered fingerprints visible on the foils and on the areas that had been screen printed (strong colour printing).

Without further contrast enhancing methods, such as dye staining, no prints were detected on the other areas of the banknotes (Figure 4, 5, and 6).

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Fig. 2. 500 €, 5-day old.



Fig. 3. 500 €, 5-day old.

As the use of UV excited fluorescent powders and stains is unsuitable for cyanoacrylate treated fingerprints on these multiple porosity surfaces, vacuum metal deposition was carried out as a sequential procedure to locate fingerprints.

The banknotes were almost completely stained a silver colour by the zinc metallization. Fragmentary ridge detail similar to that developed by cyanoacrylate fuming was developed on the foils and heavily printed areas.

In some cases, additional fingerprints were visible on the obverse side of the notes when viewed at an angle (Figure 7, 8, and 9).



Fig. 4. 500 €, 5-day old.

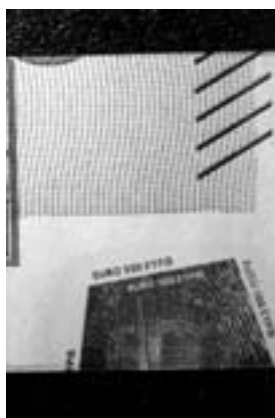


Fig. 5. 500 €, 5-day old.



Fig. 6. 10 €, 5-day old.

Cyanoacrylate fuming is suitable only for specific areas of the banknotes.

Only the foil areas of the higher-value notes are large enough in area to give a fingerprint with sufficient features.



Fig. 7. 100 €, 5-day old.



Fig. 8. 50 €, 5-day old.



Fig. 9. 50 €, 5-day old.

The vacuum metal deposition procedure turned out to be of only limited suitability. The fingerprints visible at a glancing angle have a low contrast and are therefore difficult to image. Due to the higher cost this method is not suitable for processing a large number of notes. However, it may be considered for more important/serious cases.

#### *Ninhydrin – dip method*

In principle, fingerprints on the banknotes can be visualised with ninhydrin. The majority of fingerprints developed appeared the typical strong violet colour of Ruhemann's purple. As expected, the method presents some limitations, especially in areas with strong colours, similar coloration or patterned backgrounds (Figure 10, 11, 12, and 13).



Fig. 10. 50 €, 5-day old.



Fig. 11. 50 €, 5-day old.



Fig. 12. 10 €, 5-day old.



Fig. 13. 20 €, 5-day old.

### ***Sequence DFO/Ninhydrin – dip***

DFO, like ninhydrin, also reacts with the amino acids in fingerprints and therefore was in principle suitable for visualisation of latent prints.

DFO treated prints develop with a pale salmon colour and are visible in white light. However, when illuminated with green light of a specific wavelength (for example, 530 nm) and examined with an inspection filter (B + W no. 41 red-orange), the fingerprint fluoresces brightly against a dark background. The inherent fluorescence of the banknotes was only rarely an interfering factor. After DFO treatment, subsequent treatment with ninhydrin enables further prints to be developed. However, this was not investigated in more depth in this series of experiments.

Compared with the ninhydrin method, the use of DFO produced rather better results, although once again the problematic areas (foil, strong coloured printing and pattern) set limitations.

It was also noticeable that although fingerprints developed on those areas printed with random intaglio printing, no ridge details were identifiable on account of the structure of the paper (Figure 14, 15, 16, and 17).

### ***Ninhydrin – sublimation***

In this method, Crystalline ninhydrin is heated in a vacuum chamber so that it changes to the gaseous state. This is a new procedure that is still under study. This procedure was presented for the first time by Dr Schwarz (KI 24) at the Federal States Fingerprint Forum on 06–07.11.01 in Hannover-Münden.

The banknotes were fumed in a vacuum chamber. The fingerprints developed with the typical ninhydrin colour, but not as strong as in the case of the dip method. However, the fingerprints often developed with finer ridge detail.



Fig. 14. 50 €, 5-day old.



Fig. 15. 500 €, 5-day old.



Fig. 16. 10 €, 5-day old.



Fig. 17. 20 €, 5-day old.

With one exception, visualisation of usable prints was once again impossible on the problematical areas of the notes.

However, it was noticeable that fingerprints were partially visible on the foil areas of the banknotes and these fingerprints continued without interruption onto the adjacent paper.

This phenomenon was more distinct in the case of the foil strips on the smaller denomination banknotes than with the foil patches on the larger denomination notes (Figure 18, 19, 20, and 21).

### **20-day old fingerprints**

Similar results were obtained for the 20-day old prints as for the 5-day old fingerprints.





Fig. 18. 50 €, 5-day old.



Fig. 19. 10 €, 5-day old.



Fig. 20. 5 €, 5-day old.



Fig. 21. 20 €, 5-day old.

### **3-month old fingerprints**

These experiments have not yet been concluded. However, we do not expect the results to be significantly different.

#### RECOMMENDED PROCEDURE FOR THE LOCATION AND DEVELOPMENT OF FINGERPRINTS

On the basis of the experiments carried out in this study, the following sequence of treatments is recommended at present:

1. examine the untreated notes with light sources (not short wave UV to protect DNA) for visible and latent prints;
2. cyanocrylate fuming (detection of latent prints on the foil);

3. DFO – dip;
4. ninhydrin – dip.

The development of latent prints must be checked after each step and imaged if appropriate.

The Hesse State Criminal Investigation Bureau has now used the recommended sequence of methods to examine genuine Euro banknotes obtained from the crime mentioned in the introduction. A number of usable prints were visualized with the DFO-dip treatment.

### CONCLUSIONS

The new Euro banknotes must be regarded as a “porous” substrate, and similar to DM banknotes treated for latent fingerprints using the well-established DFO and ninhydrin techniques.

However, these two techniques are unsuitable to search for fingerprints on certain areas of the banknotes (random intaglio printing, screen printing, foils).

Using the cyanoacrylate fuming method, latent fingerprints can be rendered visible on the foils, and therefore this procedure should be used before dip treatment with DFO and ninhydrin.

The ninhydrin sublimation technique (or, possibly DFO) could be a major advance in the development of new methods for fingerprint visualization. In this series of experiments, there were indications that this procedure could be used for both porous and non-porous surfaces.

#### Acknowledgments:

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