Restoration of Stamp Marks and Development of an Etching Paste

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Introduction

Stamped identification marks may be erased or defaced by the criminal but the process of stamping deforms the underlying metal structure and this can sometimes be recovered by etching. The use of a liquid etchant is, however, not very convenient in the field or when dealing with surfaces that are not flat. An investigation was therefore carried out to see whether a suitable etching paste could be made.

The study also examined the conditions necessary to completely remove the underlying changes to the crystal structure and a tentative model is proposed to explain how deep the underlying damage is. This may help assessing the potential success of recovering marks.

Method

Steel discs or bars were prepared by impressing a single letter using a die and a hydraulic press. The specimen was carefully filed to obliterate the letter and the disc thickness was measured. A pre-determined additional layer of material was removed (0.5-2.0 mm) and Fry's reagent was applied. Periodically this was removed, the specimen observed, and etching was continued if recovery was not achieved. Over-stamped samples were treated in a similar manner with 1 mm removed below the original imprint. In order to make a paste Fry's reagent was mixed with alumina powder in the ratio 3.5 ml to 4 g to give a suitable consistency.



Fig 1. Original. Fig 2. Defaced. Fig 3 Recovered

Depth of Impression.

The depth of impression was recorded by measuring how much material had to be removed to obliterate the mark. It was, however, noticed under the optical microscope that sometimes burrs of metal from filing in-filled the groove and welded together (figure 4). A consequence from a forensic point of view is the criminal is likely to believe the mark is obliterated, but during the etching stage liquid can penetrate and remove this infill and produce a sharper mark.

Figure 5 shows the appearance of the letter V with etching of the strained area visible, but a much clearer mark where the in-filled material has been etched away.



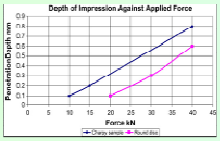

Fig 4 Infilling Fig 5. Recovery Fig 6 Depth of impression

Figure 6 shows the measured depth of metal that needed to be removed in order to obliterate the imprint and it can be seen that there is a difference between the two materials due to their different yield strengths.

Recovery.

The results of the etching tests show that the greater the applied force the deeper the impression. Up to 1 mm below the original imprint the impression could be recovered. Beyond this recovery was less likely.

Over-stamping with a cold chisel appears to make the imprinted letter unreadable, but the chisel damage is much more localised and a letter may still be recovered.

Grinding on a grinding wheel may be easier for a criminal than filing, and in this study it removed the lettering easily but it caused limited underlying damage and recovery was relatively easy. In fact, no further polishing of the sample was required when grinding was used.

Filing was most effective at obliteration and required more sample preparation for recovery. However, filing requires the removal of at least 2 mm of metal below the imprint to be effective.

A Model of Underlying Damage

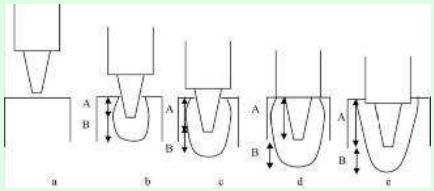

Fig 7. Limit of Plastic Deformation

It is suggested that recovery can be achieved where plastic rather than elastic deformation of the metal has occurred, and this will depend on the force applied and the yield stress of the metal. The model is discussed further in reference 1.

Development of the Paste

A paste could be easier to apply in field applications, and a range of options were considered. Mixing Fry's reagent with alumina powder was investigated and was surprisingly successful.


Fig 8. Ion separation Fig 9. Paste

It was observed that the paste produced a chromatographic effect and this affects the concentration of different ions present in contact with the metal, as discussed in reference 2. The paste also etched broader pattern that was more easily visible to the naked eye

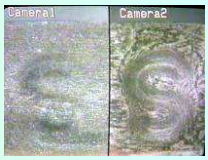

Fig 10. Liquid (left) and Paste (right)

Merits of the Paste

The ratio of liquid and solid can be adjusted to produce a reagent that will stay in place and not flow. After etching the paste can be wiped off (subject to suitable safety precautions) and a clean metal surface is obtained, avoiding copper deposition and the formation of a black oxide layer that reduces contrast. Often the paste will etch better than liquid, but as with any new or modified technique, tool-mark examiners need to gain experience in order to make a judgement of when to use it.

Conclusion

Further understanding has been gained of when erased marks may be recovered, and a paste has been developed that may be useful in recovering erased stamp marks.

References

1. Restoration of stamp marks on steel components. Forensic Science International, Volume 180 Issue 1 (2008), Pages 32 – 36, G. Wightman, J. Matthew.

2. Development of an etching paste. Forensic Science International, Volume 180, Issue 1 (2008), Pages 54 – 57, G. Wightman, J. Matthew

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