

Comparative Approach For Restoration Of Obliterated Engraved Marks On Different Metal Surfaces

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Abstract

Engraving is the process of engraving a design from a hard surface, especially to make a print for analytical purpose. These prints are widely used as serial numbers which are like a unique identification number of codes assigned for the identification of objects. Serial number of any object is present on many valuable objects like vehicles, fire arms, machinery, jewelry, musical instruments, watches, ornaments, valuable tools, antique items and many other objects. The engraved serial numbers help to identify the owner of the object. These engraved marks or serial numbers can be erased by founder who commits such like that illegal use of stolen items for that the ownership of the objects cannot be found for owner or officers.

INTRODUCTION

An engraved mark or a serial number which is a unique identification number or marking stamped on the any metal surfaces which are assigned or authorized for identification of many consumer products for identification and also used for commercial items such like that as firearms, electronic equipment, industrial machinery, musical instruments, trucks, motorcycles, ornaments, jewelry and also used for other valuable items. They provide a meaningful format by which government agencies can easily trace or find out the original registered owner. For this reason, involving the criminal activities such like that illegal use of those stolen items chance may be caused by an offender to remove or deletion of identifying data so that ownership cannot be traced or the offender can easily hide the identification number of objects. The restoration of markings or we can say serial number is a very important for forensic discipline that it includes the science and as well as the technology of materials. Which deals with the aspects of solid-state of physics, chemistry, metallurgy, and engineering? Markings such like that as serial numbers,

lettercodes and also label codes are applied to the distinguish various kinds of variety items. In some criminal cases, the serialnumbers are removed to hide the itemsfor hide the true identity (Katterwe2006). Many reagentshave been developed for the process of restoration of the erased or find out the hidden numbers which is present on erased surfaces. Restoration of a number can be accomplished whenever the obliterating process has ntototally removed all evidence of the number. Because the stamping of a number deforms themetal's crystalline structure well below the indentation, a number can appear to have beenobliterated while much evidence still remains.For the past being years, many etching reagents have been developed to find out or we can say to restore the erased andobliterated serial numbers and marks from different metal surfaces.In this current approach, obliterated engraved numbers from the surface of brass and steel have been restored and compared by using two chemical etching reagents, and alsothe comparison of best enhanced surface of metals have been compared between brass and steel. Two etching reagents have been taken and both of them are modified to increasethe contrast of the restored numbers as well as to save the time in restoring the obliteratednumbers.

Etchant:

An etchant is type of a chemical that have ability to produces a action of corrosion on the metal.

Etching:

Etching is the process related to material which is being removed or deleted from a material's surface. In forensic, it is generally the process which is using as strong acid to lacerate the layer of a metal surfacet to recover obliterated numbers and marks from the surface of any materials.

The two majortypes of etching process which are such like that-

Wet Etching –This is the process of etching that involves the using ofliquid chemicals or etchants this process is called wet etching.

Dry Etching –this process of etching called as the plasma etching process, or we can say dry etching, etchantare thegases which are used for takeoff the substrate material.

METHODS EMPLOYED FOR REMOVAL OF ENGRAVED MARKS ARE:

1. **Filing or grinding-** the process of removing the engraved part present on metal object by the grinding or hand filing with the help of a high - speed grinding wheel.

2. **Penning-** In this process merely involves which is the hammering striking on the surface with the help of hammer to completely hide or cover the number which is present on the surface.

3. **Centre punching-** this process of obliterating the numbers which is present whole surface with the help of pointed punch.

4. **Drilling-** Drilling is the process of removing the number and also the surrounding metal with the help of drill. The hole which is left is usually poured up with either the help of lead solder or with welded material.

5. **Welding-** this process of heating the surface till metal flows in the form of an arc welder.



(Fig. 1: Flap Disk of Metal Grinder)



(Fig. 2: Obliteration of Metal Plates)

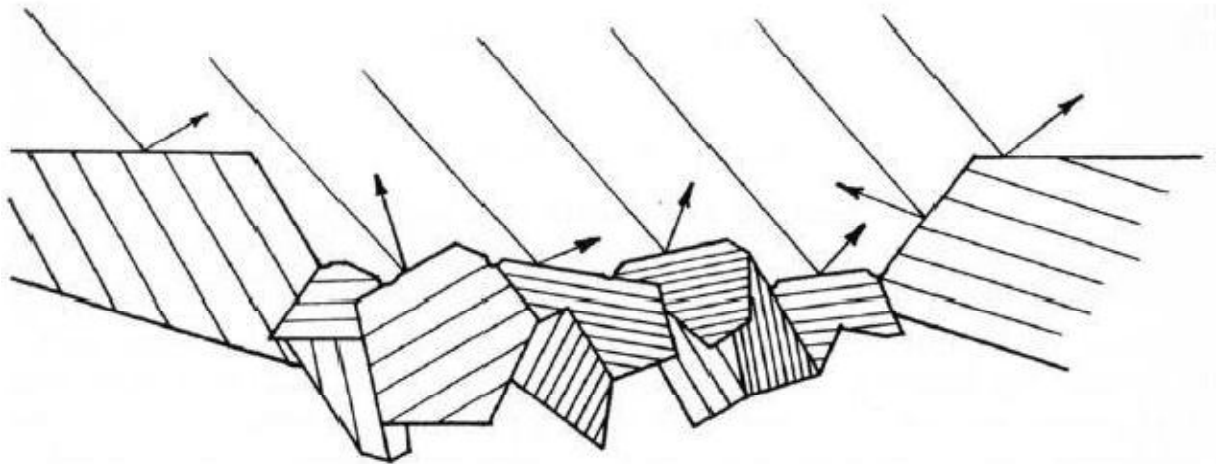
PRINCIPLE BEHIND THE RESTORATION OF NUMBER:

All the metals are in polycrystalline sort of structure, for example they are made out of an irregularly formed of crystals or look such like grains. At the point when any of the number is engraved over the metal surface, the structure of crystalline which is encompassing the stepped striking number is harmed and the structure of grain is compacted. This sort of successfully motivation to diminishes the size of the grain or the size of crystals the metal modifying or changing its physical and mechanical attributes, yet we can't see by the naked eye. The depth of metal surface is exceptionally influenced by packed the crystalline structure which will be absolutely reliant upon the metal and the additionally depend how much power applied by the procedure of punch. This is finished by just the methods for how the first serial number can be redeveloped or made noticeable. On the off chance that the surface is scraped or ground down until the number has quite recently been evacuated, the new surface will at present contain a region of adjusted crystalline structure, if the metal is effectively treated, the crushed numbers can be uncovered. This crushed region or shrouded region of crystalline structure of a metal can be uncovered by the activity of a reasonable etching reagent which will demonstrate the change in crystalline structure from a compressed to a non - compressed region.



(Fig. 6: Photo of STEEL & COPPER Samples)

VISUALIZATION AFTER ETCHING:



(Fig. 3: Light striking on a metal surface after the process of acid etching)

(Image Source: <https://www.sciencedirect.com/science/article/pii/S0015736876710284>)

The key instrument, through by which the pulverized marks is visualized, be that as it may, this phenomena is called specular reflection. After this the etching brings about the specific expulsion of certain metal segments from the various essences of the crystals, which coming about a sporadic surface. The unaffected metal surface is followed up on simply like by the etching solution, absolutely, yet to a less measure of degree and in a significantly more procedure in uniform way. The phenomena of Light on this metal surface adheres to the old style laws of physical optics and after it will in this way be differentially reflected by the metallic surface. At the point when this distinction in reflectivity will portray to those territories of discontinuity, i.e., it will demonstrate the grain limits isolating the influenced metal from that which isn't influenced. It is this distinction in specular reflectivity which is absolutely in charge of the picture gotten by the eye and saw through by the mind, and which allows the restoration of the obliterated or concealed number. In the event that the sequential number has been too profoundly ground away or it might be penetrated out, so there is no hope to reestablish or recuperate the number. Similarly, serial numbers that are daintily stepped or just engraved offer little trust in rebuilding when damaged.

STANDARD REAGENTS USED FOR ETCHING OF BRASS AND STEEL ARE:

1. Etching Reagent 1 (Fry's Reagent):

- Crystalline Cupric Chloride (CuCl_2)90 gms.
- Concentrated Hydrochloric Acid (HCl)120 ml
- Distilled Water (H_2O)100 ml

2. Etching Reagent 2 (Acidic Ferric Chloride)

- Ferric Chloride 19 gms.
- Hydrochloric Acid (HCl)6 ml
- Distilled Water (H_2O)100 ml



(Fig. 4: Fry's reagent)

HAZARDS OF CHEMICAL ETCHANTS:

1. Cupric Chloride is used as etching reagent because it havean irritant and toxic property.
2. HCLhas a nature act as a poison and toxic so it can pose to severe as contact and health hazard.
3. Ferric Chloride has a corrosive and irritant nature so that can be posesto severe as contact,inhalation, andhealth hazard.

RESTORATION BY CHEMICAL METHODS:

This is a very general technique of using chemical etching. The benefit of that is it essentially the same for all the metals. Basically, main the reagent which is applied for the purpose of the polished area with the help of a cotton swab, and arubbing action mechanism. After we take around 1 min, then the reagent is rinsed off with the help of acetone and then viewed the result. The number should begin to appear as in the form of shadow which is then often the best viewed with the help of oblique lighting. But after that If nothing appears after 1 min, the process is repeated for the consecutive alternate intervals of 2, 5, 10 min for around of 2 hours or 1 day. This approach has been conducted to compare the sensitivity and efficacy of the two modified chemical etching reagents and to find out the best surface of the metals plates in which the number is restored with good contrast. Total number of 58 samples of brass and steel has been taken for research.

METHODOLOGY OF SAMPLING BEGAN WITH SIMPLE FOLLOWING STEPS:

Punching of serial numbers on metal plates



Photographing the metal plates after punching numbers



Obliterating serial numbers on metal plates



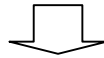
Polishing the metal plates to remove scratches



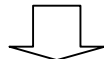
Photographing the metal plates after obliterating and cleaning metal plates



Cleaning the metal plates with acetone to remove oil and grease



Etching the metal plates to restore obliterated numbers



Photographing the restored numbers on the metal plates

ETCHING PROCEDURES:

Surface Preparation: metal surface must be treated for to reveal the crystalline structure of the metal, so it is very important to polish the metal for just use as a primary step for the recovery process. The polishing of the metal plates was accomplished by through the first removing all scratches by scratching and also for other marks with silicon carbide sandpaper. After all the process of polishing, the metal surface was degreased and washed with acetone.

Etching Reagents:

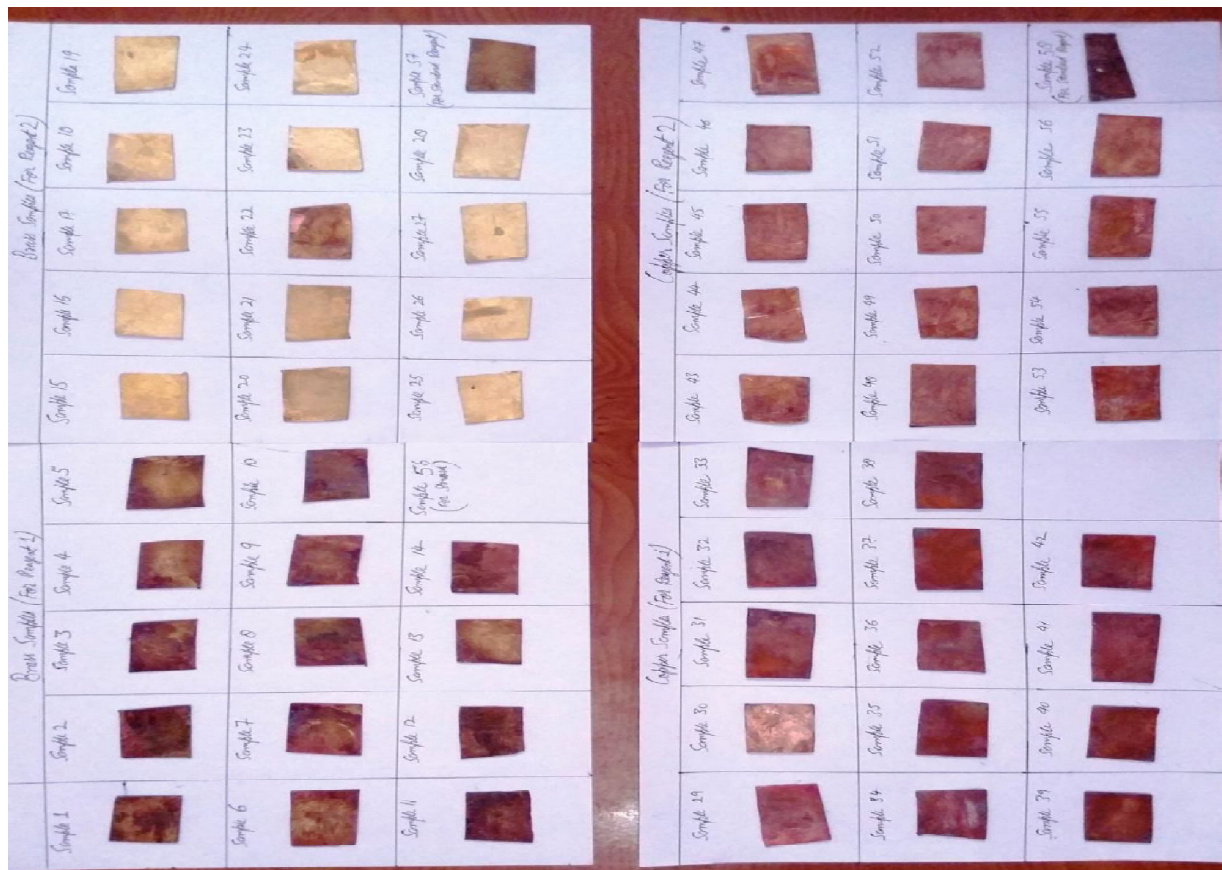
For etching the metal plates of brass and copper, three reagents were prepared. One was standard etching reagent (Fry's reagent), second one prepared was modified Fry's reagent with mixing aluminum oxide or alumina to make etching paste and the third one prepared was acidic chromium trioxide.

APPLICATION OF ETCHANTS ON METAL PLATES:

The reagents were applied on the top of the obliterated surface by swabbing process. All the samples were washed with acetone to remove grease and oil. Cotton soaked in etching solution was applied over the erased surface of metal plates. For etching with standard reagent, the surfaces of obliterated samples were etched by swabbing standard reagent (Fry's reagent) on Sample 57 of brass and Sample 58 of steel.

With the application of Fry's reagent (Solution 1), acetone swabbing was applied over the erased surface before the application of 15% Nitric acid (Solution 2) alternately. For etching with Reagent 1, the surface of obliterated samples were etched by swabbing reagent 1 (Etching Paste) on 14 samples of brass (Sample 1 to 14) and on 14 samples of copper (Sample 29 to 42). After

swabbing for 10 minutes, etching paste was left over on the metal plates for 10 minutes. Then the plates were washed with acetone. Again the fresh paste was applied on the metal surface and was continuously swabbed for about 5-15 minutes. For etching with Reagent 2, the surface of obliterated samples were etched by swabbing reagent 2 (Acidic Chromium Trioxide) on 14 samples of brass (Sample 15 to 28) and on 14 samples of steel (Sample 43 to 56) until the marks appeared.



(Fig.5: Photo of total Samples)

RESULTS-

In this research work two different reagents of varying compositions were used to restore obliterated marks on the samples (brass and steel plates), out of which one reagent

i.e. Reagent 1 (Etching Paste, composition: cupric chloride, conc. hydrochloric acid, alumina and distilled water) gave the best result as it. Standard Reagent i.e. Fry's reagent (composition: cupric chloride, conc. hydrochloric acid and distilled water) also gave better result but it was time consuming and also required two different solutions for etching. Reagent 2 i.e. Acidic chromium trioxide (composition: chromium trioxide, sulphuric acid and distilled water) did not give better results and good contrast. Sensitivity and the efficiency of applied the etching reagents for to use in recovering marks erased by grinding.

S.No.	Etching Reagent	Composition	Application Method	Time Taken for recovery (min.)	Characteristics
1.	Standard Reagent (Fry's Reagent)	(a) Cupric chloride 90 gm, conc. HCl 120 ml, distilled water 100 ml (b) 15% nitric acid	Two solutions were Swabbed alternately on the Obliterated surfaces, first With solution 1 and then with 15% HNO ₃ . Acetone Swabbing was applied between the two reagents.	30-50	Both contrast And reproducibility Were very good. The marks were Reproducible.
2.	Etching Reagent 1 (Etching Paste)	Cupric chloride 90 gm, conc. HCl 160 ml, distilled water 100 ml, aluminum oxide 200 gm	The reagent was swabbed for 10 mins and left over on sample for 10 mins. Then washed with acetone and again fresh reagent was applied until the marks fully appeared	25-45	The restoration presented fair contrast and Also reproducible.
3.	Etching Reagent 2 (Acidic Chromium Trioxide)	Chromium trioxide 24 gm, H ₂ SO ₄ 12 gm, distilled water 164 ml	The reagent was applied by swabbing on the Obliterated surface of sample.	More than 40	Marks were recovered in Poor contrast. Reproducibility Was poor.

(Table: Sensitivity and efficiency of etching reagents)

CONCLUSION

The present work has been conducted on the comparison of sensitivity of modified reagents and on the comparison of metal surfaces of brass and steel. Between the two reagents that were used for the process of restoring marks on steel and copper surfaces, after the analyzing it was found that reagent made of 90 gm cupric chloride, 160 ml conc. hydrochloric acid, 120 ml distilled water and 200 gm was found to be most effective. The all process is done according to the working manual of Directorate of Forensic Science, the main standard reagent which was used for etching of steel and copper are Fry's Reagent and Ferric.

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