

Recovering obliterated engraved vehicle identification number on vehicle frame surfaces by etching technique

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Abstract. Chemical etching, which is the most sensitive method to recover obliterated serial numbers on metal surfaces. This paper studied the method of recovering obliterated engraved vehicle identification number on vehicle frame surfaces by etching technique. Experiment research indicates that for vehicle frame materials containing Al and Si components, the use of concentrated hydrochloric acid : acetic acid : ethanol=2:1:1 (volume ratio) reagent shows good effectiveness; For vehicle frame materials Mn and Si composition, the use of concentrated nitric acid: acetic acid: ethanol=1:1:1 (volume ratio) shows good effectiveness. This recovering method has far-reaching application prospects, especially in the robbery cases involving vehicle identification numbers juggled.

Introduction

Vehicle identification number on vehicle frame surfaces is very important number of vehicle. In dealing with the cases of robbing and stealing vehicles, how to distinguish whether the vehicle identification number on the automobile frame is changed and how to reappear the original vehicle identification number is an important problem that police must face [1]. Chemical etching, which is the most sensitive method to recover obliterated serial numbers on metal surfaces [2-5]. For obliterated engraved vehicle identification number on vehicle frame surfaces, the corresponding etching reagent will vary with the chemical composition of vehicle frame. In this paper, five reagents with different proportions were used to recover the vehicle identification number on vehicle frame of the different materials respectively. Then the suited recovering reagents and their appropriate ratio were summarized for different vehicle frame materials, the influencing factors and recovering operation were discussed also.

Operational Principle

Metal chemical dynamics. The vehicle identification number is stamped on vehicle frame, and a deep depression handwriting forms on the frame surface as identification number. Stamping leads to the formation of the metal crystals relative displacement produced by plastic deformation occurs, which is distortion. According to the metal on the dislocation theory, structure on the performance of different density layers can be divided into the hardened layer, the strained layer, transition layer, substrate layer. Number imagery may be obliterated by criminals, but the dislocation of the inner latent image is usually not much affected. If grinding depth does not exceed the range the dislocation reaches, the latent image will exist under original number (Fig. 1). The metal atoms of the dislocation parts stored energy, the activation energy is higher, the metal and chemical properties of engraved parts changes and is easy to be etched. We usually using chemical etching method to improve the corrosion rate contrast of the engraved parts with other parts, in order to recovering obliterated engraved vehicle identification number on frame surfaces.

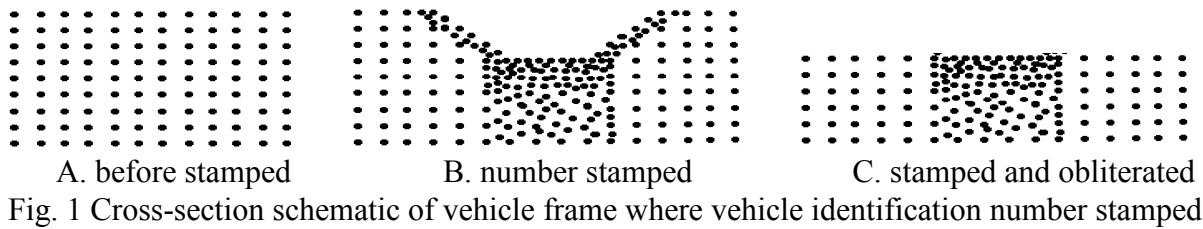


Fig. 1 Cross-section schematic of vehicle frame where vehicle identification number stamped

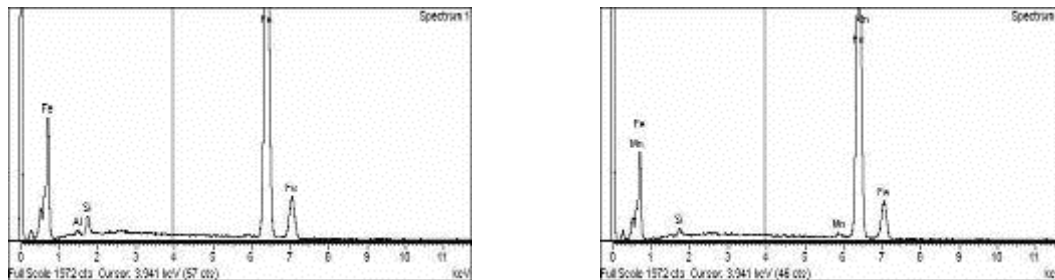
Performance of vehicle frame in acid solution. The major metal component of the frame is iron, which is easy to react with acid solution and generate hydrogen (Eq. 1). When reacting with nitric acid, nitrogen dioxide generates (Eq. 2). Oxidation-reduction can also react with ferric ion and generates ferrous ion (Eq. 3).



Experiment

Sample for the etching experiments. The two kinds of samples for the experiments was obtained from the frames of Dongfeng truck and Santana car. The frame metal was tested by EDXS (energy dispersive X-ray spectrometer) respectively. Sample 1 was found to contain 90.43% Fe, 4.77% Al, 4.80% Si; Sample 2 was found to contain 97.47% Fe, 1.40% Si, 1.12% Mn. EDXS composition analysis diagram of vehicle frame samples see Fig. 2.

Etching reagents. Concentrated nitric acid (65% ~ 68%, analytically pure), concentrated hydrochloric acid (36% ~ 38%, analytically pure), absolute ethyl alcohol, deionized water. Five etching reagents were tested on the erased vehicle frame surface. Their compositions are given in Table 1.



(a) sample 1

(b) sample 2

Fig. 2 EDXS composition analysis diagram of vehicle frame samples

Table 1. Etching reagent used in the study for recovering engraved number on vehicle frame

Etching reagent	Composition
reagent 1	Concentrated hydrochloric acid : acetic acid : ethanol=2:1:1
reagent 2	Concentrated hydrochloric acid : acetic acid : ethanol=1:1:1
reagent 3	Concentrated nitric acid : acetic acid : ethanol =1:1:1
reagent 4	Concentrated nitric acid : acetic acid : ethanol =1:1:2
reagent 5	50% nitric acid

Note: The ratio in the upper table refers to ratio by volume.

Recovering experiment. The vehicle frame samples were engraved with alpha numerical characters using marking machine and obliterated with grinding device. Swabbing technique was used to apply the reagent on the surface. The metal surface was cleaned with acetone before etching.

The surface was then rubbed with cotton soaked in the etching solution. With the application of etching reagents, recovering effectiveness were recorded with photographs using Canon EOS 350D digital camera.

Experiment results and discussion

Recovering effectiveness of etching reagent. Recovering effectiveness of etching reagents on vehicle fame sample 1 was listed in table 2. Recovering effectiveness of etching reagents on vehicle fame sample 2 was listed in table 3.

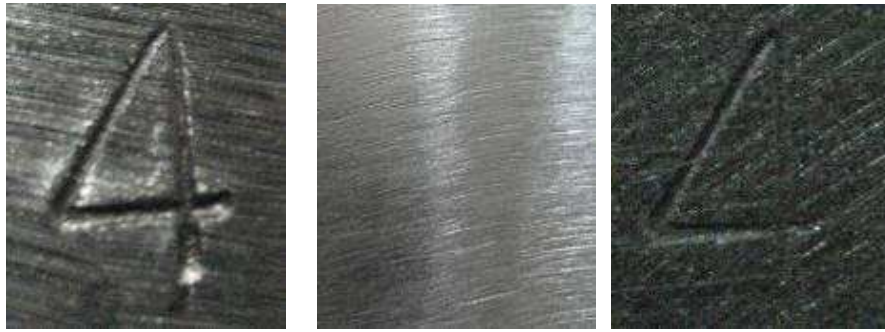
Table 2. Recovering effectiveness of etching reagents on sample 1

Etching reagent	Phenomenon of reaction	Time for recovery	Characteristic of the restored marks
reagent 1	Reacts violently with great amount of fine bubbles generated; cotton becomes light green rapidly and metal surface becomes more and more bright	15-18 min	most effective, can be easily recognizable and photographed
reagent 2	Reacts violently; Fine bubbles generated; cotton becomes light green rapidly and metal surface becomes more and more bright	20-25 min	better effective, can be recognizable
reagent 3	Reacts violently; cotton became light green and became reddish-brown gradually, accompanied by irritating gases generated	16-25 min	Faint, shows little effective
reagent 4	Reacts rapidly; cotton became light green and became reddish-brown gradually, accompanied by irritating gases generated	15-20 min	shows a little effective, a little recognizable,
reagent 5	Brown smoke and irritating gases generated, reacted rapidly at the outset and became slow gradually	15-20 min	Faint, shows little effective

Table 3. Recovering effectiveness of etching reagents on sample 2

Etching reagent	Phenomenon of reaction	Time for recovery	Characteristic of the restored marks
reagent 1	Reacts violently with great amount of fine bubbles generated; cotton becomes light green rapidly and metal surface becomes more and more bright	15-18min	better effective, can be recognizable
reagent 2	Reacts violently; Fine bubbles generated; cotton becomes light green rapidly and metal surface becomes more and more bright	20-25min	shows a little effective, a little recognizable,
reagent 3	Reacts violently; cotton became light green and became reddish-brown gradually, accompanied by irritating gases generated	16-25min	most effective, can be easily recognizable and photographed
reagent 4	Reacts rapidly; cotton became light green and became reddish-brown gradually, accompanied by irritating gases generated	15-20min	better effective, can be recognizable and photographed
reagent 5	Reaction was boiling like, great amount of yellow -brown smoke and irritating gases generated, cotton became yellow-brown	7-12min	better effective, can be recognizable

From table 2, etching reagent 1 is available to get the best recovering effectiveness (Fig. 3, Fig. 4). From table 3, etching reagent 3 is available to get the best recovering effectiveness (Fig. 5, Fig. 6).



A. Original stamping number B. Number was obliterated C. Recovering results
Fig. 3 Recovering “4” on vehicle frame sample 1 with etching reagent 1



A. Original stamping number B. Number was obliterated C. Recovering results
Fig. 4 Recovering “8” on vehicle frame sample 1 with etching reagent 1



A. Original stamping number B. Number was obliterated C. Recovering results
Fig. 5 Recovering “N” on vehicle frame sample 2 with etching reagent 3



A. Original stamping number B. Number was obliterated C. Recovering results
Fig. 6 Recovering “1” on vehicle frame sample 2 with etching reagent 3

Hydrogen generated in the reaction is taintless to environment, and no harmful to human body, but hydrochloric acid is volatile which will affect the H^+ concentration. The frame material composition had influence on recovering effectiveness of etching reagent. When recovering the vehicle sample 1 with reagent containing nitric acid, passivation phenomena took place for the composition of Al, which hindered nitric acid further reaction with the vehicle frame, hydrochloric acid is the better select selection which will not take place passivation. Vehicle sample 2 has a little bit Si and Mn, passivation reaction with iron took place also, which is negligible by control of cotton wiping speed properly, for passivation process is very slow. So the reagent 3 can show better recovering effectiveness.

Recovering the covered vehicle identification number with suitable reagent. Obliterated the original vehicle identification number by abrading and stamped new number on original position, then recovered the original number with suitable reagent respectively (Fig. 7, Fig. 8).

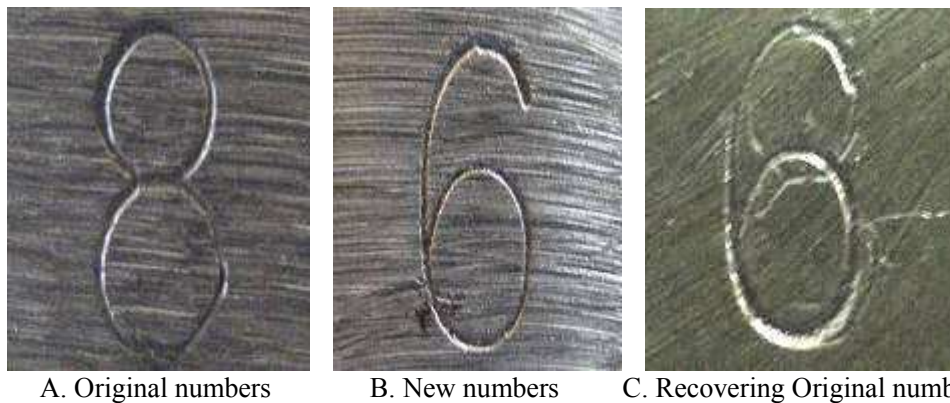


Fig. 7 Recover original vehicle number “8” under new juggled numbers “6” on vehicle frame sample 1 with etching reagent 1

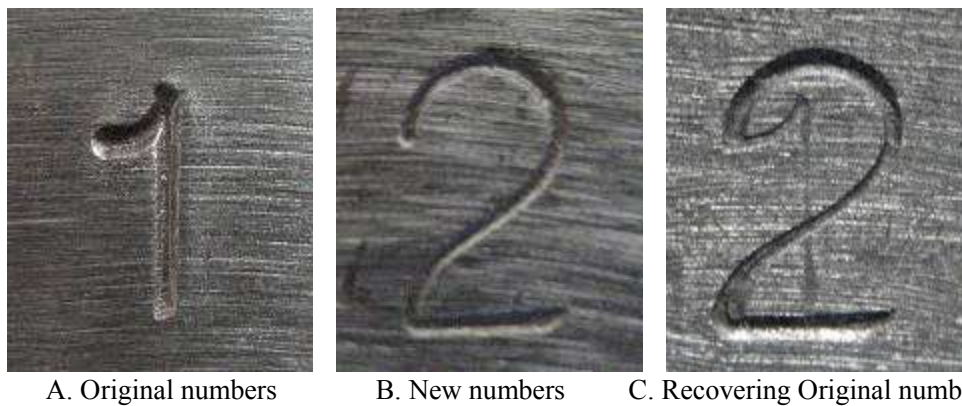


Fig. 8 Recover original vehicle number “1” under new juggled numbers “2” on vehicle frame sample 2 with etching reagent 3

Conclusion

For vehicle frame materials containing Al and Si components, the use of concentrated hydrochloric acid : acetic acid : ethanol=2:1:1(volume ratio) reagent shows good effectiveness; For vehicle frame materials Mn and Si composition , the use of concentrated nitric acid : acetic acid : ethanol =1:1:1 (volume ratio) shows good effectiveness.

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