# Recovery of Faded Prints on Thermal Paper in Contact with Adhesive Tape and Oil.

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## Abstract

In this study, two nondestructive and one destructive methods were used to recover the faded prints on thermal paper in contact with adhesive tape and oil. The former were photoluminescence and image inversion with an image processing software and the latter was background blackening with a dry hot iron. It was found that oil could cause the print to fade away very quickly while adhesive tape cause the print to fade at a much slower rate. Luminescence light and an image processing program could recover the 2 and 3 mm letter sizes of the faded print while the dry iron could not recover those samples at all. It could be concluded that both of the nondestructive methods studied could be used to recover the faded prints. However the quality of the recovered prints depends on the letter size, storage time and also the quality of the thermal paper.

**Keywords:** Thermal paper, Faded print, Luminescence light

## Introduction

Thermal paper is widely used in our daily life as store bill, ATM and credit card receipts, label, barcode, queue card, etc. It's use is increasing due to the convenience of the printing process and the economical expense. For these reasons, such prints can be used as an evidence to identify the activities of a person that might be associated to a crime. However, the print of this kind is not intended for long term storage. It may be faded over the storage time due to many factors. There is no confirmed evidence on the correlation between storage conditions and the print fading. It is known, however, that plasticizer could accelerate the fading of thermal print. Examples of such chemicals are adhesive tape compositions and oil. Very often, investigators are faced with faded thermal print and this bring difficulties to the investigator due to the lost of information. The aim of this study was to study the effect of adhesive tape and oil on the fading of thermal print and to find appropriate methods to recover the faded print.

## Methodology

The number "3856" with the size of 1, 2 and 3 mm were printed on a single sheet of thermal paper by Epson (Thailand) Co. Ltd.. A number of copies were printed and brought to contact with adhesive tape and oil. The optical images of the prints were recorded at one, two and three month. Three recovery methods, i.e. luminescence, image inversion and background blackening were used to recover the faded prints. The first two methods are regarded as physical and nondestructive methods that involved no chemical change nor treatment. Photoluminescence is a cold body radiation that is caused by specific interactions between different chemical species and photon. Image inversion of the optical image of the faded prints was carried out with the ImageJ program, a free software available on a public domain. The last method involved chemical and physical changes on the faded print and therefore destructive. In this method, a dry hot iron was placed on the faded prints in order to blacken the area that had not been printed. For each method of recovery, 10 samples were attempted

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for each cause of fading. Then the readability of the faded print was graded as readable and unreadable. Readable print means that the faded print could be read, after recovery, without having to guess at all.

## Results, Discussion and Conclusion

It was found that oil could cause the print to fade away very quickly while adhesive tape cause the print to fade at a much slower rate (Figure 1). The print that was in contact with oil faded away completely after one month while that in contact with adhesive tape became much lighter than the original but was still readable.

Figure 2 displays faded prints that were caused by adhesive tape after different period of times. Images obtained by different recovery methods are also shown in Figure 2. It can be seen that luminescence light made the prints much clearer while ImageJ program gave a slightly clearer images than the normal optical images. For longer fading times of 2 and 3 months, both luminescence light and ImageJ could recover only the 2 and 3 mm letter sizes of the faded print. On the other hand, dry and hot iron destroyed all the prints and rendered them unreadable at all.

Figure 3 displays faded prints that were caused by oil after different period of times together with images of the faded prints obtained by different recovery methods. It can seen that only luminescence that could reveal the completely faded prints. After one month, the 2 and 3 mm letter sizes of the faded print are still readable with luminescence. After 2 and 3 months, only the biggest 3 mm letter size that are readable. The readability of the faded prints and recovered faded prints are summarized in Table 1.

From the results shown, it is clear that luminescence light is the best recovery method in this study. It could recover the faded print and does not destruct the sample. ImageJ program is an image processing software which could convert the image from black to white and white to black. The readability of the recovery print depends on the contrast of the print and the background. If the faded print still contains some dark area, the converted image would be sharper than the highly faded print. The dry and hot iron could not recover the faded print at all although, from the preliminary study, it could recover the faded print caused by the passage of time. It transformed

white background color on thermal paper to black color. The contrast color of thermal paper which was black and the faded print's color which was white made the faded print readable. The dry and hot iron could be an optional method when the luminescence light and ImageJ program do not work. However, it should be used as the last resources because it is the destructive recovery method.

It could be concluded that both nondestructive physical methods could be used to recover the faded prints (Table 1). However the quality of the recovered prints was depend on the letter size, storage time and also the quality of the thermal paper.

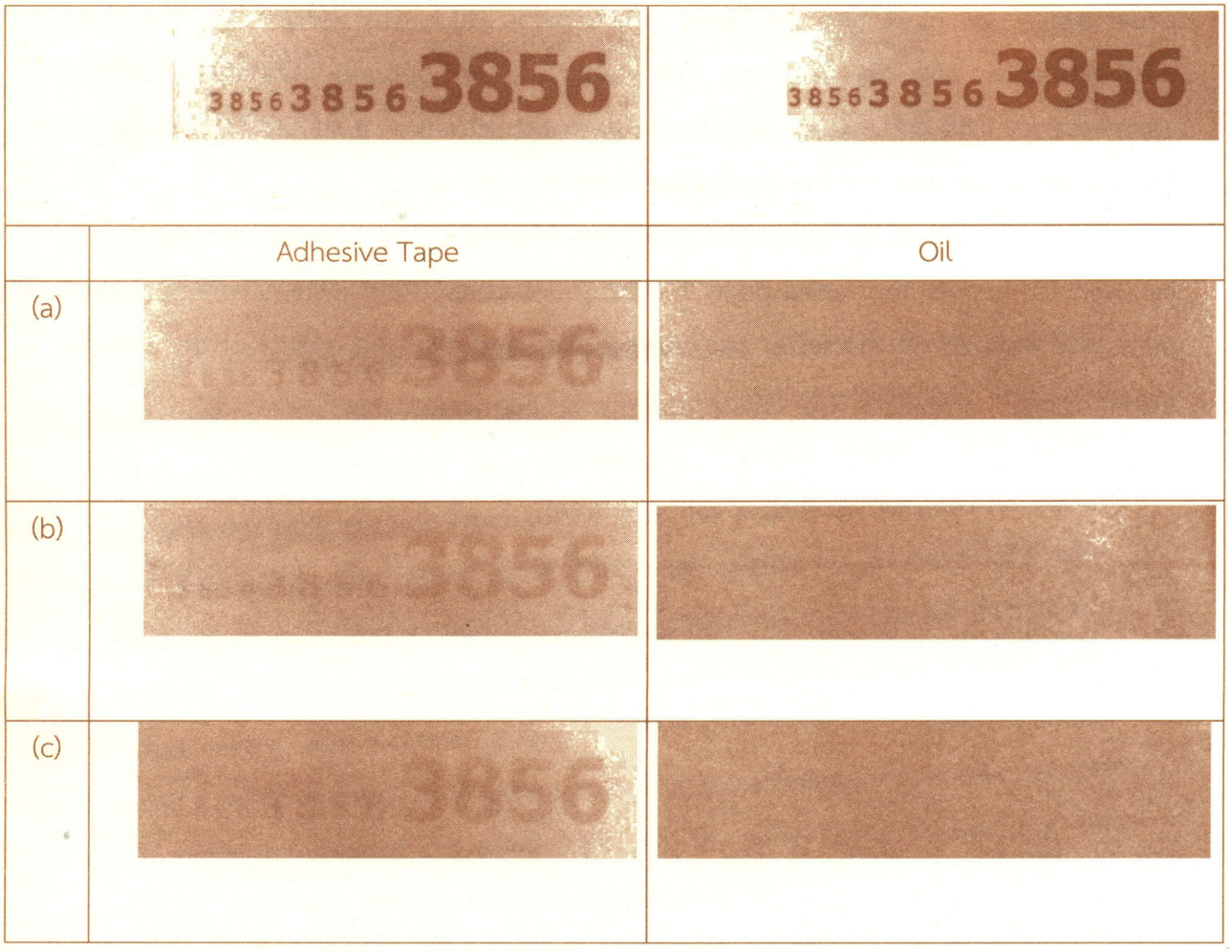


**Figure 1.** Optical images of the starting (top row) and faded prints on thermal paper that were in contact with adhesive tape and oil after different periods of time; row (a) 1 month, row (b) 2 months and row (c) 3 months.

| Method | Time after covered with adhesive tape | | |
|---|---|---|---|
| | 1 month | 2 month | 3 month |
| Normal light |  |  |  |
| Luminescence |  |  |  |
| ImageJ program |  |  |  |
| Dry hot iron |  |  |  |

**Figure 2** Optical images of faded prints caused by adhesive tape that were recorded by different methods or after treatment.

| Method | Time after contact with oil | | |
|---|---|---|---|
| | 1 month | 2 months | 3 months |
| Normal light |  | | |
| Luminescence |  | | |
| ImageJ program |  | | |
| Dry hot iron |  | | |

**Figure 3** Optical images of faded prints caused by oil that were recorded by different methods or after treatment.

**Table 1.** The readability of recovered faded prints on thermal paper in contact with adhesive tape and oil for different times.

| Cause of Print Fading | Letter Size | Naked Eye | Recovery Method | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Luminescence | | ImageJ Program | | Dry Iron | |
| | | | 1 month | 2 & 3 month | 1 month | 2 & 3 month | 1 month | 2 & 3 month |
| Adhesive Tape | 1 mm | - | √ | - | √ | - | - | - |
| | 2 mm | √ | √ | √ | √ | √ | - | - |
| | 3 mm | √ | √ | √ | √ | √ | - | - |
| Oil | 1 mm | - | - | - | - | - | - | - |
| | 2 mm | - | √ | - | - | - | - | - |
| | 3 mm | - | √ | √ | - | - | - | - |

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