Forensic Science International 255 (2015) 38–42

Contents lists available at ScienceDirect

Forensic Science International

journal homepage: www.elsevier.com/locate/forsciint

# Effects of printing and ninhydrin treatment on forensic analysis of paper

Hiromi Itamiya *, Ritsuko Sugita

*National Research Institute of Police Science, 6-3-1 Kashiwanoha, Kashiwa-shi, Chiba, Japan*

ARTICLE INFO

*Article history:*
Available online 8 June 2015

*Keywords:*
Grammage
Thickness
X-ray diffraction
Pulp observation
Printer
Detection of fingermarks

ABSTRACT

Paper is ubiquitous in human activities and can be found as evidence in the commission of many crimes such as threatening letters, deceptive advertisements and counterfeiting banknotes. To link the paper evidence to a source is a comparative process that is hampered when a blank paper is compared to a paper that has been submitted to printing or other treatments such as ninhydrin for the detection of fingermarks. During a forensic investigation, printed paper is analyzed with various instruments after fingerprint examination. In this study, the effects of printing and ninhydrin treatment on forensic paper examination of grammage, thickness, fillers, and pulp composition were studied. Grammage and thickness were increased by full-page double-sided printing, and grammage depended on the type of printer. The effects of printing on the analytical data about fillers and pulp composition were negligible, and ninhydrin treatment affected only paper thickness. These minor effects notwithstanding, the results indicate that conventional analytical methods used in forensic science for examining papers can be applied.

© 2015 Elsevier Ireland Ltd. All rights reserved.

## 1. Introduction

Paper evidence is common and most analytical techniques have been applied to this type of evidence by many authors as shown by the handbook of Brunelles and Reed [1] to more recent papers [2–6].

Little is known or documented on the effect of various treatments on our ability to compare papers such as the change of properties caused by printing or other treatments like the effect of fingerprint detection with ninhydrin. Rožić et al. [7] have demonstrated that the concentrations of some elements in printed papers are significantly higher than in blank paper, but there is a paucity of systematic studies about these effects. In order to document the effect of printing and ninhydrin treatment on paper, we studied the following conventional forensic methods for examining paper: measurement of grammage and thickness, detection of fillers by XRD, and microscope observation of pulp fibers by Graff "C" staining. We examined whether the grammage and thickness changed, whether the thin layer of ink or toner on the paper reduced the intensity of diffracted X-rays, and whether printing and ninhydrin treatment caused changes in the color of "C"-stained pulp in microscopy observations.

## 2. Experimental

Printed paper samples simulating counterfeit banknotes were printed with inkjet and laser printers, which are readily accessible in homes and offices. Blank paper was used in color printing on both sides on the entire surface; such printing was done to increase the effect on the paper. The samples in this study were blank paper, laser-printed paper, inkjet-printed paper, ninhydrin-treated blank paper, and laser- and inkjet-printed ninhydrin-treated paper. Grammage, thickness, XRD analysis, and pulp observation were examined for each sample.

### 2.1. Materials

Sheets of plain copier paper (21.0 cm × 29.7 cm, ISO A4 size) from five different brands (A–E) available in Japan were examined. Three laser printers (Nos. 1–3) and two inkjet printers (Nos. 4–5) manufactured by Japanese companies (Epson, Canon, and Fuji Xerox) were used (Table 1). Toy banknote images instead of genuine banknote images were printed on the entire surface of both sides of the paper to simulate counterfeit banknotes (Fig. 1).

Printed and blank papers were treated with ninhydrin solution following the conventional fingerprint detection protocol. Paper was treated with 0.5% ninhydrin solution. The method for applying ninhydrin solution and its solvent are shown in Table 2. After

* Corresponding author. Tel.: +81 0471358001.
*E-mail address:* hiromii@nrips.go.jp (H. Itamiya).

http://dx.doi.org/10.1016/j.forsciint.2015.05.026
0379-0738/© 2015 Elsevier Ireland Ltd. All rights reserved.

**Table 1**
Details of the printers used in this research.

| No. | Type of printer | Ink type | Manufacturer | Color | Application |
|---|---|---|---|---|---|
| 1 | Laser | – | Epson | Y,M,C,BK | Small office |
| 2 | Laser | – | Epson | Y,M,C,BK | Business |
| 3 | Laser | – | Fuji Xerox | Y,M,C,BK | Business |
| 4 | Inkjet | Pigment | Epson | Y,M,C,BK | Home |
| 5 | Inkjet | Dye + pigment | Canon | Y,M,C,BK,PGBK | Home, for photos |

Y = yellow, M = magenta, C = cyan, BK = black, PGBK = pigment black.

**Fig. 1.** Image of printed sample (A4 size). Images of toy banknotes were printed on both sides.

drying the solvent, the paper sample was heated below 100 °C to develop the fingerprint in purple.

## 2.2. Method

### 2.2.1. Grammage and thickness

Grammage (g/m$^2$) was calculated by measuring the weight (g) and area of paper (m$^2$). The weight of each sample was measured with an R160P semi-microbalance (Sartorius AG) in grams to four decimal places instead of measuring the weight of 500-sheet reams (Test Method TAPPI/ANSI T410 om-13).

Thicknesses at six points randomly chosen in each sample sheet were measured with an SSA-10 thickness gauge (ASKER, Japan) and averaged. The minimum scale value was 0.01 mm and the gauge head was $\phi$ 8 mm at a pressure of 8 kPa instead of a high pressure of 50 kPa (TAPPI Test Method T 411 om-10). All samples were kept in a regular air-conditioned laboratory prior to measurement and examinations were performed in that room.

### 2.2.2. X-ray diffraction

A paper sample was cut to size (about 5 cm × 5 cm) and both sides were analyzed. The sample was mounted on the stage as shown in Fig. 2. A SmartLab X-ray diffractometer (Rigaku, Japan) was used. Copper (Cu) Kα X-rays were supplied by the target tube. Other analytical conditions are shown in Table 3.

**Table 2**
Conventional fingerprint detection protocol.

| Condition of paper | Size of paper | |
|---|---|---|
| | Whole sheet | Small piece |
| Blank | Sprayed or brushed with acetone | Immersed in acetone |
| Printed | Sprayed or brushed with ether | Immersed in ether |

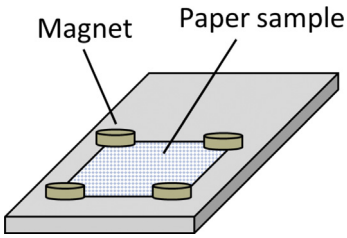


**Fig. 2.** Schematic of the sample mounted on the stage. Small magnets were placed at the four corners of the sample.

**Table 3**
XRD conditions.

| | |
|---|---|
| Tube voltage | 45 kV |
| Tube current | 200 mA |
| Scan range | 5–40° |
| Scan speed | 4°/min |
| Incident slit box | 1° |
| Receiving slit box 1 | 1° |
| Receiving slit box 2 | 2 mm |

### 2.2.3. Microscopy

Graff "C" stain is general analysis of paper fibers and also introduced in forensic handbook [1]. A modified method based on the TAPPI standard method Graff "C" stain (Test Method T 401 om-08) was used to prepare the microscopic sample for pulp observation. Small pieces of the sample (about 1 cm × 1 cm) were dissolved in boiling 1% sodium hydroxide for a few minutes, washed with water, and then neutralized with 0.2% hydrochloric acid and washed again. Individual pieces were defiberized by rolling into small pellets between the fingers, and then placed in a tube. A small amount of water was added and the tube was shaken vigorously until the small pieces of sample disintegrated. The suspension of fibers was spread on a clean glass slide and the water was evaporated. The dried pulp on the slide was "C"-stained, and the color of the pulp was observed by transmitted light microscopy.

## 3. Results

### 3.1. Grammage

The grammage was clearly increased by double-sided color printing. The increase was similar for the samples printed with the same printer, regardless of the brand of paper, and the standard deviation was small. The weight increase for laser printing was larger than that for inkjet printing (Fig. 3). The grammage of

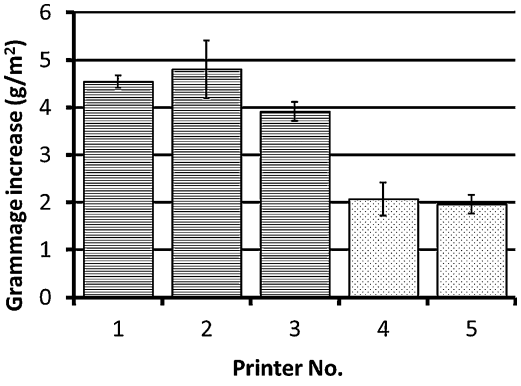


**Fig. 3.** Grammage increase of printed papers ($n$ = 15, mean ± SD). The grammage increase for laser printing (No. 1–3) was about twice as large as that of inkjet printing (No. 4–5).

Download English Version:

https://daneshyari.com/en/article/95306

Download Persian Version:

https://daneshyari.com/article/95306

Daneshyari.com