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A comparison of the use of vacuum metal deposition versus cyanoacrylate fuming for visualisation of fingermarks and grab impressions on fabrics

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ABSTRACT

Both vacuum metal deposition (VMD) and cyanoacrylate fuming (CAF) are techniques used to visualise latent fingermarks on smooth non-porous surfaces such as plastic and glass. VMD was initially investigated in the 1970s as to its effectiveness for visualising prints on fabrics, but was abandoned when radioactive sulphur dioxide was found to be more effective. However, interest in VMD was resurrected in the 1990s when CAF was also used routinely. We now report on studies to determine whether VMD or CAF is the more effective technique for the detection of marks on fabrics. Four different fabrics, nylon, polyester, polycotton and cotton, were utilised during this study, along with 15 donors who ranged in their age and ability to leave fingermarks, from good to medium to poor, thus reflecting the general population. Once samples were collected they were kept for a determined time (1, 2, 3, 4, 5, 6, 7, 14, 21 or 28 days) and then treated using either the gold and zinc metal VMD process or standard cyanoacrylate fuming.

The smoother fabrics, such as nylon, consistently produced greater ridge detail whereas duller fabrics, like cotton tended only to show empty prints and impressions of where the fabric had been touched, rather than any ridge details. The majority of fabrics did however allow the development of touch marks that could be targeted for DNA taping which potentially could lead to a DNA profile. Of the two techniques VMD was around 5 times more effective than CAF, producing a greater amount of ridge detail, palmar flexion creases and target areas on more samples and fabrics.

1. Introduction

Fabric is a notoriously difficult substrate from which to acquire and visualise latent prints and, even though several techniques have been investigated, the UK Home Office Manual indicates that there is "no proven process" of developing latent fingermarks on fabrics [1]. Recently, we reported on the visualisation of fingermarks and grab impressions on fabrics using gold/zinc vacuum metal deposition (VMD) [2] and the use of silver VMD in a similar process but on dark fabrics [3]. The current study concentrates on a comparison of the two techniques, vacuum metal deposition (VMD) and cyanoacrylate fuming (CAF), in order to determine which methodology is the most effective for the visualisation of planted fingermarks and grab impressions on selected fabrics.

VMD, the older of the two techniques, was first reported in the 1960s [4] and its first use in an operational sense was described for polythene by Kent et al. in 1976 [5]. Later, CAF was established by several groups in Japan, Britain, and Canada as a method for developing latent fingermarks [6,7]. While both VMD [8] and CAF [9] are effective methods of visualising latent prints on non-porous surfaces such as plastics and glass, VMD has the advantage that it can develop fingermarks on articles that have been wet or aged. However, VMD does have high start-up costs, needs an experienced operator and can only process one sample at a time. In comparison, CAF tends not to work well on old prints or those subjected to "harsh environmental conditions" [10] but CAF is cheaper to set up and run, multiple samples can be processed at one time, the system can be automated [1] and, in some cases, may be used at crime scenes [11]. These benefits explain why, generally, CAF is more widely used in the development of latent prints compared to VMD.

With VMD (deposited metal) and CAF (polymer), the visualant adheres to, or interacts, with different components of the fingerprint residues, so the appearance of the visualised latent fingermark, even on the same substrate, appears quite differently. VMD will usually visualise negative prints with the valleys adopting the colour of the

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vaporised metals applied, such as grey when gold then zinc are used, and the ridges, as they are protected by the fingerprint residues, will be the colour of the background substrate [8,12]. CAF will visualise positive prints due to the cyanoacrylate polymerisation being catalysed by the water and sodium chloride in the fingerprint deposits forming a white polymer [13]. Since, the polymer does not tend to form on the background substrate the fingermarks stand out from the surface as a visible print. One disadvantage of CAF is that if the surface is of a light colour the contrast may not be enough and therefore further enhancement with fluorescent dyes, such as basic yellow 40, is necessary [6].

Direct comparisons of both techniques have been carried out previously. VMD was found to produce about 12% more prints than CAF treated with basic yellow 40 on polyethylene bags [14]. However, more recent work shows that CAF is in fact more effective than VMD on modern plastic packaging, due to changes in the CA composition since the 1980s [15]. VMD was around 17% more effective than the use of CAF followed by fluorescent dye fuming for low density polyethylene [16] and the use of VMD alone, CAF alone and CAF and VMD in sequence was reported for glass slides [17]. While both VMD and CAF are more traditionally used on smooth surfaces such as plastics, several studies dating back to the 1970s [4] showed that VMD had different levels of efficacy on fabrics. The problematical nature of fabrics was also reported [18] and the limited success obtained depended on the fabrics having a smooth clean fine weave surface, such as seen with silk or nylon.

To our knowledge no work has been reported on the use of CAF with fabrics, therefore this study was designed to determine whether VMD or CAF was the more successful in the visualisation of latent fingermarks on these surfaces.

2. Materials and methods

The fabric types used in this study were cotton, nylon, polyester and polycotton (60% cotton and 40% polyester mix) and all were white in colour. All the fabrics complied with the Home Office requirement of a minimum of 3 threads per mm on fabrics being examined for fingermark development [1]. The fabrics were prepared for deposit collection by cutting 23 cm × 16 cm sized samples that were labelled with the fabric type, hand position (F—fingers, P—palm), donor number, and process day. These specimens were then kept in plastic wallets until they were processed with either gold/zinc VMD or CAF/BY40.

The 15 donors used in this study were a mix of males and females who ranged in age (35 to 60) and their potential to leave fingermark deposits (previously graded on paper). Prior to collection, the donors had not washed their hands for at least 45 min so the deposits left were “normal” and not “loaded”. The fabric swatch was laid on the collector's arm and the donor “grabbed” the sample firmly for 10 s thus depositing a mark. Only one sample was collected at a time, with a minimum of 45 min between collections if more than one sample was collected in a day, thus allowing for replenishment of fingerprint residues. After acquisition, the samples were placed in plastic wallets, in the dark, at room temperature for 1 to 7, 14, 21 or 28 days and were then processed. Overall, 600 samples, consisting of 15 donors × 10 days × 4 fabrics × 2 techniques (VMD and CAF) were acquired.

The VMD equipment used in this study was a round chambered Edwards 24″ metal deposition unit, and was operated as described previously [2]. The CAF samples were processed in a Mason-Vactron unit (MVC3000) using standard operating procedures. The fabric samples were hung in the cyanoacrylate fuming cabinet and ethyl cyanoacrylate (2 g; CSI Ltd. Superglue) was added to the aluminium foil dish in the heater. The fuming was commenced using a standard 45-min cycle with a humidity of 80% and temperature of 120 °C (15 min relative humidity cycle, 15 min superglue cycle and 15 min purge cycle). The samples were processed by dipping in basic yellow 40 solution (2 g in 1.0 L of ethanol) for 1 min, then rinsed under running tap water until the water ran clear. The fluorescent dye binds to the white CAF polymer and allows the impressions to be visualised under Quaser light (350–469 nm) and they were then photographed using a digital camera fitted with a 476 nm viewing filter.

The visualised marks were graded, from “No development” to “Excellent”, depending on the amount of ridge detail observed:

(0) No development—no visible or recognisable marks on fabric.
(1) “Empty” prints—where the donor had touched the fabric could be seen but no ridge detail observed on fingertips or palm.
(2) Fair—pattern and ridge flow and/or palmar flexion creases are visible, but with not enough detail for identification.
(3) Good—ridge characteristics (Galton details) are visible on some fingermarks.

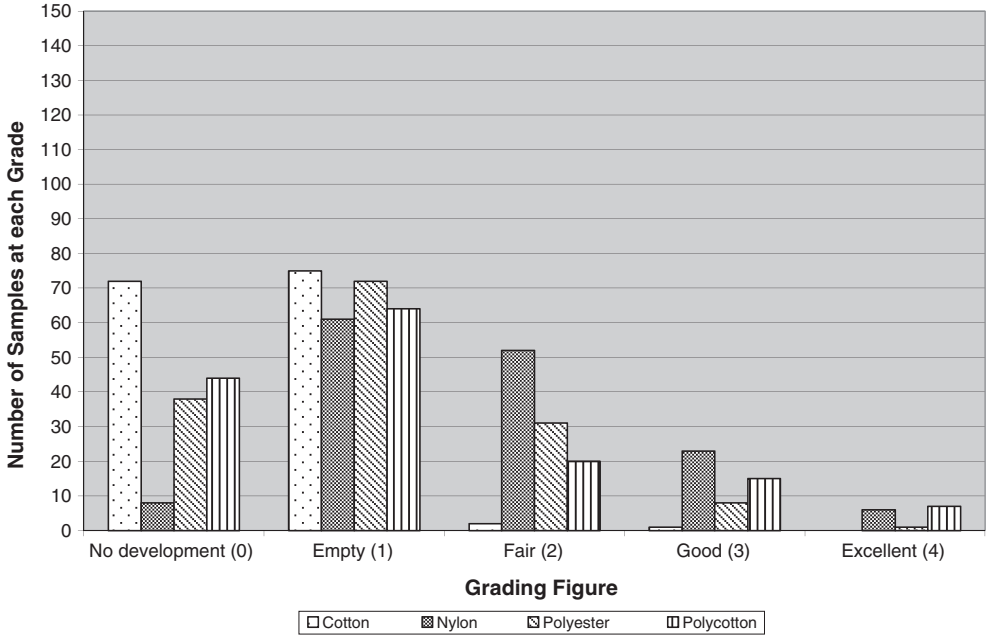

Fig. 1. Overall grading from 0 (No development) to 4 (Excellent) of samples on all fabric types visualised with VMD.