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Sputter coating a viable alternative for the development of latent prints on non-porous surfaces

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Abstract

Vacuum metal deposition and cyanoacrylate are standard techniques for the development of latent prints on non-porous surface. This paper reports sputter coating of latent prints using gold as an alternative technique for the development of such prints. In this study 50% of all the latent prints developed with sputter coating revealed 12-16 minutiae previously identified on a control ink print. Comparison of vacuum metal deposition, cyanoacrylate and sputter developed marks initially suggest that sputter coating is slightly less favourable at visualising identifiable features. However, independent examination suggests the increased clarity of sputter coated latent prints make it a comparable if not superior technique to vacuum metal deposition and cyanoacrylate. Because of sputter coatings low running and maintenance cost, compared with the other available techniques, sputter coating has the potential to become the technique of choice for the development of latent prints on non-porous surfaces.

Keywords: Latent prints; Vacuum metal deposition; Sputter coating; Fingerprint

Introduction

Cyanoacrylate fuming and vacuum metal deposition (VMD) are the standard techniques used for the development of latent prints on non-porous surfaces in forensic science laboratories in the UK [1]. VMD is a more sensitive technique than cyanoacrylate fuming especially when developing older latent prints [2, 3]. However, VMD is rarely used for fingerprint development because it is very labour intensive, has high running and set up costs, and requires a trained operator to optimise the development of latent prints.

VMD was first investigated as a technique for latent print development in the 1960's [4] and the first cited operational use was in the 1970's [5]. The standard VMD approach operates on a two step process. A very thin nucleating layer of gold is deposited uniformly on a latent print followed by a layer of zinc. The zinc only deposits on a non-metallic surface if it is at a low temperature or a nucleating metal has been deposited, it therefore forms a visible film on the gold which has not absorbed in the latent print, apposed to no film where the latent print is present.

This process has been simplified in a technique called multi-metal deposition [6] and further enhanced to deposit gold enhanced by silver on latent fingerprints [7]. This revised technique has been shown independently to increase effectiveness for latent print development, however like VMD it is labour intensive and costly. In recent years a pioneering version of single metal deposition which reduces the set up time and cost by a third has been developed [8].

A similar single metal approach to coating is used in the preparation of sample for examination by electron microscopy where a thin layer of gold is sputter coated over a specimen to increase its conductivity. Sputter coaters are associated with scanning electron microscopes which are routinely found in forensic

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science laboratories. Sputter coaters do not require specialised operators and are substantially cheaper to operate and maintain than VMD.

A process known as direct current (DC) metal sputtering had been previously investigated for its potential for the development of latent prints. The use of DC metal sputtering with copper, zinc, platinum or gold with platinum to aid the development latent prints on polythene surfaces showed that DC platinum sputtering developed prints to a higher sensitivity that cyanoacrylate fuming on aged fingerprint deposits [9].

DC sputter coating was not presented as an alternative to VMD neither has it been widely adopted by forensic science laboratories [9]. Therefore in this report the use of a sputter coater as a viable alternative to cyanoacrylate fuming and VMD for the analysis of latent prints is examined.

Materials and methods

Sputter coating of latent prints was carried out using an Emitech K550X sputter coater, designed to deposit 1.66g/m carbon fibre with a diameter of 2.5mm. With a Emitech 60mm foil target with a purity estimate of 99.99% at a vacuum of $3x10^{-4}$ mBar. Based on preliminary experiments a concentration of 60mm of carbon and 50 mA of gold was used to sputter coat latent prints for all the experiments reported here.

Ten sets of latent prints (index, middle, ring and little) were collected and deposited onto clean sterile glass microscope slides. Latent prints were not preloaded but were deposited by a standard rolling technique. After development latent prints were classified by counting the number of minutiae visible, from 16 identified at random on a control ink print.

Fingers were compared by categorising them into set groups using an adaptation of a method described by Masters & DeHaan 1996 used for analysing cyanoacrylate and VMD developed latent prints [2]. The original method had two groups, those containing 1-7 identifiable features, and those containing 8 or above. However, this method only looked for a maximum of 8+ features so the categories have been adapted to 0-3, 4-7, 8-11 and 12-16 features identifiable for the purpose of this study.

In addition single latent prints were deposited on polyvinyl chloride acetate (PVCA), polythene surfaces, and immersed in distilled water for seven days prior to development. The set of prints were developed using cyanoacrylate for comparison, using a standard method described elsewhere [2].

Results

Finger marks developed by sputter coating on a glass substrate (Figure 1) show a good level of detail. Both 1st (overall pattern shape) and 2nd level (minutiae) features are clearly identifiable in all prints and 3rd level detail (pore position) was present in some but not all prints.

The data in Table 1 indicates that half the sputter

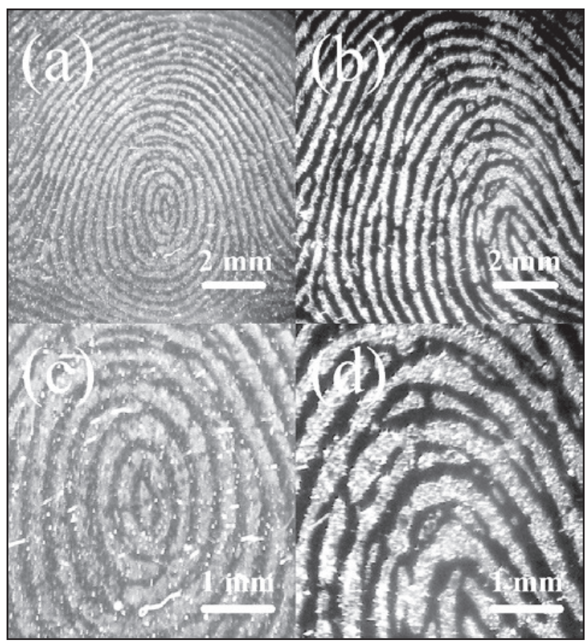

Fig.1 Representative sputter coated latent prints on a glass surface a) and b): Latent prints showing 1st and 2nd level detail. c) and d): close up views of developed latent prints showing 2nd and 3rd level detail.

coated developed latent prints (from an average of all fingers) are in the upper most classification category of 12-16 identifiable minutiae while 77% have at least 8 identifiable features, enough features to potentially make a positive identification. At least 90% of the latent prints developed have at least 4 identifiable features, enough

Table 1. The percentage distribution of identifiable minutiae on latent prints from different fingers developed by sputter coating on a glass substrate.

Identifiable Featuresl	Index	Middle	Ring	Little	Average
0-3	10%	0%	0%	20%	7.5%
4-7	40%	10%	10%	40%	25%
8-11	10%	20%	10%	30%	17.5%
12-16	40%	70%	80%	10%	50%

Table 2. The percentage distribution of the identifiable features visualised using three techniques on non porous surfaces.

Identifiable features	VMD	Cyanoacrylate	Sputter Coating
0	4.8%	0%	0%
1-7	9.5%	14.3%	32.5%
8+	85.7%	85.5%	67.5%

to provide useful information to a forensic examiner. There are noticeable differences in the percentage of 12-16 identifiable features between fingers, the middle and ring fingers have a higher percentage ($\geq$ 70%) than the index and little fingers ($\leq$ 40%). In only 3 prints of the 40 examined were no identifiable features located.

To allow comparison(see Table 2)., data previously published by Masters & DeHaan in1996 developing latent marks on glass with VMD and cyanoacrylate was compared with date from sputter coating on the same surface [2].

It can be seen using this classification scheme that VMD and cyanoacrylate fuming are both comparable, allowing visualisation of at least eight minutiae in 85% of developments. Sputter coating by comparison shows 8+ features on 67.5% of prints, but eight features is enough to make a positive identification. When developing latent prints with VMD approximately 5% of the time it failed to develop any identifiable features, whereas cyanoacrylate fuming and sputter coating always developed at least one feature. With at least one feature identified some useful information is always generated from sputter coating of latent marks [2].

Latent prints were developed on two alternative surfaces, a black Polythene bin bag and a PVCA credit card (Figure 2). Both surfaces reveal latent prints that show comparable detail to that visualised on glass. Latent marks (on glass) immersed in water for seven day were also developed by sputter coating, for comparison an identical print was developed using cyanoacrylate fuming. A comparison of the cyanoacrylate and sputter coated prints show similar levels of detail between the two types of prints (Figure 3). Prints were independently examined by Derbyshire Constabulary Scientific Support, UK who confirmed sputter coated prints reveal more detail at higher degree of clarity than cyanoacrylate fuming [10].

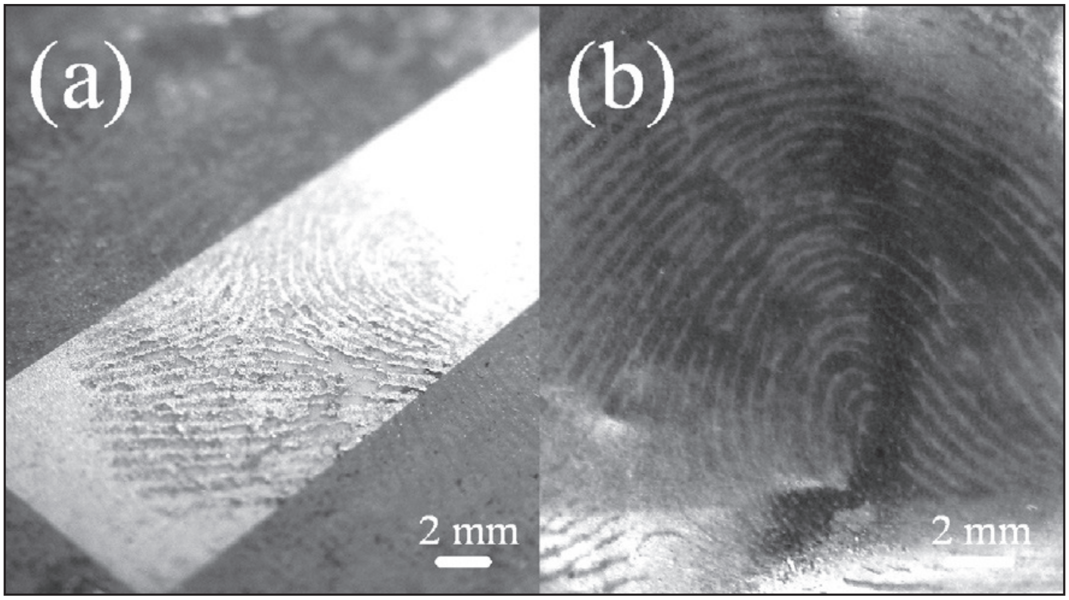

Fig.2 Sputter coated latent prints developed on a) PVCA credit card b) Polythene bin bag. Both prints reveal 1st and 2nd level detail.

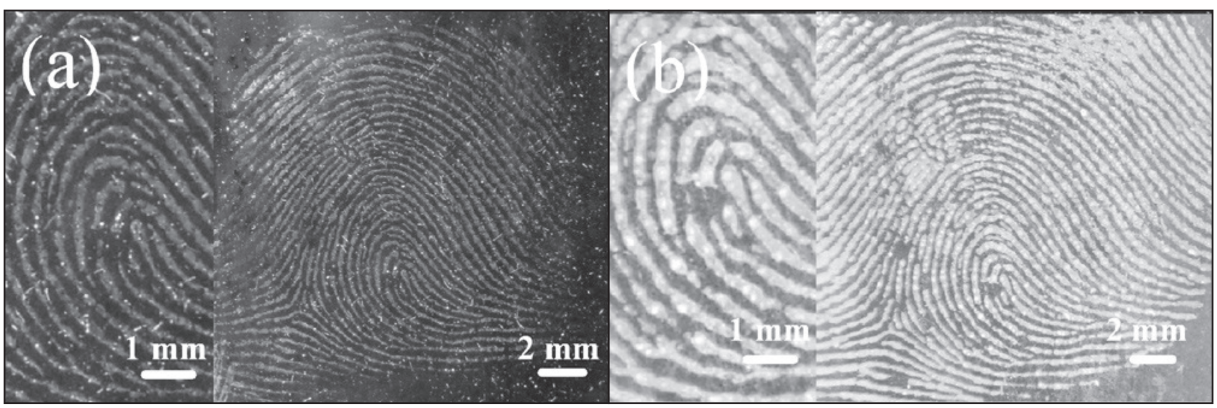

Fig.3 Identical latent prints developed with a) sputter coating and b) cyanoacrylate fuming. Both prints reveal 1st, 2nd and 3rd level detail.

Discussion

Sputter coating is a technique in its infancy as a latent mark development tool. This report shows it to be a viable technique on a broad range of non-porous substrates; including glass (Figure 1) polythene and PVCA (Figure 2) and wet non-porous substrates (Figure 3). VMD and cyanoacrylate have previously been shown to be able to develop prints on all these surfaces [2,3 &11]. Sputter coating developed on the range of substrates have been judged by professionals at Derbyshire Constabulary Scientific Support to be as good as prints by standard non-porous development techniques such as cyanoacrylate [10]. Prints developed on glass show 1st and 2nd level detail and in some instance 3rd level detail. Presence of 3rd level detail though obscured in some prints could be enhanced by further research and development of the sputter coating process.

Finger variation occurred with the development of prints on glass by sputter coating (Table 1). This variation could be caused by variations in pressure when depositing the latent print or fingerprint ‘slippage' when depositing latent marks on a smooth surface. The aggregates of gold depositing on the surface could also cause some variation [12]. In VMD gold initially forms new aggregates leading to aggregate density increasing significantly. As new aggregates reach a certain size no new aggregates form but the old existing ones appear to increase in size. These increasing sized aggregates could result in no new zinc being deposited as they no longer act as nucleation sites for zinc. The size of gold aggregates has been shown to be critical (in VMD) for development of latent marks and further refinement of the methodology could reduce this phenomenon in sputter coating of latent marks [12-14].

Although no direct comparison has been reported between VMD and sputter coating in their ability to develop latent print, a comparison of these techniques and cyanoacrylate using data previously published can be made. This analysis suggests that both VMD and cyanoacrylate are better at visualising a high number of minutiae that would be required for identification. Although this comparison may initially show sputter coating to be an inferior technique it develops at least 4 features 90% of developments and always allowed the visualisation of at least one feature, which did not occur with VMD prints.

Sputter coating may reveal fewer features, but the latent prints were judged to have a good level of clarity by experts in the field [10]. VMD and cyanoacrylate prints despite having a high percentage of 8+ features were only classed as having distinct clarity (as appose to useful clarity) in 23% and 14% of cases respectively [2]. The results suggests that although all features (out of 16) were not always visible in sputter coating, the prints were of an overall better quality and could reveal more feature outside the 16 selected for this study.

The difference observed in the quality of the prints could be explained in a number of different ways including; the number of print donors in the two studies which was multiple in the case of VMD and cyanoacrylate and single in sputter coated developed prints. The age of prints could also account for some difference, it was varied in VMD and cyanoacrylate and one age in sputter coated developed prints. Both these factors have previously been shown to have an effect on the number of minutiae visualised and the clarity of prints [15].

Conclusions

The technique of sputter coating described here may offer a realistic alternative to the time consuming and costly process of VMD. Initially sputter coating appears to visualise less features than VMD and cyanoacrylate fuming. However, photographs and expert testimony have suggested that clarity is improved [10]. Considering the length of time that cyanoacrylate and VMD have been practised and developed in forensic laboratories the potential of sputter coating is very exciting for fingerprint development in the future.

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