Home Office
Scientific Development Branch

Fingerprint and Footwear Forensics Newsletter

October 2006 **Publication 58/06**

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Programme Update

Fingerprint and Footwear Forensics

Since our last newsletter was published our programme of work has changed to include a project on the development and imaging of footwear impressions. In order to reflect this, the name of the programme has changed to Fingerprint & Footwear Forensics (FFF). The title of our User Group, chaired by Tristram Elmhirst, Head of Forensic Services at West Mercia Constabulary, has also changed to the Fingerprint and Footwear Forensics User Group (FFFUG).

You will find more detail about the footwear project later in this newsletter.

FERRT Course at HOSDB

The Centrex National Training Centre for Scientific Support is upgrading its training facilities at Harperley Hall. Major building work started in September with the demolition of the laboratories used for the FERRT course. During this phase of the build at Harperley Hall the HOSDB laboratories were used to run the two week FERRT course.

Steve Bleay preparing Vacuum Metal Deposition equipment for FERRT students and trainers at HOSDB laboratories

News from the Scientific Support Laboratories' Group

We invited Andy Ritchie, Assistant Director for GMP's Scientific Service Branch and National Fingerprint Board (NFB) member for Scientific Support Laboratories to contribute a brief update to this publication

and its readers on recent developments regarding changes to the reporting of laboratory matters.

'Further to the most recent NFB meeting in September, it has been agreed for the Scientific Support Laboratories' Group (SSLG) to be a work group in its own right, rather than a Development Group sub-group. This represents a significant step in raising the profile and value of laboratory work. The continued interest and support of CC Michael Baxter (NFB Chair) and DCC Barry Taylor in this business area is much appreciated.

Forces should have received a letter from Mr Baxter, providing notice of the intention to begin the collection of Laboratory Performance Indicators. The initial pilot will start in November with the aim of formal introduction in April 2007.

Meetings have been held between Val Bowman, Tristram Elmhirst, Peter Hall (SSM, GMP) and myself to improve communication between stakeholders in laboratory matters and to provide clarity in the development of strategic and tactical issues pertaining to laboratory work. Significant progress has already been made to ensure that Scientific Support Managers and laboratory practitioners are equally sighted and engaged on the future.

The next SSLG Conference is provisionally set for 5 & 6 June 2007 at Chancellor's, Manchester: further details will follow.

Please remember that communication is vital to maintaining good progress: therefore, feel welcome to address any comments or ideas relating to Scientific Support Laboratories to either Val Bowman

(valerie.bowman@homeoffice.gsi.gov.uk)

or to me.

(Andrew.Ritchie@gmp.pnn.police.uk)'

Andy Ritchie, October 2006

Summary Reports of recent studies: Development Techniques

Use of DMAC on Thermal Papers

We often receive enquiries about processes not currently recommended in the Manual of Fingerprint Development Techniques (MoFDT). In many cases we have previously evaluated the technique and found its performance to be inferior to published processes but in other cases more research may be required.

One process that falls into this category is DMAC (Dimethylaminocinnamaldehyde), a chemical that was first investigated for fingerprint development on porous surfaces in the 1970s. A formulation based on a solution of DMAC in CFC was produced, which gave a red/pink reaction product with fingerprint residues. The DMAC formulation was believed to react with the urea component in the fingerprint. Although giving good results in laboratory tests, the formulation was withdrawn from operational use when it was discovered that its performance was significantly poorer than Ninhydrin, especially when marks were more than a few days old. Diffusion of the developed marks was also observed.

More recently DMAC has again been proposed as a fingerprint reagent, in particular for development of fingerprints on thermal papers. The technique proposed involves impregnating sheets of paper with a solution of DMAC in methanol and allowing them to dry. The thermal receipts are sandwiched between two layers of the DMAC-impregnated paper and kept in a press overnight. The DMAC fumes permeate the thermal receipts and react with the fingerprint deposits to give a fluorescent product.

Marks developed in this way are viewed by illuminating with the broad blue Quaser excitation band (400 – 519nm) and using a 529nm viewing filter.

The stated advantages of this technique over the existing Ninhydrin and DFO formulations for thermal papers are that it does not cause any blackening of the thermal paper and all of the text remains visible, as shown in the image below.

Areas of ridge detail on a thermal receipt processed using DMAC

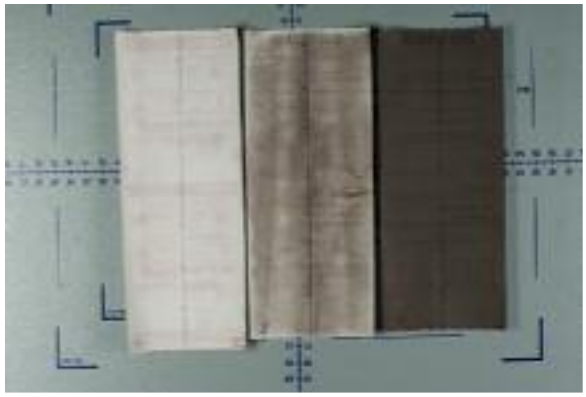
The Fingerprint and Footwear Forensics User Group asked for a comparative study to be carried out to establish the relative effectiveness of DMAC fuming, DFO and Ninhydrin. The study was carried out by Jodie Lee, an undergraduate student from Lincoln University on summer placement at HOSDB.

Four main areas were investigated:

1. What is the best Ninhydrin/DFO formulation to use on thermal papers?
2. With which fingerprint constituent does DMAC react?
3. How effective is DMAC in relation to Ninhydrin and DFO?
4. Is it possible to use DMAC in a sequential process?

1. For Ninhydrin and DFO, three approaches were considered: the standard MoFDT formulation, the MoFDT formulation for thermal receipts and pre-dipping in ethanol for 5-10 seconds to remove thermal printing followed by processing with the standard MoFDT formulations. Results from the trial of different ninhydrin processes are shown in the next image; results for DFO formulations are very similar.

It can be seen that the ethanol pre-dip is by far the most effective in producing a clear background, although all printed text is removed. In some cases the 'thermal paper' formulation results in the same surface blackening as seen with the standard process, a result not previously observed when the 'thermal paper' formulations were devised. The ethanol pre-dip followed by processing with the standard MoFDT technique was used for the comparative trials with DMAC.



Effect of different Ninhydrin formulations on thermal papers: from left to right; ethanol pre-dip followed by standard MoFDT formulation, 'thermal paper' MoFDT formulation, standard MoFDT formulation.

2. To identify the component of the fingerprint residue with which DMAC is reacting, small discs of filter paper were impregnated with fingerprint deposits, urea solution, sodium chloride solution, an amino acid mixture and a lipid mixture. All were processed using the DMAC 'fuming' development technique outlined above.

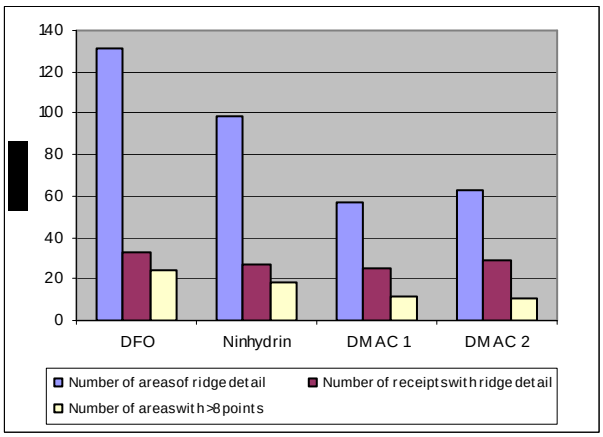
The excitation and emission spectra were obtained from each sample using a spectrofluorophotometer. The results indicated that the DMAC fuming technique does not react with urea, but appears to react with amino acid constituents.

3. To establish the relative effectiveness of DMAC, DFO and Ninhydrin experiments in the laboratory were followed by a pseudo-operational trial. For the pseudo-operational trial a bundle of assorted thermal receipts was divided into three batches of 33 receipts, each batch containing an equivalent mix of thermal receipt types (i.e. three 'Tesco' receipts in each batch, two 'Esso' receipts in each batch, etc.). One batch was processed using DMAC, one using ethanol pre-dip followed by DFO and the final batch using ethanol pre-dip followed by Ninhydrin.

The developed receipts were assessed in terms of overall areas of ridge detail, number of receipts yielding ridge detail and areas of ridge detail developed with >8 visible minutiae.

The initial DMAC experiment was carried out using impregnated sheets approximately one month old (DMAC1), so the test was repeated using freshly prepared sheets to see if this affected the outcome (DMAC2).

The results of this test are summarised below.



Comparison of different processes in pseudo-operational trial on thermal receipts

All of our experiments, both in this trial and in laboratory tests, demonstrated that the performance of DMAC is significantly poorer than the processes currently recommended for treating porous surfaces, developing only approximately 50% of the marks obtained using DFO.

4. Finally, the position of DMAC in a sequential processing route was examined. The receipts from the above trial were divided and processed in the following sequences:

DMAC – DFO

DMAC – Ninhydrin

DFO – DMAC

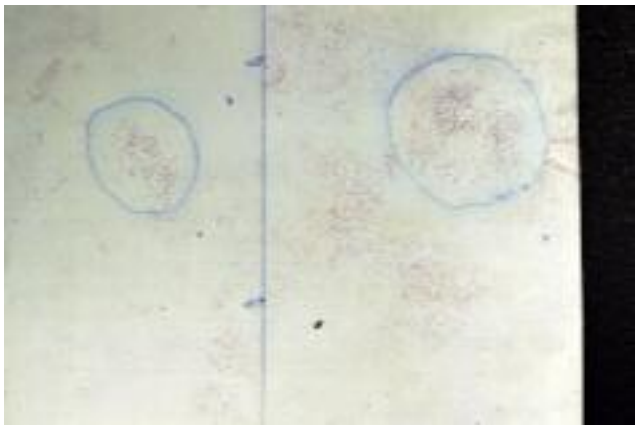
Ninhydrin – DMAC

The results are summarised below:

Sequence	Added areas of ridge detail	Removed areas of ridge detail	Added areas >8 pts	Removed areas >8 points
DMAC/ DFO (1)	22	2	1	1
DMAC/ Nin (1)	22	1	3	1
DMAC/ DFO(2)	22	0	2	1
DMAC/ Nin (2)	22	0	4	0
DFO/ DMAC	0	0	0	0
Nin/ DMAC	1	0	0	0

Results of sequential processing

It is evident that both DFO and Ninhydrin can be used after DMAC and will develop additional ridge detail. The use of DMAC after DFO and Ninhydrin developed few, if any additional marks. An example of additional areas of detail developed using Ninhydrin after DMAC is show below.



Additional areas of ridge detail developed using Ninhydrin after DMAC (areas originally developed using DMAC are ringed in blue)

Conclusions

From these experiments, it appears that DMAC is significantly less effective than both DFO and Ninhydrin on thermal receipts and in conclusion, we do not recommend it for operational use. However, if it is necessary to retain the printed text on the receipt, the process might be used bearing in mind that other techniques (e.g. Physical Developer, ThermaNin, 1,2 Indandione) may still be more effective in developing marks and retaining printed text. Research into the use of these techniques on thermal papers is planned for later this year.

Pre-dipping thermal receipts in ethanol prior to processing with Ninhydrin or DFO is the most effective method of preventing the blackening of thermal receipts during processing. This approach could be used in preference to the 'thermal receipt' formulations in the MoFDT.

Using the current DMAC fuming technique the DMAC does not appear to react with the urea in fingerprints; instead there appears to be a reaction with the amino acid component of fingerprints. This is in contrast to the proposed mechanism of the original DMAC solution.

DFO and Ninhydrin can both be used after DMAC in a sequential process and will develop additional marks. However, initial indications are that DFO or Ninhydrin alone will produce more marks than a DMAC-DFO or DMAC-Ninhydrin sequence. DMAC used after DFO and Ninhydrin appears not develop any significant additional detail.

Physical Developer

EEC Directive 2003/53, which came into force in 2005, imposed restrictions on the marketing and use of nonylphenol (NP) and nonylphenol ethoxylates (NPE).

Synperonic N, one of the co-detergents used in the Physical Developer process (PD) is an NPE class compound. The directive stated that NP and NPE compounds may not be placed on the market or used as a substance or constituent of preparations in concentrations equal to or higher than 0.1% by mass for nine different purposes. Although this did not apply to the PD process directly, HOSDB felt that Synperonic N may become harder to purchase in the future, if it becomes less economic to produce. A piece of work to look for a possible replacement was started.

In the course of this work it was confirmed that it would not be possible to synthesize Synperonic N because it is a complex mixture of isomers and a small change in the composition may have a profound effect on the finely balanced performance of the process.

Seven alternative detergents were identified as possible replacements but unfortunately PD solutions made with any of them proved to be less effective at developing fingerprints than the original formulation. This is in line with other attempts by researchers to substitute this component of the formulation.

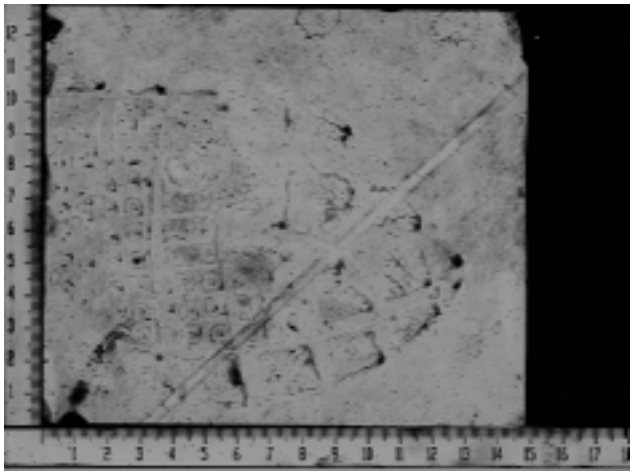
Until HOSDB has tested other possible detergent replacements as they are identified, there is no change to the recommendations in the MoFDT.

Footwear Project Update

For many years the contribution of shoe-mark data to police intelligence, crime detection and prosecution has been considered undervalued by many working in this field. Nevertheless, it is generally recognised that marks left by a suspect's footwear at a crime scene may be extremely valuable in the ensuing investigation. In August 2005, a joint ACPO/PSU workshop was held to define a vision for the capture and exploitation of footwear evidence and intelligence by the police service of England and Wales. This was held ahead of legislation changes on 1 January 2006, enabling the police service to take footwear impressions from suspects apprehended by the police. For this vision to succeed, gaps in the current system were identified and work streams set up to fill these gaps. Several areas of work were identified for HOSDB and have been endorsed by the Fingerprint and Footwear Forensics User Group.

Since the ACPO/PSU workshop, we have visited police forces, forensic suppliers and companies in order to improve our understanding of the whole process from scene of crime or custody suite procedures to methods for making comparisons for intelligence or identification purposes.

One of the areas identified was the setting of standards for imaging of footwear marks at scenes of crime or in the custody suite and this work has now been approved by HOSDB as part of the Digital Capture of Crime Scene Marks project and is being managed by Stephen Bleay.



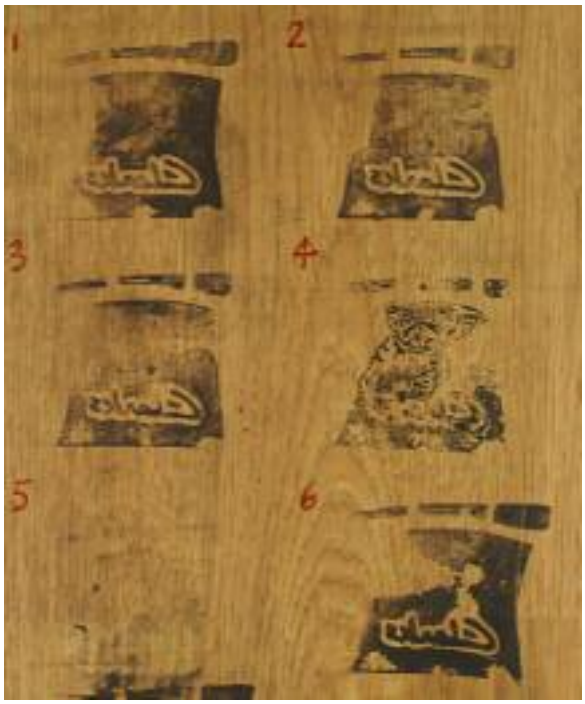
Reverse image of a dusty footwear mark lifted from lino flooring with a black gel-lifter and imaged using the BVDA GLScan.

HOSDB was also asked to provide information on development techniques and retrieval methods for the recovery of footwear marks at the crime scene which could be included in a best practice manual. This work forms the major part of the footwear project and is managed by Helen Bandey.

In order to focus our efforts, a workshop was held in March 2006 to identify problematic areas of footwear retrieval. This included identification of likely footwear contaminants (eg. blood, soil etc) and the possible surfaces on which they might be

deposited (eg carpet, tarmac etc). We also explored the likely frequency of occurrence of these contaminants and surfaces in investigations and the perceived difficulty of retrieval of footwear marks in these situations. This, to some extent, has enabled us to prioritise the materials and surfaces which would give maximum benefit to the police service.

We are now mid-way through a six-month feasibility study where we are assessing the potential of currently used fingerprint and footwear development techniques as well as other possible enhancement processes across a range of surfaces and contaminants. The figure below shows a typical surface (laminate flooring) treated with a fingerprint process for various contaminants.



A sample of footwear marks made with a range of contaminants on laminate flooring and treated with a fingerprint development process.

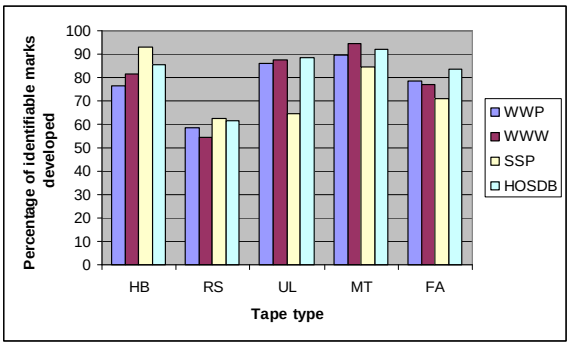
Once we have reviewed the results of the feasibility study with the FFFUG and other practitioners, potentially useful processes will be studied in more detail in a full project along with blood enhancement reagents (including luminol) and lifting methods.

White Powder Suspension for Adhesive Tapes

Earlier this year HOSDB supplied each police force with some titanium dioxide powder. This particular grade had been identified from a large number of possible candidates as the most successful for use in the white powder suspension (WPS) process for dark coloured adhesive tapes. The source of this supply and grade is no longer available but since it proved so successful, we would like to be in a position to be able to recommend an alternative which performs at least as well as the original. As well as a detailed examination of the action of the original powder, in order to understand why it performed so well, we have undertaken a comparison of its performance with the commercially available WPSs.

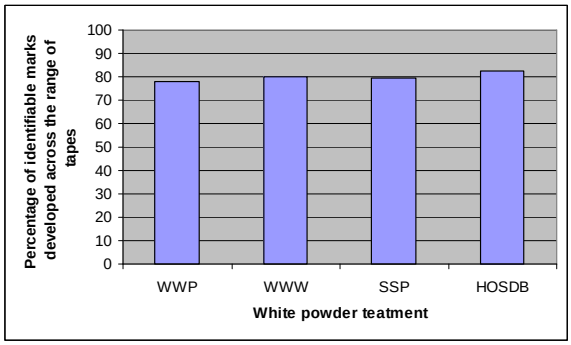
We investigated the performance of three commercially available WPSs (White Wet Powder [WWP: Kjell Karlsson], White Wet Wop [WWW: Armour Holdings] and White 'Sticky-Side Powder' [SSP: Sirchie]) directly comparing each with the HOSDB white powder in the formulation that we currently recommend. In the course of these investigations almost 15000 fingerprints were developed.

The graph below shows the performance of the WPSs across a range of five black adhesive tapes.



Performance of white powder suspensions on a range of black tapes

Although there is some variation in the performance of the HOSDB formulation between the tapes, we found that the HOSDB powder as part of the HOSDB formulation was the most effective overall as shown in the graph below.



Average performance of WPSs across a range of tapes

Until we are able to update our information as the project progresses, our recommendation is that the HOSDB formulation should be used on all suitable dark coloured adhesive tapes. Suitability is judged on the lack of background deposition from the spot-test described in our earlier newsletter giving advice on 'Additional Fingerprint Development Techniques for Adhesive Surfaces' (Publication 23/06).

Operational Deployment of Nd:YAG Green (532nm) Laser and VMD

This year several forces have visited HOSDB with operational casework requiring specialist techniques, including laser examination and vacuum metal deposition. This has given benefits to both parties: in many cases police forces have been rewarded with marks being detected on the exhibits and HOSDB staff have been able to observe the effectiveness of recently published techniques on operational work first hand. As stated in previous newsletters we are happy to offer the use of our facilities for this purpose and to assist with the loan of equipment for evaluation. The laser has proved particularly popular in this respect with bookings for a loan period extending well into 2007.

Our experience of operational work using a combination of laser examination and VMD has revealed a consistent trend in the results. On several of the exhibits laser examination has revealed marks that are not developed by any subsequent fingerprint development techniques, including VMD. However, VMD carried out after laser examination has regularly developed marks not detected by the laser. In one case identifications were made to a householder from the marks detected by laser and to the suspects from the marks detected by VMD. The recently published VMD technique using silver has also successfully developed several marks on exhibits where the gold/zinc process was ineffective.

The laser has also been used to identify regions of ridge detail that can then be swabbed for DNA. This targeted approach has been shown to give a significant improvement in the number of DNA profiles obtained compared to speculative swabbing and has reduced the expense of processing large numbers of DNA swabs.

The important points to note from the experiences to date are:

Laser examination and VMD are both highly effective processes and should be used on all serious cases. The techniques are complementary and may develop different sets of marks.

Silver VMD has been shown to develop identifiable marks that would not have been brought up by the gold/zinc VMD process. Its use is recommended if the gold/zinc VMD process does not result in widespread zinc deposition on the exhibit.

It is well known that all fingerprint processes can be used to identify regions where exhibits have been handled and enable subsequent DNA swabbing to be targeted towards areas more likely to yield profiles. However, laser examination can offer additional benefits in some situations, where a non-contact technique may be needed.

Equipment Update

Labcaire Superglue Cabinet

In April 2003 we reported on a benchtop superglue cabinet manufactured by Labcaire (Publication 6/03). At that time the cabinet required some minor changes after a first evaluation at HOSDB. The changes were made and the effectiveness of the cabinet deemed satisfactory after subsequent testing. CSI Equipment Ltd, the current supplier of the cabinet, was asked by HOSDB to perform exposure monitoring tests for ethyl-cyanoacrylate around the cabinet during use. This was done by the Health and Safety Laboratory (HSL) and showed that levels are well below the

working exposure limit (WEL) for ethyl-cyanoacrylate.

Labcaire superglue cabinet testing at HOSDB

Dishes for Physical Developer

Devon and Cornwall police fingerprint laboratory have located a website that sells large pyrex dishes (40×27cm) suitable for physical developer. The website is www.newellcookware-europe.com.

Recent Publications

Over the last year, we have distributed a number of publications in addition to the regular newsletters.

The results of Part III of the powders project, comparing the performance of a range of powders for fingerprint development on textured or problematic surfaces, is to be published shortly.

This follows Part I (Publication 54/04, August 2004 – Evaluation of Fingerprint Brushes for Use with Aluminium Powder) and Part II (Publication 08/06, February 2006 – Evaluation of Fingerprint Powders on Smooth Surfaces).

A best practice guide for the recovery of fingerprints from arson scenes (Publication 26/06) was published in April. It includes guidance on soot removal as well as advice on best sequences of development techniques to use on different surfaces.

We try to ensure that these publications reach the right people but we are know that this is not always possible, especially if multiple copies are needed. If you would like additional copies please call Stephen Eldridge or visit our website (www.hosdb.homeoffice.gov.uk) to access and download pdf versions of all of our latest publications.

Please let us know if you have any difficulty accessing the information you need.

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