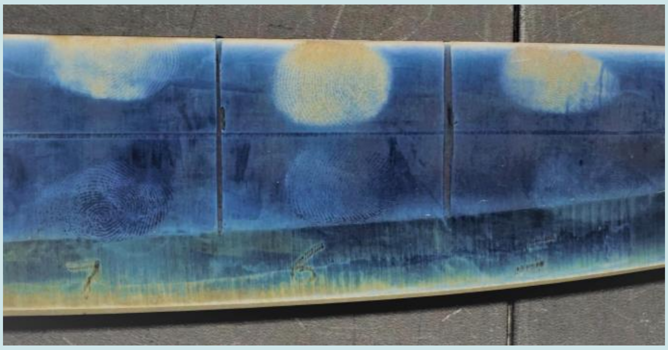
Fingermark Visualisation Newsletter

July 2020

IN THIS ISSUE



Images of RECOVER LFT treated samples displaying planted fingermarks on a stainless steel knife blade (top) and fingermark ridge detail developed on a naturally handled and subsequently fired 5.56mm brass cartridge casing (bottom)

INTRODUCTION

We hope everyone is keeping well during the current situation, and that this newsletter provides a refreshing break from the COVID-19 articles and stories ever-present on our screens and in the newspapers around the world.

This newsletter contains a range of articles covering topics from new compostable substrates to quality assurance via collaborative exercises and test targets. However, the main body of this newsletter reports findings from two recent in-house studies looking at the value of a promising new and novel fingermark visualisation process (RECOVER LFT) for use on metal surfaces. In all cases, the value of collaboration with external organisations, such as operational policing, government organisations, academia, industry and the international community, is instrumental in ensuring the outputs are both relevant and robust.

Closure of Dstl Sandridge site

After more than four decades of research, development and operational support, the fingerprint laboratory at Sandridge ceased functionality on 31st March 2020. Most of the team have now relocated to Wiltshire in readiness for new facilities at Porton Down. Over the summer, interim laboratories are to be used whilst we await completion of our refurbished laboratories, which we hope to have up and running towards the end of the year and fully operational in 2021. However, during this time of uncertainty and transition to new facilities, the team will be working hard to prepare an update to the Fingermark Visualisation Manual (FVM), publish research, progress projects with a range of external organisations, as well as overseeing the transfer of facilities to the new site.

Publication No. DSTL/PUB124325

RESEARCH AND DEVELOPMENT

Fingermarks on compostable 'plastics'

Huge amounts of single-use plastics are dumped into oceans and landfills every year resulting in an increasing drive to find more environmentally friendly alternatives. Compostable polymers ('plastics') are a new type of material that are growing in popularity as alternatives to traditional plastics. They are usually bio-based and decompose back into natural products, such as carbon dioxide and water, when composted. With these materials being increasingly used for everyday applications, such as magazine covers, food waste bags, supermarket bags etc., it is more likely that fingerprint laboratories will encounter them being submitted from crime scenes.

So how can they be identified? Materials which are certified as compostable under BS EN 13432 are identified with a range of logos, with different labels for items that are 'home compostable' or 'Industrial compostable'. Items that are 'home compostable' break down at lower temperatures, typically 20-30°C, over a period of up to 12 months, whereas Industrial composting occurs at 58°C (+/- 2°C) for a maximum of 6 months[1]. Unfortunately, we have also come across some packaging with no logo or explanatory text.

Examples of Logos from the UK's primary certification bodies for EN 13432, Din Certco (Germany) and TÜV AUSTRIA (formerly Vinçotte) (Belgium).

It is not currently known how effective fingermark recovery is from compostable polymer substrates compared to traditional polymers such as polyethylene and polypropylene. Compostable polymers biodegrade in a relatively short amount of time (months) and, in general, the process of composting happens more effectively in warm, damp conditions. Therefore, there is a concern that 'wet' fingerprint treatments or even high humidity, could affect surface integrity, and fingermark recovery.

To see if these surfaces are likely to present a problem for fingermark visualisation, Dstl carried out a small observation-based test using three different types of compostable polymer:

- A clear brochure wrapper with an 'OK Compost' logo (Industrial). The wrapper was crinkly and relatively rigid to touch.
- A white translucent magazine wrapper (potato starch based) with an 'OK Compost HOME' logo. This wrapper was soft and flexible to the touch:

- A green translucent food disposal bag with the industrial compostable 'Seedling' logo. The bag was very soft and flexible to touch, similar to the translucent magazine wrapper:

[1] Association for Organics Recycling. *Concise guide to Compostable Products and Packaging* (2011). Available from http://www.organics-recycling.org.uk/page.php?article=1983&name=Concise+guide+to+compostable+products+and+packaging. Accessed May 2020.

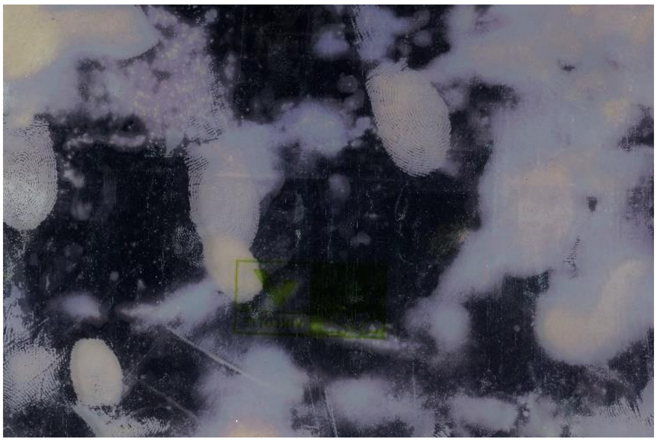
Following natural handling of the items, the three types of substrate were treated with three single processes that could be used on soft plastic:

- Vacuum Metal Deposition (VMD);
- Superglue Fuming followed by ethanol-based Basic Yellow 40 (BY40 (EtOH)) dye staining;
- Multi-Metal Deposition (MMD) (translucent magazine wrapper and green food bag only).

Preliminary Findings

Clear brochure wrapper

When treated using VMD gold/zinc, a patchy zinc coating formed rapidly. However, upon addition of silver, some further development occurred ‘filling in the patches’. The type of development observed was very similar to observations when treating thin, transparent polystyrene and polyethylene terephthalate films.



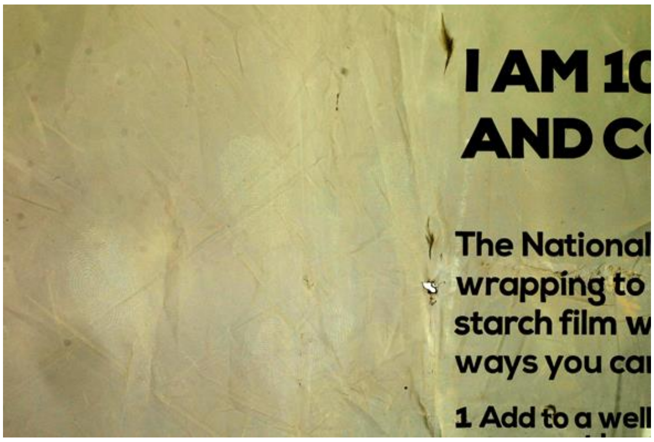
Clear brochure wrapper treated with VMD (gold/zinc then silver)

Superglue Fuming resulted in good development of fingermarks with clear ridge detail. Subsequent treatment with BY40 (EtOH) gave strong staining of the developed fingermarks with no detrimental effects to the polymer itself.

Clear brochure wrapper treated with Superglue Fuming then BY40 (EtOH)

White translucent magazine wrapper

Treatment with VMD resulted in no gold/zinc coatings and only a faint coating with silver. Some marks did develop but they were very faint and lacked contrast.



White translucent magazine wrapper treated with VMD (gold/zinc then silver) (with no post-imaging enhancement)

Processing this type of polymer with Superglue Fuming gave good development of marks, although these were white against a white background and not always easy to discriminate with white light (note: UV Reflection was not used but may prove beneficial). Upon BY40 (EtOH) treatment, the substrate curled a little and became saturated in solution. Upon drying, the substrate remained slightly curled but structurally sound. The surface had absorbed some of the BY40 dye but it did not interfere with viewing the marks. (Note: one-step superglue methods may prove beneficial if fluorescence is required).

White translucent magazine wrapper treated with Superglue Fuming – BY40 (EtOH)

The sample processed using MMD did not give particularly good discrimination of marks, with high background development.

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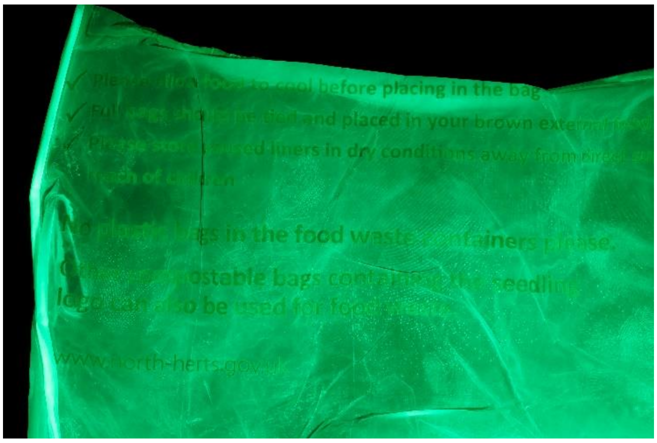
Food disposal bag

Treatment using VMD caused the rapid formation of a gold/zinc layer, negating the need for a silver cycle. Although paler in colour, the treatment provided good discrimination of the marks.

Green food disposal bag treated with VMD (Au/Zn)

Superglue Fuming caused the bag to curl slightly, suggesting elevated humidity within the superglue cabinet may have an impact on the polymer, and it was difficult to see if any marks had been developed.

Dye staining the bag made it 'soggy' and difficult to handle and caused curling. Although some marks were seen, it was evident that significant dye uptake by the background had occurred.



Green food disposal bag treated with Superglue Fuming then BY40 (EtOH)

Finally, reasonable results were obtained using MMD but there was still more background staining than seen for other types of substrate.

These preliminary findings do illustrate some important points regarding the processing of compostable polymers for fingermark evidence. Most importantly, there were significant differences in how two of the best processes for non-porous surfaces (Superglue Fuming/BY40 (EtOH) and VMD) interact with the three compostable materials tested here.

For VMD, deposition rates varied and in some cases further treatment with Silver was required (to varying levels of success).

Superglue Fuming and BY40 (EtOH) caused varying levels of destruction on the two soft and flexible materials tested here. This was due to either the high humidity within the superglue cabinet and/or the dye solvent. This suggests they may be semi-porous in nature. The process was successful on the clear brochure wrapper which was quite different in its physical properties to the other two.

MMD was used in this study as it is the single most effective process on some plastic packaging (cling film). Although there was some success, it is not widely used in UK operational laboratories due to process complexities.

So where does that leave us? Compostable polymers (and other biodegradable materials) are in their infancy as organisations strive to find alternative to single-use plastics. However, it is apparent from this small test that it may be difficult to provide generic guidance for fingermark visualisation that would be applicable to all compostable polymer products.

We hope this article has raise awareness of this issue. At this time, we'd recommend looking out for compostable polymers and considering processing options carefully. If possible, try processes on duplicate surfaces before applying them to exhibits or test processes on small areas of exhibits, for example, carry out a spot test to check for background retention.

We aim to increase both in-house and external studies on this topic going forward, and engage with as wide an audience as possible in order to provide future guidance. From an operational perspective, please let us know if you are seeing increasing amounts of new materials (such as compostable or biodegradable) and if these surfaces are presenting particular operational challenges.

RECOVER LFT Update

In our March 2019 newsletter we provided a brief update on the disulfur dinitride (S_2N_2) process, detailing the results of in-house work undertaken using prototype equipment. The findings highlighted that the S_2N_2 process may offer additional operational benefits over existing processes on metal surfaces. Recommendations were made to replicate trials using the recently commercialised equipment (RECOVER LFT) and on substrates representative of forensic casework. This initial study by Bleay *et al.* has now been published in a peer-reviewed journal (see page 16).

Dstl were one of the first organisations in the UK to obtain the RECOVER LFT equipment in March 2019 and training, by Foster and Freeman Ltd, followed in July 2019. There is a requirement to gather validation data for its use on casework, and determine if it adds value to the toolkit already used by fingerprint laboratories. We approached this challenge via multiple routes. Firstly, we established a UK RECOVER LFT user group, and held a meeting at Sandridge in September 2019 to share initial thoughts and findings. Secondly, we engaged with international colleagues and shared early evaluation findings. Thirdly, we conducted in-house evaluations, where the focus was driven by pressing operational needs (namely gun and knife crime) of the Metropolitan Police Service (although any findings are clearly relevant nationally).

This article provides a summary of two recent in-house 'sprint' studies (study conducted over a short timeframe and with a focussed goal). The first study focuses on fingermark visualisation on fired cartridge casings due to the extremely low (<1%) success rate commonly reported by operational policing; the second study focuses on knife blades due to the growing incidents associated with knife crime in the UK.

For both studies there must be a word of caution up front. Firstly, manufacturer's instructions, as given during initial training, were followed throughout. We are aware that as the knowledge on the new process builds then processing instructions will evolve too. Secondly, both studies involved using RECOVER LFT at the end of a sequence i.e. as a last resort, where less rigorous testing is required for its use on casework. This is unlikely to be the optimal sequential processing route, but it may add value to current routes and this can be further improved going forward.

Study 1 - Fired Cartridge Casings

Aims

The aims of this study were:

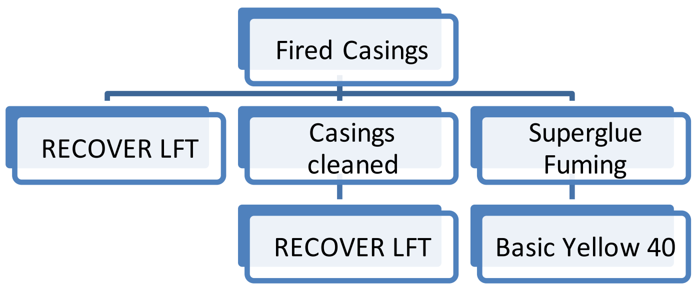
- To determine the relative effectiveness of RECOVER LFT and Superglue Fuming/BY40 for fingermark visualisation on fired cartridge casings;
- To determine if cleaning samples prior to RECOVER LFT has any effect on visualisation of marks (as reported in the initial study);
- To mimic the operational scenario as much as possible by following pseudo-operational trial plans as closely as possible.

Superglue Fuming/BY40 was chosen for comparison as operational input suggests it is the most common process used on such exhibits.

Experimental

Spent Casing Collection: 19 donors across two locations were asked to load ammunition into magazines to simulate a 'real world' scenario and allow the deposition of natural fingermarks. Ammunition was left *in-situ* in magazines for a minimum of 30 minutes prior to being fired with various firearms. In total 745 spent cartridge casings from various calibre brass ammunition (9mm (356), 5.56mm (365) and 7.62mm (24)) were collected.

Processing Options and Details: Casings were split evenly into three separate sample sets, each to be treated by a different processing route:



Summary of the different processing routes for the casings study.

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All samples were visually examined prior to chemical treatment and any samples displaying possible ridge detail were imaged.

For RECOVER LFT, processing was conducted using the small development chamber, Develop™ precursor charge R1 (Batch D0001) and an R1 brass control sample to ensure development was occurring. Fuming times were between 13-20 minutes for 9mm and 5.56mm brass casings; 7.62mm casings were treated for 32 minutes as no development was observed on any casing after 20 minutes treatment time.

Casings ready to process within RECOVER LFT

The cleaning regime involved casings being washed with warm water, detergent and subsequently rubbed with ethanol. Cleaned casings were allowed to dry for a minimum of 1 hour prior to RECOVER LFT treatment.

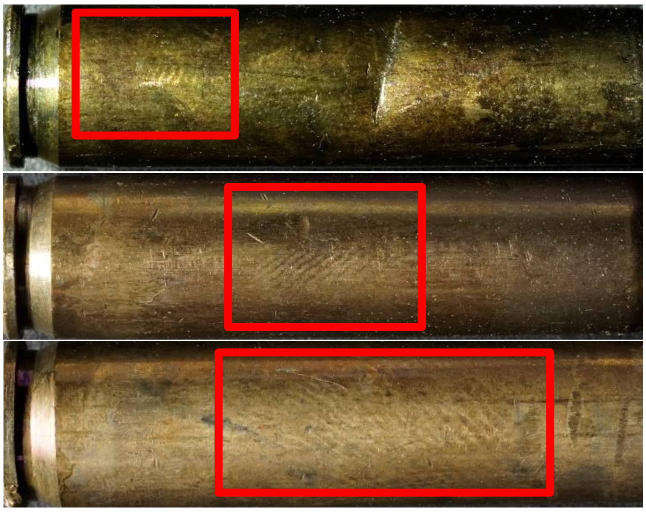
Superglue Fuming and BY40 (EtOH) dye staining were conducted according to the process instructions outlined in the FVM. Images of Superglue Fuming treated samples were captured prior to BY40.

Grading: For this study a new 0-3 grading scheme was devised (as shown in the following table) that reflects the type and size of ridge detail visualised on small and curved surfaces (i.e. casings).

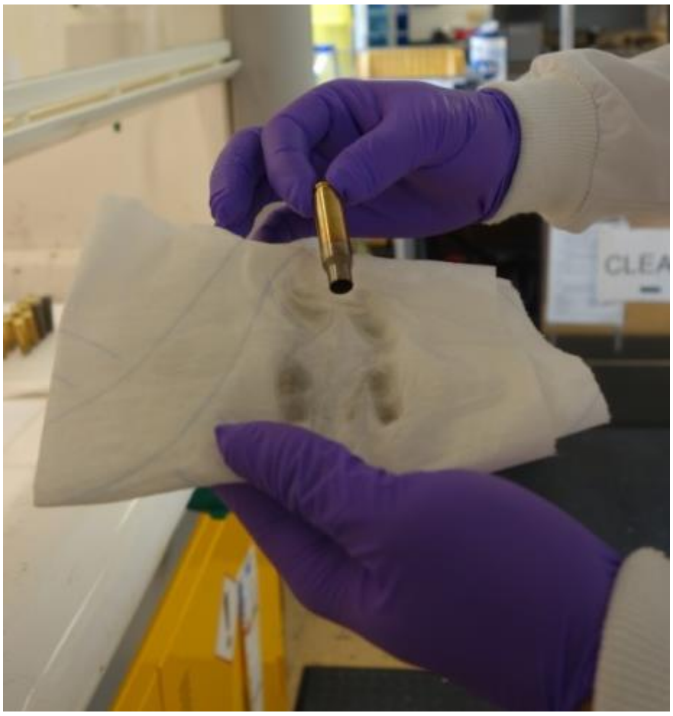
Casings achieving Grades 2 and 3 were focused on as these samples displayed more defined ridge detail.

Grade	Characteristics		
0	No evidence of ridge detail on casing		
1	Limited evidence of ridge detail		
	≤3 ridges	Low quality	Short ridge length
2	Clear evidence of ridge detail		
	>3 ridges	Reasonable quality	Medium ridge length
3	Very clear evidence of ridge detail		
	>6 ridges	Good quality	Long ridge length

Grading scheme used to assess ridge detail on fired casing samples



Examples of casings displaying Grades 1 (top), 2 (middle) & 3 (bottom) level ridge detail

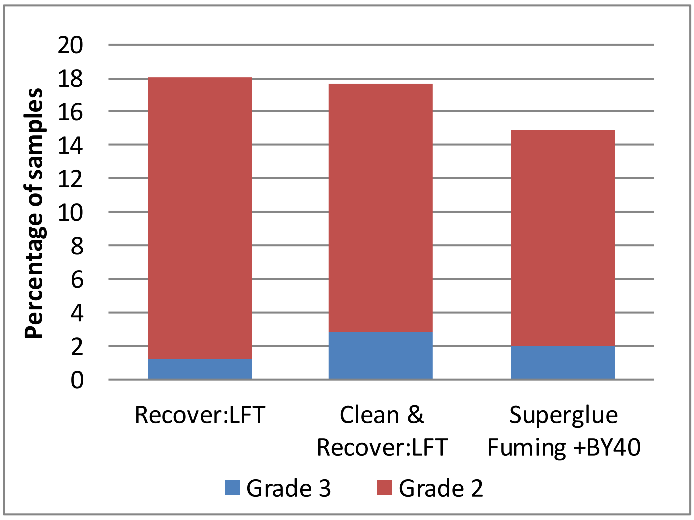


Contaminants removed as a result of ethanol cleaning

Results and Discussion

Out of 249 samples treated with RECOVER LFT only, 123 (49%) displayed some evidence of touch or fingermark ridge detail (grades 1-3). However, only 3 (1%) samples developed a grade 3 mark. 45 (18%) samples treated with RECOVER LFT only developed a grade 2 or 3, the highest combined percentage when comparing fingermark visualisation processes used within this study.

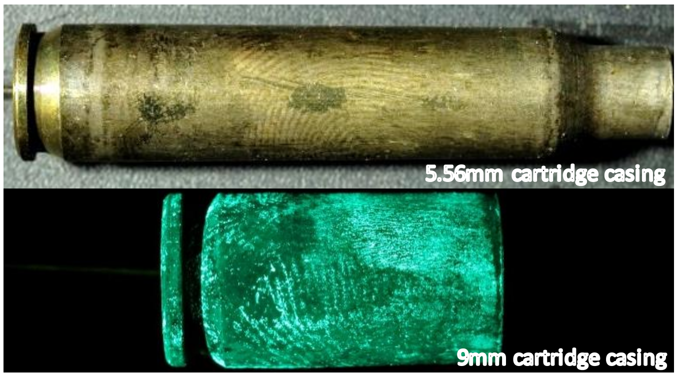
Nevertheless, Superglue Fuming/BY40 treated samples marginally produced the highest quantity of grade 1-3 results, samples displaying evidence of touch, with 125 (50%) samples achieving these grades. The additional BY40 step after Superglue Fuming produced an additional two grade 3 marks, one less grade 2 mark, 28 additional grade 1 marks resulting in 29 less grade 0 marks.



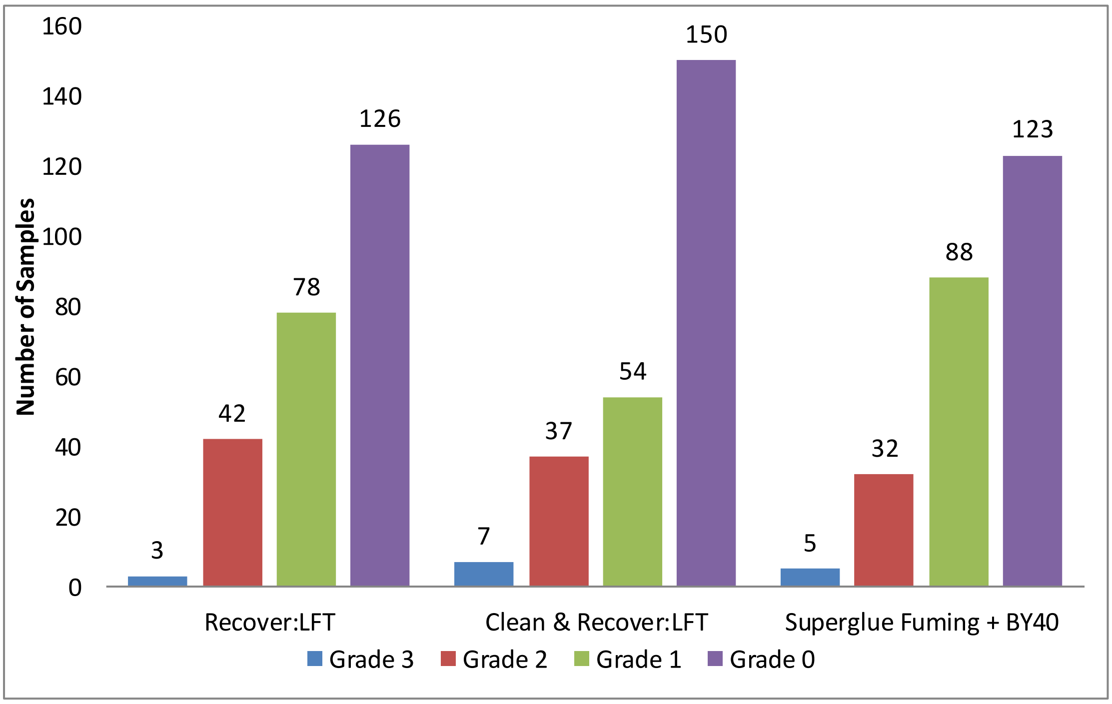
Graph displaying the percentage of combined grade 2 and 3 samples from each processing sequence.

Overall RECOVER LFT (both with and without a cleaning regime employed prior to treatment), visualised marginally more marks (~3%) of comparison quality (grades 2 and 3) than Superglue Fuming + BY40. However, it is unclear if these small differences are significant and further work would be required to ascertain this.

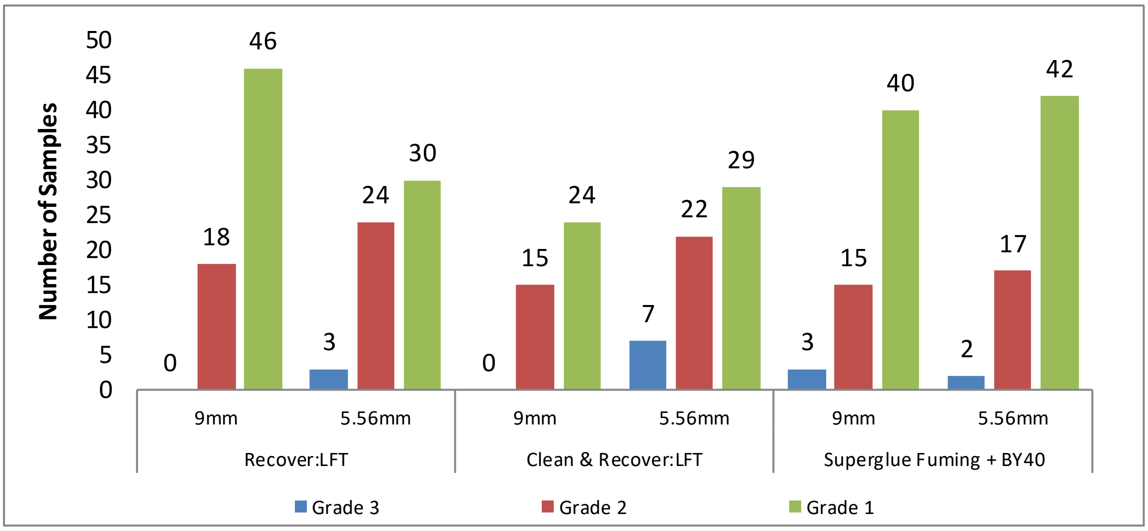
The cleaning of casings prior to RECOVER LFT treatment offered no obvious advantage in this trial. Although results produced from casings which had been cleaned and subsequently treated with RECOVER LFT produced the highest proportion of grade 3 results, it also produced the highest proportion of samples graded 0. This suggests that the cleaning regime used in this trial may, on some casings, improve mark quality, whilst on others it may decrease the quality of the mark.



RECOVER LFT only treated 5.56mm (top) & Superglue Fuming + BY40 treated 9mm cartridge casings (bottom) displaying the best grade 3 fingermark ridge detail out of all 745 samples.



Graph displaying the grading results for all 745 chemically treated samples within this study



Graph displaying grading results for 356 9mm & 365 5.56mm calibre casings treated with three processing routes.

It was expected that good quality ridge detail would be more prevalent on larger calibre samples due to the increased surface area for fingermark deposition and decreased pressure exerted on the casing during the firing process. This was confirmed with twelve grade 3 marks on 5.56mm cartridge casings compared to only three on 9mm casings. Due to the limited number of 7.62mm calibre casings, it is not possible to draw any meaningful conclusions from that dataset.

Casing imaged pre-treatment (top), after Superglue Fuming (middle) and after BY40 (bottom).

Fingermark ridge detail was observed on some samples prior to chemical treatment, the image above displays an occurrence of this. Subsequent images captured after processing show that there was no benefit to treating this particular sample with Superglue Fuming followed by BY40. BY40 may have hindered visualisation by staining the background as well the fingermark ridges, thus lowering the contrast between ridge and background. This shows the importance of visual examination as well as capturing superglue marks before BY40 dye staining.

Conclusions

This pseudo-operational trial on casings has indicated that RECOVER LFT was comparable to Superglue Fuming followed by BY40. In some instances, RECOVER LFT may offer additional benefit to the fingermark visualisation processes currently employed on fired brass cartridge casings in forensic laboratories; however, further work is required to provide a stronger evidence base for this. It is anticipated that fine tuning of the process, including optimising pre-cleaning of the casings, will only improve its mark visualisation potential.

A key limitation of this study, which may explain the lower than expected level of high quality marks observed with RECOVER LFT, could be attributed to the length of time fingermarks were left on ammunition prior to firing. Due to the locations used and associated time-frame constraints for this sprint study, a 30 minute ageing period (time between loading and firing) was used. However, it may be that this is not long enough for sufficient surface/fingermark reactions to occur and subsequently affected fingermark development. Therefore, future studies will incorporate extended ageing times between loading and firing as other organisations have reported varying levels of success when longer time-frames have been used. However, we still believe this study reflects, to a degree, the operational realities of mark recovery of casings in the UK where often small calibre ammunition is used and the time between loading and firing will vary.

Study 2 – Stainless Steel Kitchen Knifes Blades

Aims

The aims of this study were:

- To determine the impact of standard fingermark visualisation processes on the effectiveness of RECOVER LFT;
- To determine if RECOVER LFT can find extra marks after such processes, irrespective of the outcome of the first aim;
- To determine if the chemical process residue needs to be removed prior to RECOVER LFT.

Due to time constraints, the value of RECOVER LFT at the end of a full sequential processing route was not tested; however, understanding the impact of individual processes was deemed an important first step in determining this.

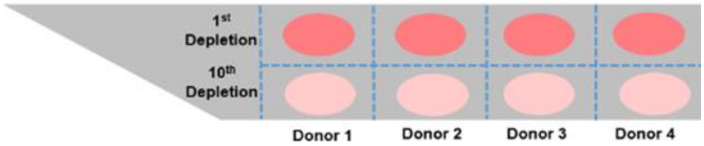
In addition, only the knife blades were examined, although clear guidance for processing whole knifes will be required and this will be incorporated into future studies.

Experimental

Knife Preparation: Four different brands of kitchen knife were used. Five sets of knives were prepared, each containing nine of each brand, thus a total of thirty-six knives were in each set.

Image of one set of knives prepared for donor deposition.

For each set, the 1st and 10th fingermark in a depletion series, from eight donors, were deposited onto the blade as shown in the schematic. This method maximised the working space on the blade, whilst allowing us to gain useful information on process sensitivity and donor variation. Fingermarks were aged for 1 day, 1 week or 3-4 months.



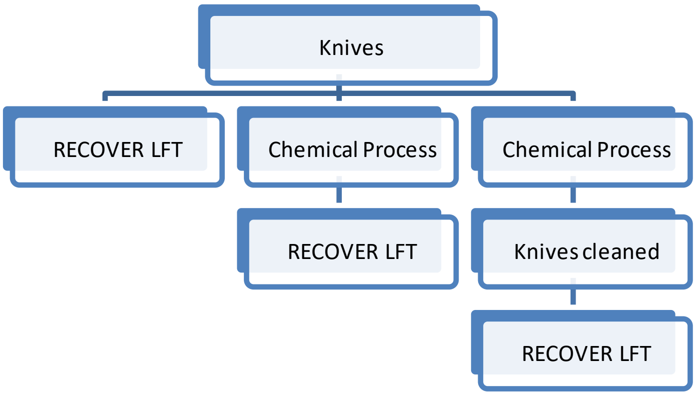
Schematic diagram of a knife showing positioning of 1st and 10th mark in a depletion series for four donors on one side of a knife

In total, 180 knives were used and 2880 fingermarks processed and analysed.

Processing Options and Details: Each set of knives was used to study the interactions of one chemical process on RECOVER LFT. In total, five commonly used chemical processes were studied – one for each set of knives:

- Powder Suspension (Carbon-based)[2]
- Superglue Fuming
- Superglue Fuming followed by BY40 dye staining
- Acid Yellow 7
- Basic Violet 3

Each set of knives was divided into three groups, each to be treated by a different processing route:



Summary of the different processing routes for the knife study.

For the five chemical processes listed above, process instructions, as outlined in the FVM, were followed.

For RECOVER LFT, processing was conducted using the large development chamber, Develop™ precursor charge R4 (Batches D0003 or D0009) and a stainless steel control sample to ensure

[2] Note: the FVM recommends Iron-oxide based Powder Suspension on this substrate. Carbon-based was used in this study as it is currently used by the MPS due to known issues (as reported in the March 2019 newsletter) with iron-oxide formulation. The carbon-based formulation is an acceptable alternative until this issue is resolved.

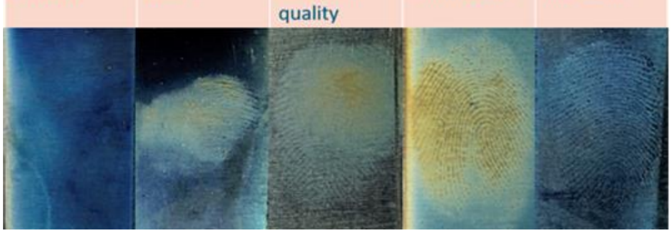
development was occurring. Fuming times were between 2-3 hours. For each run, four knives (all brands, one age, for one route) were loaded into the chamber in such a way as to maximise the chance of even development.

Knives ready to process within RECOVER LFT

When required, Powder Suspension; Basic Violet 3 and Acid Yellow 7 treated knives were cleaned using soapy water and a clean cloth followed by rinsing and drying. For Superglue treated knives, this cleaning regime was not sufficient so an additional ethanol wash was also used.

Grading: After processing, fingermarks were visually examined and graded using a 0 – 4 grading scheme. Grades 3 and 4 are considered of value – i.e. the fingerprint may contain sufficient detail for identification.

0	1	2	3	4
No evidence of fingermark contact	Evidence of contact but little ridge detail	Less than 1/3 of ridge detail is of workable quality	Between 1/3 and 2/3 of ridge detail is workable	Above 2/3's of the ridge detail is workable



Examples of marks graded 0 – 4 following RECOVER LFT processing

Results & Discussion

Observations: After processing the knives with RECOVER LFT it was observed that the 1st depletion fingermarks were often gold in colour and the 10th depletion blue in colour. It is believed that this colour difference is due to slightly different polymer growth mechanisms caused by varying amount of fingermark residue on the surface. This in turn impacts on how light is scattered from the surface and thus the colour we observe.

Image displaying the colour difference between the 1st (left) and 10th (right) depletion fingermarks visualised after RECOVER LFT

A difference in the quality of fingermark visualisation between different knife brands was observed. Differences were also seen between this study and the initial study (see page 16) on stainless steel, so it may be that different types or grades of stainless steel behave differently. This needs further exploration.

Throughout this study it was observed that if the knife blade was located close to the precursor vial in the chamber then what could be described as a triangular 'blasting' effect of precursor developed on the tip of the blade (see image on next page). This does not appear to have affected the results in this study as the tips of the blade were not used for fingermark deposition. However, for operational casework consideration should be given to exhibit placement and orientation in the chamber in order to avoid this effect.

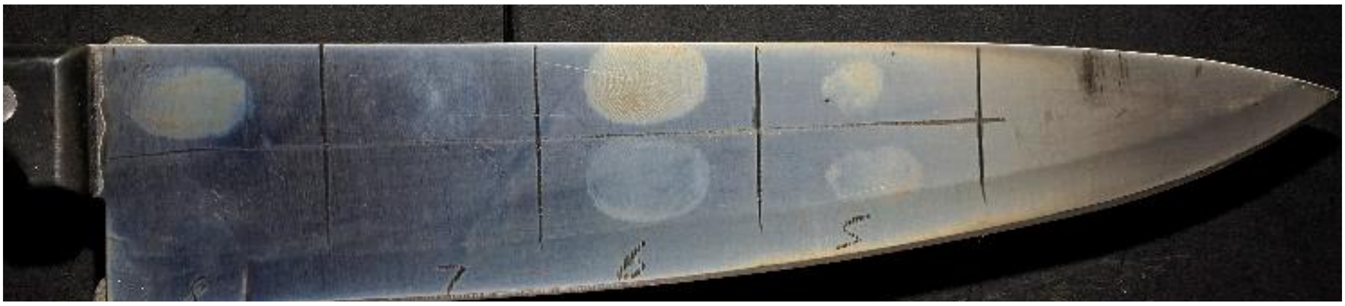


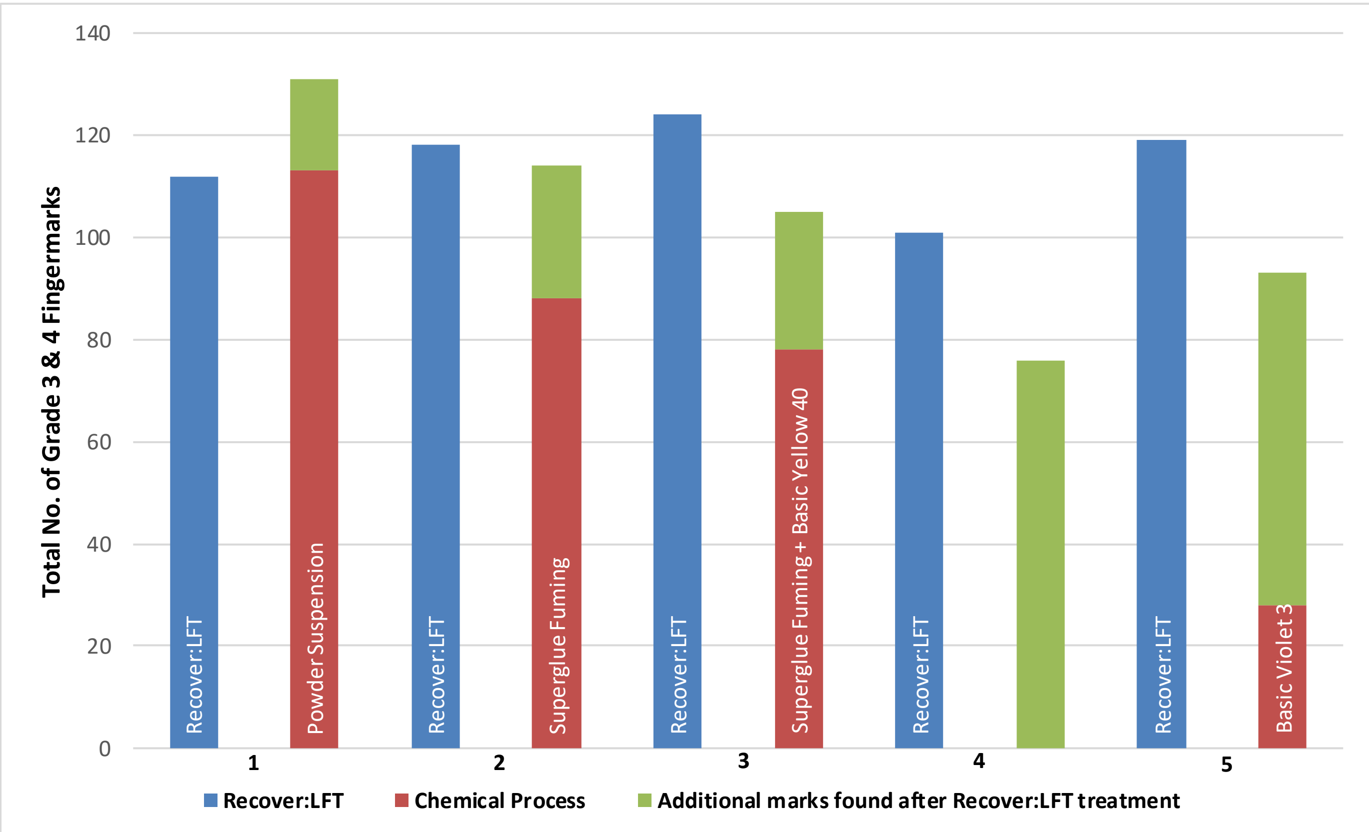
Image of Knife displaying the 'blasting' effect starting at the tip of blade.

Direct comparison of RECOVER LFT and chemical processes: In addition to meeting the aims of this study, we were able to directly compare RECOVER LFT to other chemical processes (see blue and red bars in graph below). The data indicates that:

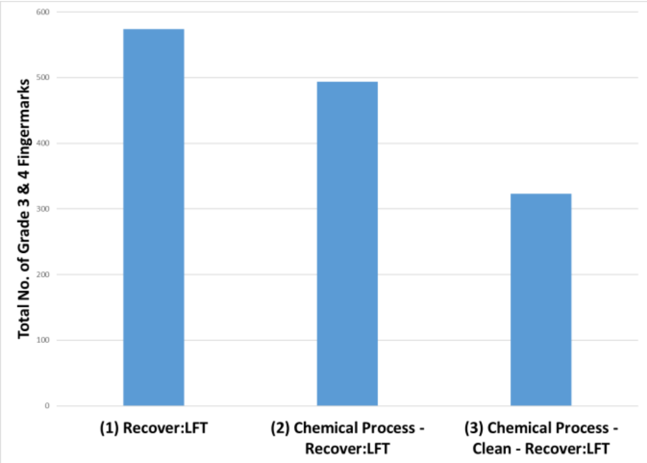
- RECOVER LFT, as a single process, is at least as effective as the other processes assessed in this study.
- most importantly, it was similar in performance to Powder Suspension and found considerably more high quality marks than Superglue Fuming (with and without BY40);
- as expected, Basic Violet 3 visualised the fewest high quality fingermarks. As Acid Yellow 7 is a protein stain, mark development was not expected.

Added benefit of RECOVER LFT after chemical processing: The green bars on the graph below demonstrate that RECOVER LFT visualised further higher quality marks when used after all of the chemical processes individually. This suggests that it is likely to add benefit at the end of full sequence, but the extent is yet to be determined.

Impact of chemical processes on RECOVER LFT: The effectiveness of RECOVER LFT decreases if another chemical process (with and without cleaning) is completed first (see graph on next page). However, this loss must be weighed up against the additional higher quality marks visualised by using it in sequence with other processes. This potential for visualisation of additional identifiable fingermarks is highly valuable.



Graph displaying the number of grade 3 & 4 fingermarks visualised after RECOVER LFT as a stand-alone process vs. other chemical processes followed by Recover LFT. Note: caution must be taken when cross-comparing datasets (1-5) as these were conducted at different times.



Graph displaying the total number of the grade 3 & 4 fingermarks for the RECOVER LFT Process in each of the three sequential processing scenarios.

Subjecting stainless steel knives to a cleaning stage before RECOVER LFT treatment has proven, in this study, to be detrimental to fingermark visualisation. Further work is required to determine an optimal cleaning regime if it is deemed it adds any value.

Fingermark visualisation decreased with age of mark. This is typical of many visualisation processes (although not all) where mark constituents are targeted rather than a corrosion signature (which should improve with age). This may be different on other more reactive substrates and shows that a greater understanding of the mechanism is required.

Conclusions

This short study has indicated that RECOVER LFT is a promising new process for the visualisation of fingermarks on stainless steel knife blades. As a single process, it is similar to, or outperforms standard visualisation processes on this substrate. Further work is required to determine if it is best used as a stand-alone process or in sequence with others, and the optimal position within the sequence would also need investigating. However, as a last resort process, it demonstrates value even if the processing conditions can be further improved.

Dstl will now build on these positive findings by conducting further in-house studies, and work closely with the manufacturer and other organisations to ensure the RECOVER LFT potential is realised.

RECOVER Precursor Batch Variations

In November 2019 Foster and Freeman Ltd. notified customers of an impurity in batches D0001-D0008 of Develop™ precursor material that may have an impact on shelf life and subsequent effectiveness. This followed concerns from users where differences in the used vials were observed (see image below) indicating that there may be variability in the precursor.

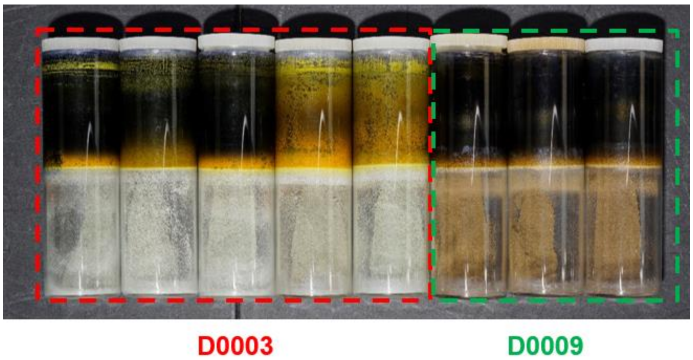
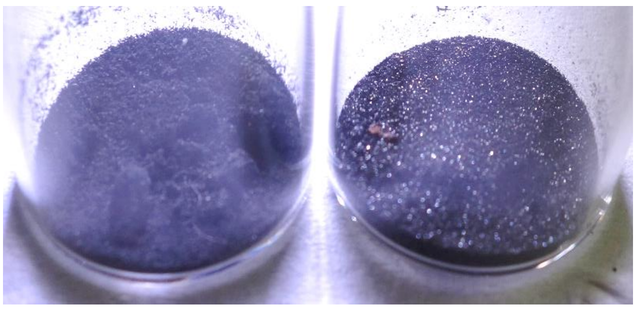


Image of used R4 precursor vials encountered during Dstl knife study

This information potentially has an impact on both RECOVER LFT studies reported in the newsletter, as the majority of data was generated using these batches of precursor material.

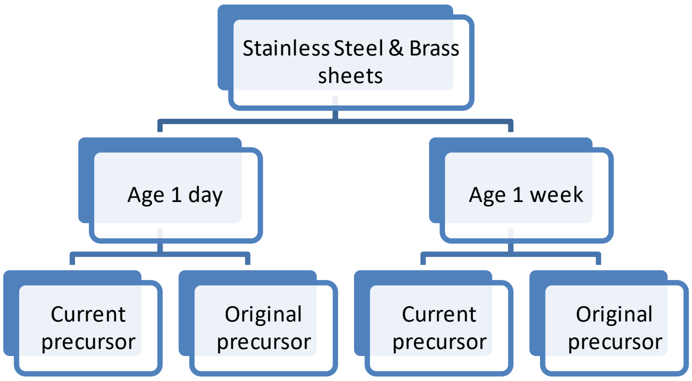
To better understand this we compared the performance of 'current' batches of precursor material (D0009 onwards), which Foster and Freeman Ltd. stated did not contain an impurity, against 'original' batches D0001-D0008.

Firstly, we visibly compared the two batches. The image below displays the noticeable difference between the two R2 precursor batches; the original R2 precursor has a matt-like appearance in comparison to the current one which has a speckled dark grey/black appearance. According to the manufacturer, the 'current' precursor has the correct appearance.



Images of the 'original' (left) and 'current' (right) Develop™ R2 precursor

80 Split fingermarks (1st & 10th depletion) were deposited on brass and stainless steel sheets, from ten donors, and aged for either 1 day or 1 week. One half of each mark was subject to RECOVER LFT treatment using 'current' precursor material, whilst the other half was treated with 'original' precursor.



Summary of methodology used within the precursor study

Samples were imaged and graded using the same grading scheme outlined in the knife study (see page 10).

Brass 1 week aged samples displaying Grade 4 marks for all 1st depletion fingermarks

There were visual differences in the deposition of the polymer between the precursors, with both the colour and level of background development varying. In general, marks visualised with current precursor were bluer than those visualised with original precursor, which were whiter in appearance. It has been reported by the manufacturer that reverse development is more likely with the original precursor, but that was not observed in this small study.

For most split marks, grades were similar, but there were some instances where either one or the other of the precursors tested was more effective at mark development. It may be that other factors are influencing this, such as the position of the sample in the chamber, although this was controlled as much as possible. However, overall developed fingermark ridge detail between the batches was similar (as determined by grade scores).

The findings from this short study suggest that results produced in initial studies are still valid, as current and original batches of Develop™ precursor performed comparably, albeit the marks did appear different. Foster and Freeman Ltd. believe they have resolved this issue and consistent batches will be supplied going forward.

Summary

The findings from both studies have highlighted the impact that surface specificity has on fingermark visualisation, with both studies yielding very different results. It is believed that interactions between the mark and surfaces (i.e. corrosion in the case of reactive metals) is important to the success of this process making this an extremely novel approach to visualisation. Thus, on spent casings, where the fingermark material is likely to have been severely damaged during firing, this process could offer value by interacting with a corrosion signature instead.

The methodology used in the casings study was chosen to reflect, as closely as possible, an operationally realistic scenario for the UK. This included using commonly encountered ammunition which was loaded into a firearm in a natural way. Results were generally poor, but no worse (and in some cases marginally better) than the most likely used of the traditional processes (i.e. Superglue Fuming and BY40). It is acknowledged that this may not be optimal for RECOVER LFT. A recent publication[3], which focused on planted marks and larger calibre ammunitions, showed a greater level of mark recovery and also identified that an optimised cleaning phase is essential for the process to be most effective. This, along with a wider range of times between loading and firing, will be incorporated into future studies.

[3] D. Wilkinson, D. Hockey, C. Power, R. Walls, J. Cole. *Recovery of Fingermarks from Fired Ammunition and Detonated Improvised Explosive Devices using S_2N_2 – A Proof of Concept Study.* Journal of Forensic Identification. 70(1) (2020) 59-88

The findings from the knife blade study was a contrast to the casings study, with fingermark visualisation exceeding expectations, to the point where it is competing with ‘the best of the rest’. The trends seen in this study point towards a different mechanism associated with polymer growth i.e. cleaning is detrimental and development gets worse with age – this is more aligned to a process that is targeting mark constituents rather than a corrosion signature. Going forward, studies need to expand to take account of processing a whole knife along with a wider variety of knives.

The RECOVER LFT process is still in its infancy in terms of having an optimised final system and there is clearly a lot to learn with regard to how the process works. As with all processes, considerably more validation data than that presented here is required, but this article has clearly showed its potential. We will continue to report on progress from Dstl studies, but also encourage sharing of information and further collaboration so that best practice guidance can be issued as soon as possible.

Reports from both studies were submitted to the MPS to support their efforts to include RECOVER LFT into their ISO 17025 scope of accreditation. We’re pleased to say they were successful.

The information from both studies is being compiled for publication in a peer-reviewed scientific journal. If you would like more information or would like to be part of a UK Recover LFT user group then please contact us on **FI_enquiries@dstl.gov.uk.**

Amino Acid Calibration Targets

Nigel Custance (Bounded Solutions), in collaboration with Dr Ruth Croxton (University of Hull, formerly University of Lincoln) and Terry Kent (independent) have developed prototype calibration targets which can be used to test the effectiveness of the Ninhydrin process. This type of test has the potential to be very useful in a laboratory environment for a range of quality assurance applications.

We have been working in collaboration with Bounded Solutions to trial the calibration targets. These calibration targets include strips of amino acids with a range of different intensities. Once processed with ninhydrin, the strips are scanned to assess the intensity of the amino acid blocks and provides an accurate objective measure of the level of ninhydrin development. An example of one of the strips is shown on the right.

Following discussions at a Fingerprint Enhancement Laboratory (FEL) Expert Network meeting, nine UK police forces volunteered to take part in an inter-lab trial using the prototype targets, where the aim was to feedback on their usefulness and any design improvements. Targets were processed with Ninhydrin and returned to Dstl before being sent anonymously to Bounded Solutions for analysis along with feedback.

Feedback from forces was encouraging. Although emphasis is not being put on comparative results for this prototype trial, the results did indicate that the calibration targets, once validated, will prove a very useful tool. We are keen therefore to support the originators of this product to get it to a point where is can be bought and used, with confidence, to provide assurances of method effectiveness. In the first instance, we would like to get it to a stage where we can run a full collaborative exercise across UK police laboratories.

Dstl Collaborative Exercise

This year, Dstl launched a Collaborative Exercise (CE) funded by the Home Office and supported by the Forensic Science Regulator. To our knowledge, this national CE is the first of its kind within the UK for the field of fingermark visualisation. It is based on similar exercises run by the European Network of Forensic Science Institutes (ENFSI) Fingerprint Working Group. The driver for such an exercise is to raise standards by sharing knowledge and exchanging experiences and, from Dstl's perspective, it will help us identify where the FVM guidance could be improved.

The exhibit chosen for this exercise was wrapping paper as it can be a challenging substrate for fingermark visualisation due to its semi-porous characteristics. Participants were asked to treat the item as a major crime exhibit. Exercise packs containing the exhibit were sent to 24 participants from across the UK in February 2020. Results were due to be presented at this year's FEL National Conference in June 2020, however, this has now been postponed due to Covid-19. The deadline for submitting results has been extended to 31st July 2020 and we hope to present the findings and have lively discussions on recovery approaches, successes, problems etc. at the first available opportunity.

The wrapping paper chosen for the Collaborative Exercise

Journal publications

Since the previous newsletter, papers have been accepted and published in appropriate scientific journals. For any police forces wishing to add these documents to their validation libraries, the appropriate references are:

- S. Bleay, L. Fitzgerald, V. Sears, T. Kent. *Visualising the past – An evaluation of processes and sequences for fingermark recovery from old documents*, Science & Justice, 59(2) (2019) 125-137
- S. Bleay, P. Kelly, R. King, S. Thorngate. *A comparative evaluation of the disulfur dinitride process for the visualisation of fingermarks on metal surfaces*, Science & Justice, 59(6) (2019) 606-621
- J. Dawkins, L. Gautam, H. Bandey, R. Armitage, L. Ferguson. *The effect of paint type on the development of latent finegrmarks on walls,* Forensic Science International, 309 (2020)

ADVICE

During the last 12 months, the fingerprint team at Dstl answered 144 fingerprint-related forensic enquiries. This equates to more than two enquiries a week. This is a similar number to the enquiries received the previous financial year, at 150.

Some interesting enquiries have included providing advice on processing unusual surfaces where no chart exists (see FVM page 2.4.9). Common enquiry topics were Iron Oxide Powder Suspension, Indandione and Physical Developer formulations, and also enquiries regarding Powders validation. We are happy to assist with enquiries but please continue to check the FVM and the Source Book v2.0 (2^{nd} Edition) before contacting us on **FI_enquiries@dstl.gov.uk.**

CONTACT US

Enquiries

Please direct all enquiries to the following central mailbox:

FI_Enquiries@dstl.gov.uk

Note: Dstl's email system does not send out-of-office replies to non-Dstl accounts. To avoid delay to enquiries that are time-critical, please ensure that the central mailbox is used in preference to individual staff mailboxes.

Address

Dstl, Porton Down, Salisbury, Wiltshire, SP4 0JQ, UK

Publications

Fingermark and related forensic documents, including the Source Book v2.0 (second edition), can be found on the following website: https://www.gov.uk/government/publications/dstl-forensic-publications
These documents were produced by a team of scientists within the Dstl Security Systems Programme. This team integrated across to Dstl in April 2018 from the Home Office Centre for Applied Science and Technology (CAST), which was previously known as the Home Office Scientific Development Branch (HOSDB) and Police Scientific Development Branch (PSDB). In order to maintain one single archive for these reference documents, this series of publications includes those produced prior to April 2018.

For sales of the Fingermark Visualisation Manual (FVM) please contact Clare Polley, Official/Library Channel Sales Manager, Williams Lea Tag, WLT (Clare.Polley@wlt.com)

Home Office Commissioning Hub

This fingermark visualisation research has been funded by the Home Office. If you have a new work requirement that you would like the Dstl team to explore, please contact the Home Office Commissioning Hub, who are responsible for tasking Dstl on behalf of the UK Home Office & Law Enforcement; their email address is CommissioningHub@homeoffice.gsi.gov.uk.

The RECOVER LFT studies discussed in this newsletter were independently and externally reviewed prior to release. Furthermore none of the Dstl researchers involved in these studies are associated with the original development work of the process.