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CASE REPORT

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Visualization of Latent Fingerprint Corrosion on a Discharged Brass Shell Casing

ABSTRACT: Latent fingerprint visualization on discharged shell casings can provide good forensic evidence, particularly if the casing is recovered at the scene of a crime where a firearm has been discharged. Unfortunately, visualization of such latent fingerprints when they were deposited prior to discharge of the firearm is problematic as both increased temperature and abrasive friction can inhibit fingerprint visualization with conventional techniques. We present a case study that demonstrates latent fingerprint visualization on a discharged shell casing recovered 14 years ago from the scene of a homicide. Previous cyanoacrylate fuming of the casing had failed to reveal any fingerprints. We use a visualization technique in which a conducting carbon powder adheres preferentially to latent fingerprint corrosion of the casing surface, following the application of a potential of 2.5 kV to the casing. This technique presents opportunities for the review of old cases and for consideration of its use in current cases.

KEYWORDS: forensic science, latent fingerprint, print visualization, metal surface, weapons, criminalistics

Visualization of latent fingerprints on discharged shell casings can provide good forensic evidence, particularly if the casing is recovered at the scene of a crime where a firearm has been discharged. In these circumstances, a fingerprint can link an individual to the casing before it was loaded into the firearm and hence, potentially, provide a link to the perpetrator of the crime.

Unfortunately, visualization of latent fingerprints on discharged shell casings when the fingerprints were deposited prior to discharge of the firearm is problematic. The effects of increased temperature due to the firing process, especially blowback (1), and abrasive friction caused by loading and ejection of the shell have been shown to inhibit subsequent fingerprint visualization (2). A number of techniques have been investigated to visualize these latent fingerprints using electrochemical redox reactions with the metal, the reaction being inhibited by the presence of the fingerprint deposit (2,3). More conventional visualization techniques, such as cyanoacrylate fuming (4), have also been employed with mixed results (5).

In a departure from visualization techniques that require a chemical reaction with the deposit, Williams et al. (6) and Williams and McMurray (7) demonstrated fingerprint visualization on metals using a Scanning Kelvin Microprobe. This technique is based on a measurement of the potential difference arising between a wire probe and the metal surface due to differences in their respective work functions. The magnitude of this potential difference is affected by fingerprint corrosion of the metal surface. By measuring this variation in potential, an image of the fingerprint has been visualized in terms of potential difference. Williams et al. reported that rubbing fingerprint deposits vigorously with a paper tissue several days after deposition had little effect on work function measurements, which would support their fingerprint visualization resulting primarily from a reaction between the metal and fingerprint deposit. This technique was demonstrated on brass shell casings where the fingerprint was deposited postfiring.

More recently, one of us (JWB) has considered the corrosion of a range of metal elements and alloys by fingerprint deposits (8,9). It was shown how fingerprint deposits on brass produced sufficient corrosion of the metal to enable the fingerprint to be visualized even after the residue of the fingerprint deposit had been removed by cleaning the metal in warm water to which a few drops of commercial detergent had been added. This visualization was achieved by employing a novel technique which required the application of a potential to the brass with respect to earth from a high voltage unit of *c.* 2.5 kV followed by the introduction of a conducting carbon powder (grain size *c.* 10 μm) (8). The introduction of the conducting powder was facilitated by using Cascade Developer (Foster and Freeman, Evesham, UK) which comprised *c.* 400 μm spherical beads that were coated with the conducting powder. By rolling the spherical beads back and forth across the surface of the brass (at a potential of *c.* 2.5 kV), the conducting powder was found to adhere preferentially to the areas of corrosion on the metal thus enabling the fingerprint to be visualized. Under laboratory conditions, this technique demonstrated the visualization of a latent fingerprint on a fired 9-mm shell casing that was deposited prior to loading the shell into the firearm (8). In this report, we describe the application of this technique to shell casings recovered from the scene of a homicide using a refinement of apparatus described previously (8).

Case Description

The victim in this case was a 48-year-old male. The victim had recently begun dating a woman who was separated from her husband. The victim lived in a floor level apartment, with apartments to either side of his. The front door of the apartment was accessed by an outdoor hallway that led to a parking lot.

On the night of the homicide, the victim was having dinner with his girlfriend. According to the girlfriend's statement to investigating officers, there was a knock on the door at around 7:20 PM. The

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girlfriend stayed at the dining table while the victim went to answer the door, and from her location, she could see the victim but could not see who was at the door. The victim opened the door and said something to the effect of, "Oh!" and looked quizzically at the girlfriend. Immediately, there were four shots heard by the girlfriend and the victim fell backwards onto the floor.

Subsequent investigation revealed that several people in the apartment complex heard the shots, although no one witnessed the shooting. Four 9-mm brass shell casings were located just outside the victim's door. These casings were later subjected to a visual examination for latent fingerprints followed by cyanoacrylate fuming (4). Each casing was then treated with Blitz™ fluorescent powder (Lightning Powder Company Inc., Jacksonville, FL). No latent fingerprints were visualized on any of the four casings.

Results

During the summer of 2008, 14 years after the homicide and the original examination for fingerprints, the four shell casings were re-examined. Initially, a visual examination confirmed that no fingerprint ridge detail was apparent on the casings. In view of this, it was decided to heat each casing to *c.* 700°C over an open flame. This was performed for two reasons:

1. to remove any fumed cyanoacrylate deposit that may have been adhering to the surface of the casings and
2. to induce a corrosive reaction between the brass surface of the casing and ionic salts present in any fingerprint deposit remaining on the surface of the casing. Previous work has shown that heating fingerprint deposits on brass to this order of temperature can provide a corroded image of the fingerprint (8).

Following this, each casing was inspected again visually and the faint appearance of fingerprint ridge lines was noted on one casing (referred to as item 3). A potential of 2.5 kV was then applied to each casing in turn and the conducting carbon powder referred above was introduced using apparatus shown schematically in Fig. 1. This apparatus was intended to overcome a previously encountered problem of the spherical beads depositing carbon powder at the point where they struck the surface of the casing (through a sudden change in momentum of the beads). This was achieved by introducing the beads first onto a planar metal tray in electrical contact with the casing. This apparatus also allowed the whole surface area of a casing to be examined without the need to remove the potential in order to reposition the casing.

In Fig. 1*a*, the casing to be examined is shown to be placed on the gap in the metal wire rail, the length of this gap being dictated by the caliber of the casing. The other (strike) end of the casing is shown to be placed firmly against the sprung metal plunger to provide additional stability and to ensure good electrical contact. The wire rail, metal plunger, and shell casing were all in good electrical contact with the metal platform, to which the 2.5 kV was applied. A wooden rod, machined to provide an interference fit to the inside of the casing, enabled the casing to be revolved while maintaining electrical contact through the metal plunger. In Fig. 1*b*, the metal tray is shown as connected electrically to the platform and is free to be tilted to encourage the spherical beads to roll towards the shell casing, the tray being positioned against the uppermost surface of the casing. Introducing the spherical beads to the metal tray (rather than directly to the casing) was found to prevent carbon powder depositing on the casing as described above. By turning the wooden rod, the casing could be rotated freely while applying the spherical beads from the tray, thereby exposing progressively the entire casing surface to the beads.

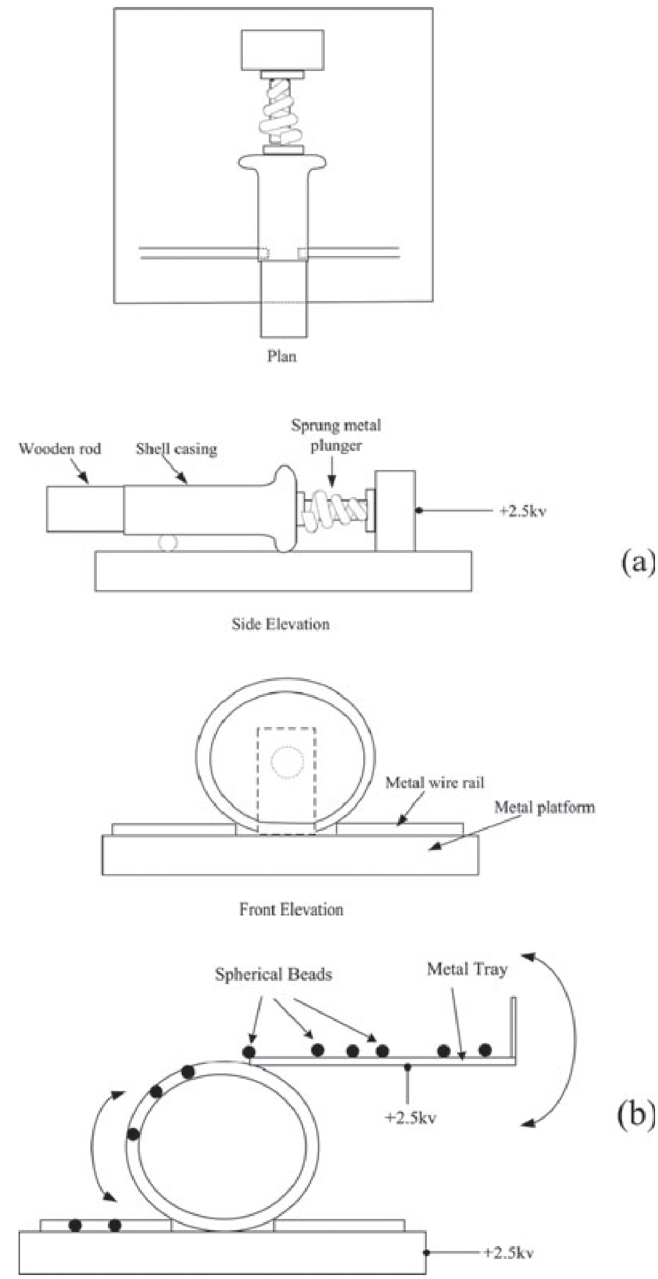

FIG. 1—*Schematic drawing of the apparatus (a) to apply an electric potential to a shell casing followed by (b) the introduction of carbon-coated spherical beads to the casing from a metal tray.*

The conducting powder was found to adhere only to a small area of one casing, that casing being item 3, with the powder adherence being in the same location as the faint ridge lines identified above. Following this process, item 3 was heated to 150°C in order to "bake" the conducting powder onto the surface of the casing and thus provide a more durable image (8). Figures 2*a* and 2*b* show this area on item 3 under different lighting conditions.

In Fig. 2*b*, a series of small black dots can be seen both within the darkened area of conducting powder and also in the area immediately above it. It is thought that this may be indicative of black copper (II) oxide formed during the corrosion process and which has been observed previously (10). Interestingly, there has been no adherence of the conducting powder to the reference number

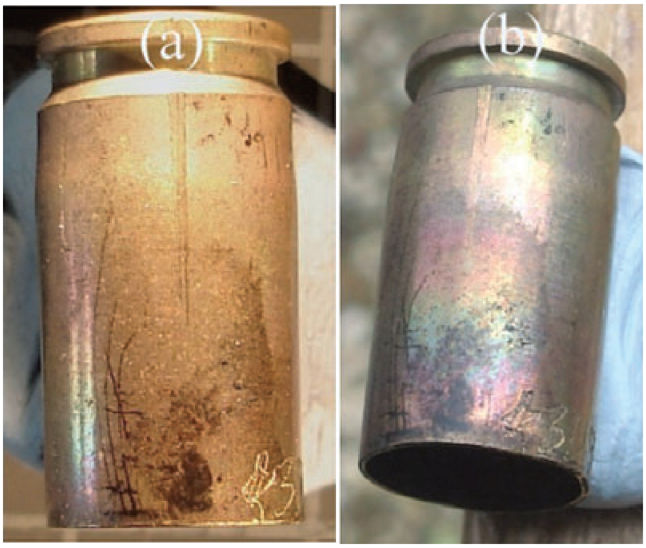

FIG. 2—*Fingerprint ridge lines on shell casing (item 3) following heating to 700°C and the application of a conducting carbon powder.*

engraved into the lower right hand side of item 3, which might be expected if the adherence of the conducting powder was determined by the occurrence of a depression in the metal surface rather than a change in its electrical properties (8,10).

Discussion

Despite both the time elapsed since this crime was committed and the previous cyanoacrylate fuming of the shell casings, fingerprint ridge lines were visualized by means of the above technique on one casing (item 3). After extensive interviews were conducted with the family and friends of the victim, a strong suspect was identified. Interestingly, witnesses had reported seeing the suspect with a 9-mm, semi-automatic handgun *c.* 2 weeks prior to the murder, and that the suspect was extremely conscious of leaving any latent fingerprints on the shell casings. One witness related how the suspect had taken a bullet the witness had handled and wiped it off with his shirt before inserting it back in the magazine. Thus, should this suspect be the offender, the opportunities to visualize latent fingerprints on the shell casings were always limited with, potentially, only one casing having been handled. The use of this technique suggests an opportunity for both old cases involving the discharge of firearms to be reviewed as well as a consideration for current cases.

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