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TECHNICAL NOTE

CRIMINALISTICS

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The Effect of Electrostatic Fingerprint Visualization on Integrated Ballistic Identification Systems

ABSTRACT: Visualization of fingerprint corrosion on spent brass cartridge cases by the application of a high electrical potential and conducting carbon powder is becoming an accepted method of fingerprint enhancement. However, to date, no examination has been made of any effect this technique has on ballistic identification. To resolve this, images of the breech face and firing pin marks were captured on six plated nickel and six brass primer cup spent cartridge cases. Three nickel and three brass cases were then subjected to the application of a potential of +2500 V for a period of 1 min. The remaining cases were additionally subjected to the application of carbon powder. These latter cases were then washed to remove all traces of powder. Each case was recaptured with the same ballistic identification apparatus and imaging procedure. None of the twelve cases showed any visual difference after the application of the potential or conducting powder.

KEYWORDS: forensic science, latent fingerprint, print visualization, ballistics, firearm identification, cartridge cases

Recent research has focussed on fingerprint imaging techniques that exploit the chemical reaction that can occur between the metal surface and the fingerprint deposit. This reaction, effectively a corrosion of the metal, results in a change to both the chemical and physical characteristics of the metal surface (1–4). We have shown how leaving fingerprint sweat deposits on planar brass disks in air at room temperature for several days produced sufficient corrosion of the metal to enable the fingerprint to be imaged even after the residue of the fingerprint deposit had been removed (3).

This visualization was achieved by employing a novel technique, which required the application of a potential to the brass (>1 kV) followed by the introduction of a conducting carbon powder (grain size *c.* 10 μm) (3). The introduction of the conducting powder was facilitated by using Cascade Developer (Foster and Freeman, Evesham, U.K.). The developer is comprised of *c.* 400 μm spherical beads that are coated with the conducting powder. By rolling the spherical beads back and forth across the charged brass surface, 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 cartridge case that was deposited prior to loading the cartridge into the firearm (3). Subsequently, this technique was used to visualize fingerprints on a brass cartridge case recovered from a homicide (5). More recently, an instrument has been constructed to facilitate the use of this technique on spent cartridge cases (Fig. 1; [6]).

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Of additional importance in the investigation of gun crime is the use of ballistic identification. Just like fingers can leave identification marks on touched objects, a firearm's interaction with the cartridge case and bullet can alter their surfaces in a unique way. When considering spent cartridges, impression, striation, and shearing processes produce tool mark patterns on the body (chamber marks), rim (extractor marks), head stamp (ejector marks), and primer (breech face impression and firing pin impression marks) regions of the cartridge case to name a few (http://www.firearmsid.com/A_Introduction.htm [accessed August 4, 2010]). These patterns are observed and captured through direct optical imaging using numerous lighting geometries (http://www.firearmsid.com/A_Introduction.htm [accessed August 4, 2010]). Recently several optical methods for the 3D capture of fired cartridge case and bullet surface topographies have been proposed (7,8 and refs cited) and commercially deployed (http://www.fti-ibis.com [accessed August 4, 2010]).

In this technical note, we examine the effect of the aforementioned fingerprint visualization technique on the breech face impressions on spent cartridge cases. More specifically, we want to verify if this technique alters in any way the marks left by the firearm on the piece of evidence surface. This particular region was selected because it is seated on the primer of the cartridge and is usually made of softer material more prone to be affected either by the application of the strong electric potential or the friction of the powder-coated spherical beads.

Materials and Methods

For these experiments, 12 spent brass cartridge cases were selected. The primer cup of items 1–6 is made of plated nickel while that of items 7–12 is made of brass. Images of the breech face and firing pin marks of those cartridge cases were

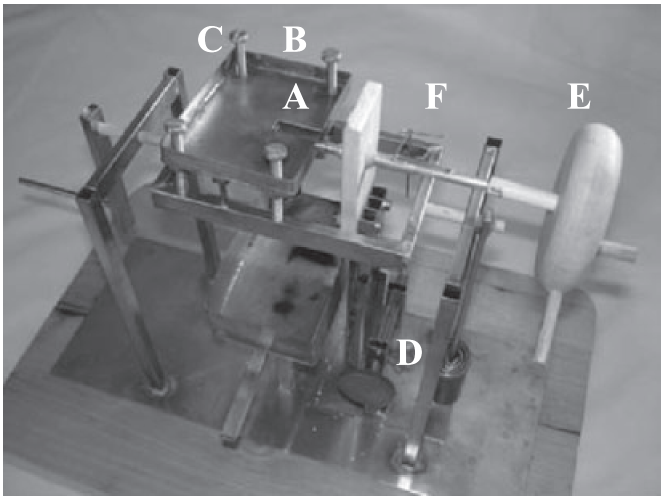

FIG. 1—*Instrument to visualize fingerprint corrosion on fired cartridge cases. A cartridge case (A) is positioned through the cut-out in the brass tray (B) and can be adjusted by means of the four screws (C) and the rack and pinion (D). Cascade developer is introduced to the tray (B) whilst the cartridge case (A) is rotated by the wheel (E). Electrical contact to the tray and cartridge case is made via phosphor bronze contacts (F).*

captured on an IBIS® BRASSTRAX-3D™ imaging station. Ring light images of the breech face and firing pin marks were captured along with a side light image of the breech face mark and an all-in-focus diffused light image of the whole spent primer.

IBIS® technology was preferred to a conventional microscope for the various image capture automation and repeatability it provides (i.e., zoom factor, illumination intensity and geometry, focus, etc.).

Items 1–3 and 7–9 inclusive were then subjected to the application of an electrical potential of +2500 V (with respect to earth) for a period of 1 min. Items 4–6 and 10–12 inclusive were connected to the instrument shown in Fig. 1 and subjected to an examination for fingerprint corrosion. This entailed applying +2500 V to the cartridge case for a period of 1 min followed by the application of conducting powder whilst the cartridge case was being rotated. It was ensured that the spherical beads and conducting powder made contact with the primer cup on each cartridge head. All six cartridge cases (cases 4–6 and 10–12) were then washed in a 0.5 L solution of warm water containing a few drops of commercial detergent and rubbed vigorously with a nonabrasive cloth. This washing regime has been shown to effectively remove debris from the surface of metal (9).

Each cartridge case was then recaptured with the same apparatus and procedure as depicted above. Images of each cartridge case captured before and after the fingerprint visualization procedure was applied were carefully compared using the IBIS® MATCHPOINT+™ viewer in search for marks that would have appeared or disappeared during the process.

Results and Discussion

None of the cartridge case captured images showed any visual differences after the application of a high electrical potential of +2500 V for 1 min or after having gone through the whole procedure of fingerprint corrosion pattern visualization. Furthermore, ring light images of the breech face marks have been submitted to a pixel-to-pixel comparison algorithm. The results showed that the degree of discrepancies between the images before and after the finger mark visualization procedure is comparable to, or less than those observed between successive BRASSTRAX-3D automated captures of the same cartridge case.

Conclusion

Based on the above experimentation, we conclude that the aforementioned fingerprint restoration procedure produces no interference with ballistic identification analysis, at least at the optical resolution in usage with BRASSTRAX-3D, which is around 5 μm. Since the interacting dust covered beads are *c.* 400 μm in diameter and the powder grain size is <10 μm, it is doubtful that significant damages appear at a smaller scale.

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