Forensics Applications of X-ray Fluorescence Spectroscopy in Combination with Advanced Light Source Sample Discovery

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Gunshot residue is expelled as tiny particles when a gun is discharged and includes bits of bullet, brass jacketing, lead and primer residue. Primer residues contain unique chemical components from the propellant and igniters decomposing, a rapid heating and cooling affect. The presence of these components is indicative of a suspect firing, handling or being in the close proximity of a gun being fired.

Fluorescence images are obtained using a Forensic Light Source and various filters to highlight locations of different chemical compounds. EDXRF spectra record X-ray fluorescence and detects chemical element from as small as 10 µm spot.

Both techniques are non-destructive and mutually complimentary. Fluorescence imaging records a large area such as a hand or a sleeve of the suspect, and quickly identifies the regions of interest. It provides information on chemical compounds and their distribution. EDXRF can analyze the isolated spots or map the regions of interest at high spatial resolution. It provides information on chemical elements and their distribution. The results from both techniques can validate each other increasing the credibility of the forensic evidences.

Experimental conditions

The sample is a piece of cotton fabric shot with a gun. The surrounding areas were examined for residues.

A 500W Forensic Light Source (CrimeScope CS-16-500) with a short pass filter was used to illuminate the sample. Images were recorded using a digital camera (PrintScope) with an orange barrier filter and a darkening hood to block the reflecting excitation wavelength.

An EDXRF microscope (XGT-5000) was used to collect element spectra of various spots identified from fluorescence images at 10 µm spot size. The sample chamber was kept under vacuum.

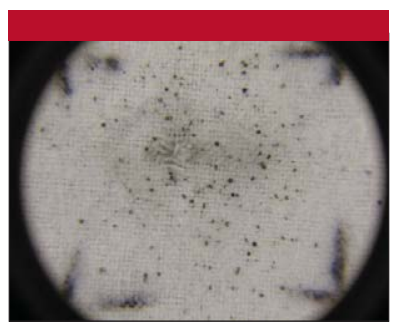

Figure 1: White light image.

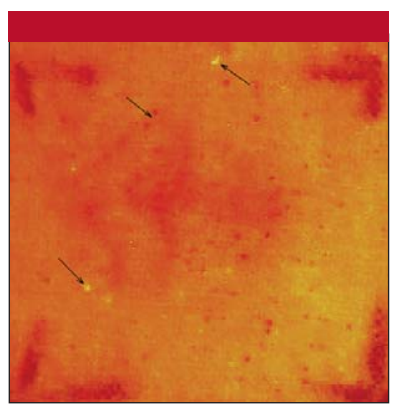

Figure 2: Forensic fluorescence image.

Results

White light image (Figure 1) shows black specs on the white fabric sample. Fluorescence image (Figure 2) shows some black specs becoming opaque indicating there are some similar chemical components, while the remaining black specs are unchanged or can not be seen at all. It also shows two yellow spots. The locations of these spots do not correlate with locations of black specs indicating these are different chemical components.

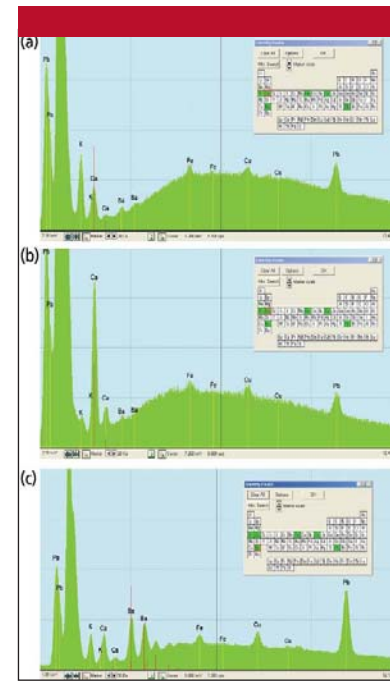

Figure 3: EDXRF spectra of (a) yellow spot 1, (b) yellow spot 2, and (c) opaque spot

Two yellow spots and one opaque spot were isolated and analyzed with EDXRF (Figure 3). The most noticeable characteristics of EDXRF spectra are that yellow spots show higher contents of calcium than the opaque spot, while the opaque spot shows higher barium contents than yellow spots.

Conclusions

Using forensic fluorescence imaging and EDXRF spectroscopy, the chemical characteristics of gun shot residues were determined. It is demonstrated that EDXRF spectroscopy and fluorescence imaging provide complimentary information.

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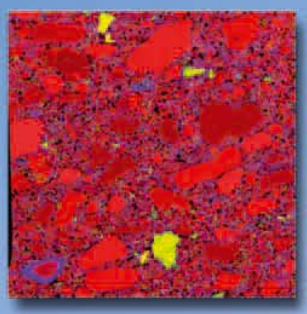

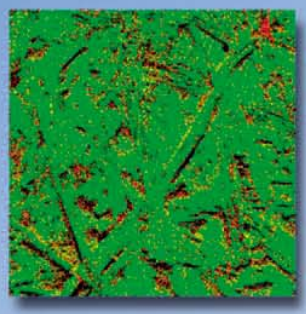

Materials

Alloys and metals
Semiconductors
Layer thickness
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Fillers and coatings

Biology / Medicine

Tissue
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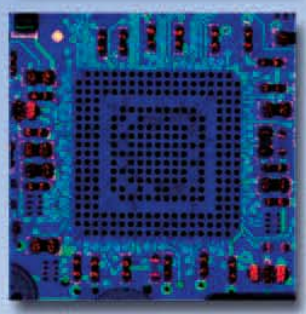

Electronics

Resin embedded components
Solder defects
WEEE/RoHS
Troubleshooting
Plating thickness
Contaminants

Forensics

Fingerprints,
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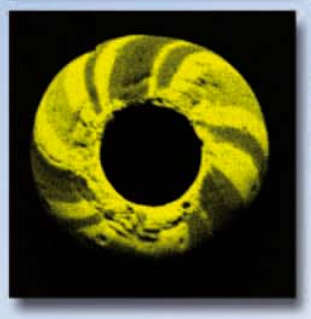
Gun shot residues,
Gems
Inks
Pigments



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