Rapid Investigation of Evidence Using Multi-Spectral Imaging

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1. INTRODUCTION

Imaging is the easiest, non-destructive method for detecting forensic evidence at crime scenes. Different evidence types have either characteristic absorption or fluorescent properties when illuminated under certain light wavelengths. It may be possible to speculatively detect blood, semen and fingerprints this way. Rapidly detecting and imaging evidence, particularly fingerprints, at the crime scene could be a major advancement in forensic evidence retrieval and preservation.

2. FINGERPRINTS

Contain amino acids: Tryptophan & Tyrosine

These fluoresce under UV radiation as a result of excitation of electrons[1]

The different fluorescent or absorbent properties of the fingerprint and surface give an image

The difference in contrast between the print and surface determines the quality of the image

IMAGE 1. *Substrates/surfaces used to image different evidence targets using multi-spectral imaging and the evidence type deposited on them*

3. BLOOD

Blood contains haemoglobin (Hb)

Hb can be oxygenated or deoxygenated

Hb absorbs UV and visible radiation

The wavelengths of peak absorption depend on the oxygenated state of Hb (Figure 1)

The surface properties will depend whether blood appears bright or dark when imaged[2]

4. SEMEN

Semen contains Flavin and Choline-conjugated proteins (among others) which cause semen to fluoresce under a number of different wavelengths[3] (Table 1)

5. METHOD

Three evidence targets – fingerprints, blood and semen – were deposited on different substrates/surfaces (Image 1)

The targets were illuminated under a number of wavelengths (Figure 2)

The targets were imaged using two types of multi-spectral cameras: one optimised for the UV-Vis region, one for the Vis-NIR region

Each camera contained 8 filters in a filter wheel formation between the lens and CCD. The wavelengths of these filters are confidential.

The fluorescent or absorbing characteristics of each evidence target were imaged and the best light wavelength to filter combination determined

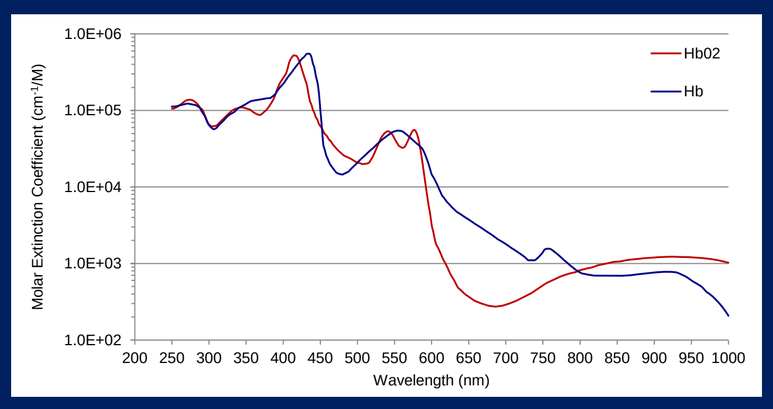

FIGURE 1*. Oxygenated and deoxygenated haemoglobin absorption peaks*

Excitation Light (Light Source Wavelength)	Fluorescence (Emitted Light)
200-400 nm (UV)	Blue Fluorescence (no filter)
400 nm (Violet)	Yellow Fluorescence (600 nm [yellow] filter)
450 nm (Blue)	Yellow Fluorescence (600 nm [yellow] filter)
550 nm (Green)	Orange Fluorescence (650 nm [orange] filter)
550-600 nm (Green-Yellow)	Red Fluorescence (700 nm [red] filter)
550-600 nm (Green-Yellow)	Black 'Fluorescence' (425 nm [violet] filter)

TABLE 1. *Excitation and fluorescence wavelengths of semen[4]*

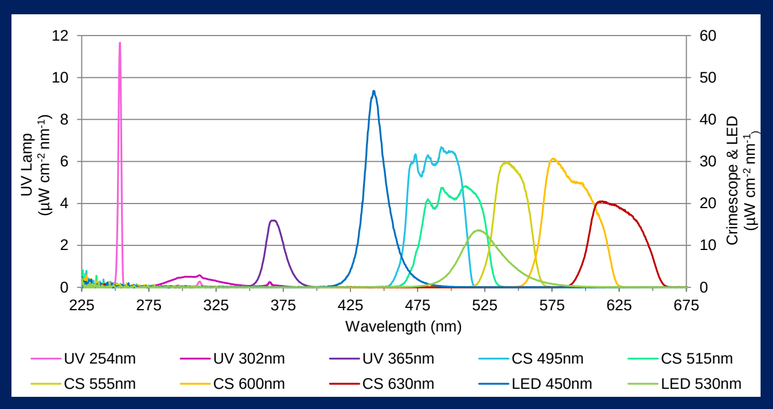

FIGURE 2. *Spectral information of wavelengths used in this investigation per light source*

6. RESULTS

The evidence targets were either visible or not, with some images needing enhancing via CLAHE (Contrast Limited Adaptive Histogram Equalization). The results are given in Table 2 and Images 2 to 5.

	High Quality Visualization	CLAHE Needed	Not Visible
Fingerprints	PH FM BB	FS BC BL GP WP	PP
Blood	PC BL LC BB	RS	DC
Semen	BB PC LC	DC RS	-

TABLE 2. *Full results per evidence target*

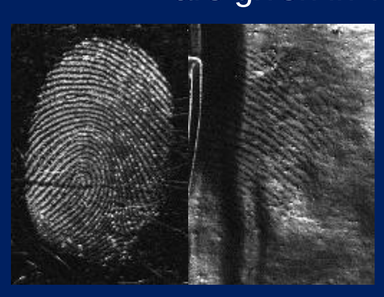

IMAGE 2. *Fingerprints on PH (left) and BB (right)*

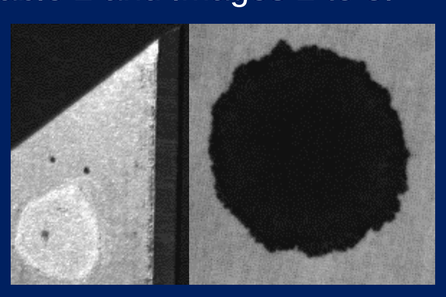

IMAGE 3. *Blood on BL (left) and PC (right)*

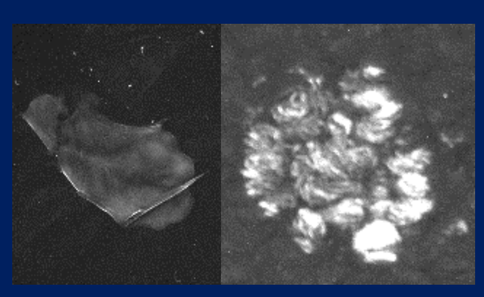

IMAGE 4. *Semen on BB (left) and LC (right)*

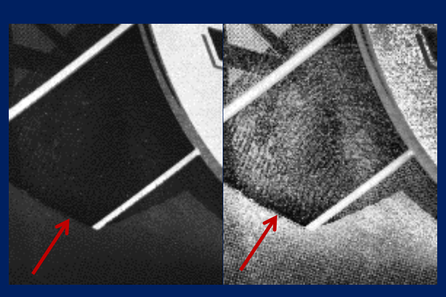

IMAGE 5. *Original image (left) and CLAHE (right) of fingerprint on BC*

BB = Bin Bag BC = Beer Can BL = Blade DC = Dark Carpet FM = Al Foil Matt FS = Al Foil Shiny GP = Glossy Paper LC = Light Carpet PC = Pillowcase PH = Phone PP = Pad Paper RS = Red T-shirt WP = White Paper

7. CONCLUSION

This method of rapidly detecting evidence at a crime scene has potential, but needs development

7 specific filters with 4 specific light source wavelengths were appropriate for high quality visualization of fingerprints, blood and semen

Optimal light source wavelengths and corresponding camera filters per target cannot be given for confidentiality

8. REFERENCES

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9. ACKNOWLEDGEMENTS

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