Alternative Light Source
Presumptive Identification and Imaging of Bloodstains on Colored and Patterned Fabric

[2]Haley Eiland, B.S. & [1]Elizabeth Gardner, Ph.D.

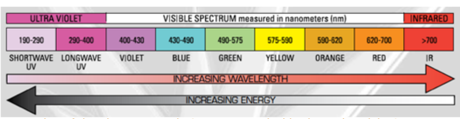
University of Alabama at Birmingham, [1]Department of Criminal Justice, [2]Department of Chemistry

1 INTRODUCTION

Identifying, documenting, and analyzing bloodstained evidence is an important part of crime scene investigation. Since this evidence is often not visible to the naked eye, forensic scientists rely on advanced technologies, such as an alternative light source (ALS), to assist in presumptive identification of blood evidence. The objective of this research was to determine if infrared (IR) and ultraviolet (UV) light offer a reliable, nondestructive method for presumptively identifying blood stains on colored and patterned fabric. Various fabric swatches were treated with neat, whole blood and photographed under IR and UV light using the Leeds LSV2 Spectral Vision System. A total of 48 fabric swatches were examined. Bloodstains on 46 of the 48 fabrics were identified using infrared and ultraviolet light sources. The stains on two fabrics were not visible under any light source. Both stains were on dark brown, patterned fabric, supporting previous research by UAB-MSFS student Olivia Foust.

2 AID OF ALTERNATIVE LIGHT SOURCE IN BLOOD DETECTION

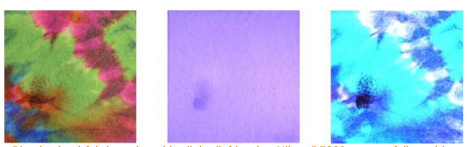
When matter reacts with light, it either absorbs, transmits, or reflects electromagnetic radiation as photons. Upon exposure to light, hemoglobin in blood strongly absorbs shorter, blue and green wavelengths and reflects unabsorbed longer wavelengths perceived as red by the human eye. Dyes used to color fabrics also react with light and may interfere with the detection of any bloodstains present on the fabric.



Portion of the Electromagnetic Spectrum used with Alternative Light Sources. Courtesy Spex Crimescope FLS.[1]

The human eye is most sensitive to light at wavelengths between 400 and 700 nm. Infrared (IR) wavelengths extend past the visible spectrum of light and range from 700 to 1500 nm. Most dyes used to color fabrics fall in the range of visible wavelengths and transmit IR wavelengths. Hemoglobin in blood, on other hand, absorbs IR wavelengths causing the blood to appear as a dark spot under IR light. The results is that many dyes and patterns are not visible under IR, while the bloodstain appears as a dark spot, as seen in the figure below.

Ultraviolet wavelengths fall below the region of visible light and range from 10 – 400 nm. UV light, like infrared, is also absorbed by hemoglobin in blood making bloodstains darken. The greatest difference between UV and IR light relates to the way they react with certain dyes in fabrics, as shown in the images below. Unlike IR wavelengths, ultraviolet light is reflected by certain color dyes causing the fabric to luminescence. The result provides a contrast between the brightly luminescent fabric and the darkened bloodstain.



Bloodstained fabric under white light (left) using Nikon D5200 camera followed by IR light (center) and UV light (right) using Leeds LSV2 Spectral Vision System.

3 METHODS

TREATMENT OF FABRIC WITH BLOOD

- Fabric swatches were treated with neat, whole blood.
- Swatches were allowed to air-dry in an open area of the laboratory.

PHOTOGRAPHY OF BLOODSTAINED FABRIC

Images of each sample were taken under the following conditions:

- White light
- Infrared and ultraviolet light with LSV2 Spectral Vision System
- One week from the day of treatment, a second set of photographs was taken under all three light sources to determine if the age of the blood influenced ease-of-detection and clarity of the photographs.

ANALYSIS OF IMAGES

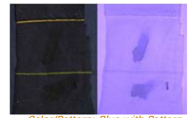
- White light, infrared, and ultraviolet images of each bloodstained fabric were compared to determine the reliability of an ALS for screening, documenting, and presumptively identifying bloodstains on colored and patterned fabric.

4 SCANNING AND IMAGING OF STAINS ON FABRIC USING AN ALS

INFRARED LIGHT SOURCE – PRESUMPTIVE IDENTIFICATION OF BLOODSTAINS ON FABRIC (EXAMPLES A – L)

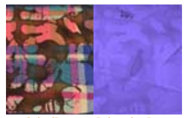
A) *Color/Pattern: Brown with Pattern*
Material: Unknown

B) *Color/Pattern: Black with Pattern*
Material: 100% Cotton

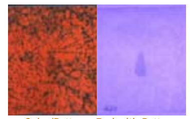


C) *Color/Pattern: Blue with Pattern*
Material: Unknown

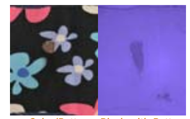
D) *Color/Pattern: Brown Solid*
Material: 100% Cotton



E) *Color/Pattern: Poly-color Pattern*
Material: 100% Cotton

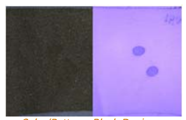


F) *Color/Pattern: Red with Pattern*
Material: 100% Cotton



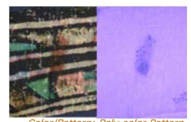
G) *Color/Pattern: Black with Pattern*
Material: 100% Cotton

H) *Color/Pattern: Brown with Pattern*
Material: 100% Cotton

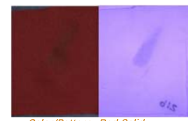


I) *Color/Pattern: Black Denim*
Material: 100% Cotton

J) *Color/Pattern: Brown with Pattern*
Material: 100% Cotton

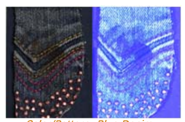


K) *Color/Pattern: Poly-color Pattern*
Material: Blend
(50% Cotton / 50% Polyester)



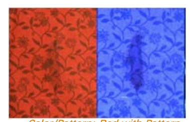
L) *Color/Pattern: Red Solid*
Material: Blend
(79% Polyester / 21% Rayon)

ULTRAVIOLET LIGHT SOURCE – PRESUMPTIVE IDENTIFICATION OF BLOODSTAINS ON FABRIC (EXAMPLES M – P)



M) *Color/Pattern: Blue Denim*
Material: Unknown

N) *Color/Pattern: Green with Pattern*
Material: 100% Cotton



O) *Color/Pattern: Red with Pattern*
Material: 100% Cotton

P) *Color/Pattern: Blue Denim*
Material: Blend
(96% Cotton / 4% Spandex)

Shown above are 16 of the 46 positive presumptive identifications of bloodstains on fabric using an infrared (IR) or ultraviolet (UV) light source. Stains on images A – L were presumptively identified as blood using IR light and images M – P using UV light. The image on the left of each set represents the sample under white light and the image on the right under the designated light source, either IR or UV.

6 MATERIALS

BLOOD AND FABRIC

- Blood was collected via finger sticks from a single individual over the course of five weeks
- Blood was immediately applied to fabric
- 48 colored and patterned fabrics of different material composition were collected and cut into swatches of approximately 4 inches by 4 inches
  - 39 fabrics from second-hand stores and local fabric shops
  - 9 fabric from Olivia Foust's previous research; scrap fabric donated by local quilt-maker so material composition unknown

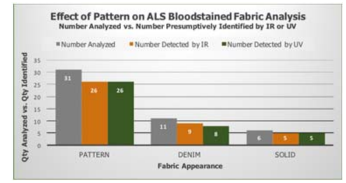
ALTERNATIVE LIGHT SOURCE

Leeds LSV2 Spectral Vision System

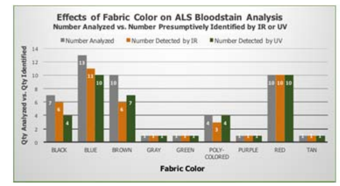
- Mobile stand for monitor and keyboard
- Moveable arm attached to device head containing touch screen monitor, cameras, lights, lenses, and filters
- Scientific CCD sensor for clear images with little to no background noise
- Camera functions at full resolution with speed of up to 40 frames per second enabling real-time screening and imaging
- Motorized par focal zoom options
- Chromatically corrected close-up lenses
- Large range field of view with ability to screen area from approximately 1–26 inches in size
- Multi-wavelength LED lighting functions (7): ultraviolet (365 nm), near infrared (850 nm), white bandwidth (400–700 nm), and four fluorescent light settings (400–590 nm)
- Filter cassettes (5): 550 nm, 570 nm, 610 nm, 830 nm, 440 nm
- Software runs on version of windows comparable to most computers
- LSV2 Instrumentation settings used for infrared and ultraviolet imaging:
  - Camera positioned approximately 10 inches above evidence table
  - Focal range adjusted using dioptic lens setting +2.0
  - Infrared images taken using near infrared 850nm LED light and near infrared 830nm barrier filter
  - Ultraviolet images taken using ultraviolet 365nm LED light and clear 400nm barrier filter
  - Automatic settings were applied to image intensity and shutter speed
  - Brightness, aperture, zoom, and gain (amplification) were manually adjusted for the best quality imaging of each bloodstain

LSV2 Spectral Vision System. Courtesy Leeds LSV2 Online Brochure.[2]

5 ANALYSIS OF DATA



Comparison of the effects of patterned, denim, and solid colored fabrics on presumptive bloodstain identification via IR and UV light.



Comparison of the effects of primary fabric color on presumptive bloodstain identification via IR and UV light.

The use of infrared and ultraviolet light sources yielded positive presumptive identifications for the presence of blood on 46 of the 48 fabrics. Infrared light proved most useful on fabrics of darker hues while ultraviolet light was most successful on light to medium blue denim and fabrics with bloodstains located on lighter or brighter colored areas. Two fabrics contained stains that were undetectable with either white, IR, or UV light. The two false negatives, shown below in images Q and R, were on dark brown patterned fabrics. The locations of the bloodstains are indicated by the circled area..

FALSE NEGATIVES – NO BLOOD WAS DETECTED WITH WHITE (LEFT), IR (CENTER), OR UV (RIGHT) LIGHT

Q) *Color/Pattern: Brown /Embossed Pattern*
Material: 100% Felt

R) *Color/Pattern: Brown Pattern*
Material: 100% Cotton Corduroy

7 CONCLUSION

48 fabrics in a variety of colors and patterns were analyzed to determine if an alternative light source offers a reliable, safe, and non-destructive method for presumptively identifying bloodstain evidence.

- 26 of the of the stains were visible to the naked eye and presumptively identified as blood using either IR or UV light technology
- 14 of the bloodstains that were not visible under white light were detected and photographed using IR light
- 6 fabrics stains not visible under white or IR light were visible under UV light.
- 2 stains, both on dark brown fabrics could not be detected under white, IR, or UV light

These results confirm data obtained in previous research of infrared photography by MSFS student Olivia Foust. Dark brown dyes in fabric may absorb IR and UV wavelengths of light, similar to the hemoglobin in blood, making it difficult to create a contrast between the latent evidence and the background.

ACKNOWLEDGEMENTS

LSV2 Spectral Vision System (alternative light source) was loaned to UAB's Department of Criminal Justice by the manufacturer, Leeds.

REFERENCES

1) "Spectrum and Applications at a Glance". Spex.[Online]. http://www.horiba.com/fileadmin/uploads/Scientific/Documents/Forensics/fls.pdf. (Accessed May 22, 2017).
2) See *Leeds* website: (Leeds LSV2 Brochure and Tutorials). http://www.leedsmicro.com/Forensic_Imaging_Tools-LSV.html. [Online]. (accessed August 3, 2016).