

THE USE OF LEUCO CRYSTAL VIOLET TO ENHANCE SHOE PRINTS IN BLOOD

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BACKGROUND

The application of Leuco Crystal Violet (LCV) for the enhancement of footwear and fingerprint impression evidence was first utilized in the FBI Laboratory in late 1993, after learning from Mr. John F. Fischer (1) of the formulation of this reagent. Mr. Fischer subsequently made a presentation on this topic at the International Symposium on Footwear and Tire Tread Impression Evidence at the FBI Academy in June, 1994. He has recently provided a newer formulation for Leuco Crystal Violet.(2)

LEUCOCRYSTAL VIOLET

Crystal Violet is a cationic triarylmethane dye which has an affinity for both cellulosic and proteinaceous materials.(3) Crystal Violet is often called the more familiar name Gentian Violet.

Leuco Crystal Violet is the completely reduced form of Crystal Violet and is therefore colorless. When LCV and hydrogen peroxide come into contact with the hemoglobin in blood, a catalytic reaction occurs and the solution turns to a purple/violet color.

FORMULATION

Two formulations involving hydrogen peroxide, sulphosalicylic acid, water and LCV have been used in the past with success. - The most recent formulation (5) for the reagent provided by Mr. Fischer, with fixative, is as follows:

1. Dissolve 10 grams of 5-sulphosalicylic acid (Sigma # S-2130) in 500 ml of 3% Hydrogen Peroxide.
2. Add and dissolve 4.4 grams Sodium Acetate
3. Add and dissolve 1.1 gram of Leuco Crystal Violet (Sigma # L-5760) (A magnetic stirrer should be used)

(NOTE: If LCV crystals have become yellow instead of white, obtain fresh LCV)

After the solution is mixed it should be stored in dark colored glassware and refrigerated. It will last several months.

Although this reagent can be mixed and stored as above and then carried to the crime scene, mixing could be easily accomplished in bottles at the crime scene if the need occurred.

APPLICATION

The above formulation for LCV includes 5-Sulphosalicylic Acid, which fixes the blood;

therefore the solution may be directly applied to the impressioned area in one step. This newer formulation appears to be more sensitive, results in a more vivid Violet color and eliminates some of the fading and color changes occasionally encountered with earlier formulations.

Applications of LCV may be made by lightly spraying (with an aerosol device) or by immersion. The reaction takes place rapidly. Where the LCV clear solution comes into contact with blood, the blood impression turns a purple/violet color, instantly providing improved visualization.

DISCUSSION

When bloody footwear impressions are visually located or otherwise suspected at a crime scene, LCV application provides a quick and uncomplicated method of visualizing and enhancing those impressions. Prior to the use of LCV, some more commonly used choices for enhancement of bloody footwear impressions consisted of Amido Black, Diaminobenzidine (DAB) and Luminol. The application of the alternatives Amido Black or DAB to large areas, particularly carpeted rooms, is burdensome and often logistically not possible, due to the porous and absorbable nature of some surfaces. Although portions of carpet or flooring known to contain bloody footwear impressions could sometimes be removed and taken to the laboratory for such processing, this procedure often results in overlooked latent impressions which would go unnoticed without on scene chemical processing. Those impressions would therefore not be discovered and removed from the scene. The advantage of developing all of the impressions at the scene and then being able to include them and their relative position and direction in the crime scene sketch would also be compromised.

Another alternative, Luminol, has been used frequently in cases where the background colors of the substrate would interfere with Amido Black or DAB or in the case of carpeted surfaces, where it would not be feasible to use Amido Black or DAB. Luminol is very sensitive to blood and, because it is applied in total darkness, the substrate background color does not interfere with visualization of the impression. However, the choice of Luminol is accompanied by other restrictions, such as the large amount of time needed for luminol processing and the difficulty of photography in total darkness. In addition, prior to Luminol processing, a screening of the entire floor surface is necessary to specifically identify the location of each impression, so that close-up examination quality photographs can be taken. Luminol photography of large areas, as with a general crime scene photograph, would not provide the necessary detail for examination, and, due to the photographic law of inverse proportions, may not adequately result in exposure of all impressions and therefore could result in the loss of evidence. In addition, with luminol treatment in total darkness, it is considerably more difficult to accurately record the specific direction and relationship to other items at the scene.

The application of LCV, particularly to large crime scene areas in most scenarios, has several distinct advantages over Amido Black, DAB and Luminol. It is easy to mix and, with reasonable safety precautions, does not present any significant health hazards. It is easy to apply with pressurized spray devices. It results in almost instant visualization of impressions which in turn enables that information to be incorporated in photographs and crime scene notes and sketches. In most instances, LCV provides sufficient additional visualization to warrant additional examination quality photographs be taken. If further improved visualization is needed, the area containing the impressions can be removed from the scene to the laboratory where specialized photography and further enhancement with the Amido Black may be performed.

The LCV overspray may discolor some substrates in time due to photo-oxidation; however this does not occur immediately. Individual impressions which are detected can be individually removed from the scene. The subsequent processing with Amido Black methanol/glacial acetic acid formulation will further enhance the impression and eliminate most discoloration.

SEQUENCING

After treatment of a bloody impression with Leuco Crystal Violet, additional detail can often be obtained with conventional black and white photography utilizing necessary filtration to drop the background color of the substrate. In addition, both visible fluorescence and infrared luminescence enhancement via specialized photography have been reported. (4)

As previously reported, LCV can be followed with the methanol/glacial acetic acid Amido Black stain formulation. LCV cannot follow nor be followed with Diaminobenzidine (DAB).

It is also noted that LCV can follow luminol treatment of blood stains. However, if this sequence is used, it is necessary to first fix the stain with a 2% 5-Sulphosalicylic Acid solution prior to luminol treatment, since luminol treatment without fixation causes significant leaching and loss of detail.

CONCLUSION AND RECOMMENDATIONS

Leuco Crystal Violet is a relatively safe, inexpensive and convenient method for processing the floor areas of crime scenes to both enhance and develop faint or latent bloody footwear impressions. With a fixative in its formulation, it can be applied quickly and successfully to any surface, providing improved visualization of blood. It is far more convenient and versatile than luminol and allows for better crime scene notes and observations of the footwear impressions since it is applied and viewed in existing ambient light. Alternate light sources, specialized photography of developed impressions and subsequent treatment with Amido Black can provide further enhancement of detail for comparison.

LCV may cause some discoloration of impressions on adjacent surfaces after a period of time; however, this discoloration is removed with subsequent treatment with Amido Black. The newer formulation provided above also eliminates much of this.

Experience would suggest that visible bloody impressions on porous items such as paper, wood, fabric and medium to dark blue colored carpeting are best processed with DAB, and if needed, followed with Amido Black. But for the processing of large areas, particularly areas where many latent footwear impressions may be present, LCV does an impressive job which has distinct advantages over the other choices.

Footnotes:

(1) Forensic Analyst, Orange County Sheriff's Office, Orlando, Florida

(2) Fischer, J.F. (1995) Personal communication.

(3) Green, F.J., (1990) The Sigma-Aldrich Handbook of Stains, Dyes and Indicators. Aldrich Chemical Company, Inc. Milwaukee, Wisconsin.

(4) Lake, S. (1994) "Optical Enhancement of Leucocrystal Violet Treated Impressions in Blood" Victoria Police State Forensic Science Laboratory, Australia (unpublished)

(5) Bodziak, W. (2002) Personal communication: Newer formula (the one described above) works better than the formula from 1995 (500 ml 3% hydrogen peroxide, 10 g 5-sulphosalicylic acid, 3.7 g sodium acetate, 1 g Leuco Crystal Violet).