Forensic Comparison of Trace Materials: Applying a Color Standard for Image Consistency and Reliability

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datacolor CHROMACAL™

Case Study

BACKGROUND

Gina Londino is a Senior Lecturer at Indiana University Purdue University Indianapolis ("IUPUI") in the Forensic and Investigative Sciences Program. Professor Londino teaches a variety of forensic science coursework including forensic microscopy. The microscope is a very important tool for any forensic analyst and using microscopic images is routine in analysis of trace materials in forensic science. Prof. Londino is a member of American Academy of Forensic Sciences and the American Society of Trace Evidence Examiners.

Sarah Mehling earned a Bachelor of Science degree from the Forensic and Investigative Sciences program at IUPUI, with a concentration in forensic chemistry. She is pursuing a Master's degree in the forensic science program at IUPUI.

THE CHALLENGE

In forensic science, part of the responsibility of the trace evidence examiner is to compare unknown trace materials with trace materials from known a source. Types of trace materials include items such as glass, fibers, explosives, and hair. When comparing trace materials, the microscopist looks for similarities in size, surface features, optical properties, and color. With the use of a specially configured dual microscope, an unidentified item (placed on one microscope) is compared to an item with a known identity (placed on a second microscope). A bridge between the microscopes permit a side-by-side visualization of both items, comparing features and color. A digital image of this side-by-side view is inserted into a case report.

Prof. Londino commented, "The main problem with comparing specimens is that the color seen in the microscope is not the same as that seen on the computer screen or in the case report. This is compounded when sending images to other forensic examiners because image consistency cannot be guaranteed. Color is a major determining factor when comparing two specimens. This can be particularly difficult if relying on a captured image as the comparator in color to what is being visualized under the microscope. Having an accurate and consistent representation of the specimen is crucial to forensic analysis."

WHY INTERESTED IN CHROMACAL?

Prof. Londino observed that digital images of specimens (displayed on computer monitor or projected onto a screen) varied from the appearance in the microscope. She was interested to see if ChromaCal could deliver more consistent images in both quality and color to minimize artificial impacts due to equipment and session-to-session variability. Prof. Londino commented, "ChromaCal could not only greatly improve my analysis capabilities, but also improve collaborations with other forensic scientists, as well as provide a new standard for training of students."

Prof. Londino constantly seeks to employ best teaching practices using microscopy in the classroom and, to that end, uses two microscopes equipped with video imaging systems in her forensic microscopy teaching laboratory. "It's very important to show students what I see under the microscope. I use these [microscopy systems] every day in my teaching."

EVALUATION AND RESULTS

Ten undyed hair samples of varying color from dark to light were imaged. A single strand of each sample was mounted to a slide using Permount™. Each sample was imaged four separate times, along with the same ChromaCal color calibration slide during each session. Specimen and calibration slide images were captured using identical parameters, including the filter positions on the polarizing light microscope. For this experiment, polarizers were positioned in parallel orientation, not crossed polarizers.*

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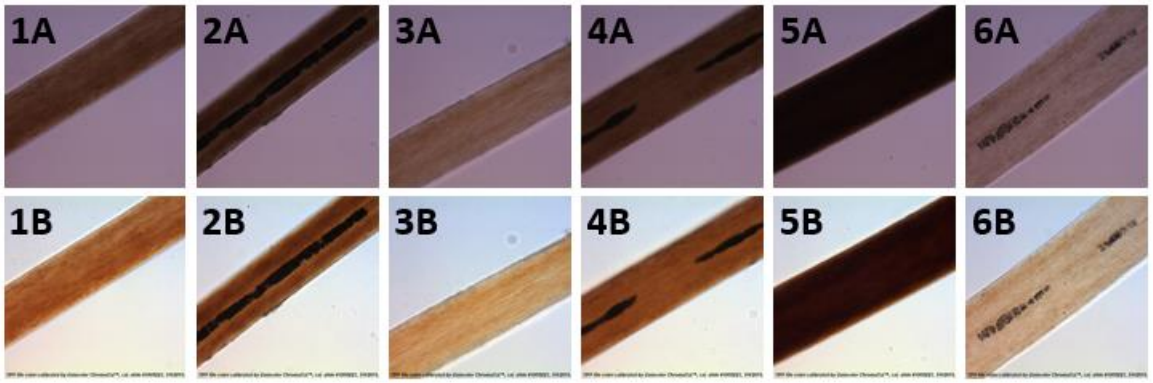
In evaluating the results, Prof. Londino noted, "After image calibration, the hair color in the image was the same as the color viewed under the microscope. Prior to calibration the images were dark and had a slight blue tint. There was also less detail in the original images. ChromaCal corrected all of these imperfections. Calibrated images were lighter and brighter with no color tint. More detail was visible, even the colorless medulla on several hairs. Regardless of exposure in the original image, calibrated images were accurate and reproducible, and resulted in highly consistent images both in color and tonal ranges."

"ChromaCal successfully produced accurate and reproducible images that were highly representative of the specimens as viewed under the microscope."

"ChromaCal-calibrated images are representative of good laboratory practice and ethical imaging … evidence examinations must be scientifically valid to be admissible in court"

Figure 1. Examples of original images (top row) and the corresponding ChromaCal-calibrated images (bottom row).



CONCLUSIONS

Prof. Londino identified the following benefits when using ChromaCal:

- "ChromaCal calibration software provides a repeatable way to produce quality images that show actual color viewed under the microscope."
- "ChromaCal follows best imaging practices by saving images in Tagged Image File Format (TIFF) to eliminate possible loss of data, and as an 8-bit color format to comply with industry standards for other devices and software (e.g. computer displays)."
- "ChromaCal-calibrated images are representative of good laboratory practice and ethical imaging. This is especially important in the field of forensic science because evidence examinations must be scientifically valid to be admissible in court."
- "For an analysis to be scientifically valid the method must be generally accepted in the community of practice. According to the Microscopy Society of America, generally accepted imaging operations include gamma correction, histogram stretching, brightness adjustments, and contrast adjustments. ChromaCal exceeds these practices, and objectively calibrates to a standard, thus avoiding any user bias and subjectivity often associated with other image adjustments."
- "ChromaCal successfully produced accurate and reproducible images that were highly representative of the specimens as viewed under the microscope. This study confirms the potential of color correction for the analysis of hair samples in forensic laboratories. Future studies will be applied to the microscopic examination of trace materials, such as optical properties of fibers and minerals."

*ChromaCal is currently not designed for use in crossed polarization techniques.

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