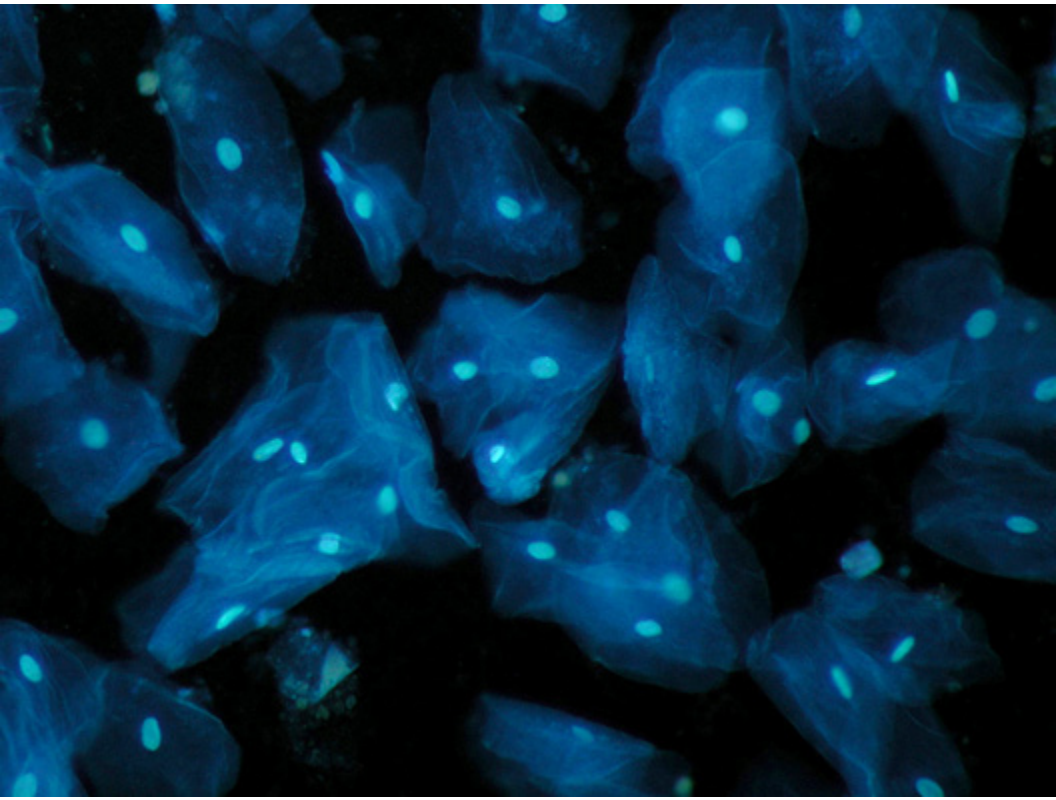
Inter/Micro 2016

An International Microscopy Conference
June 6–10, 2016 • Chicago



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McCrone Research Institute, Inc.

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Welcome to Inter/Micro 2016

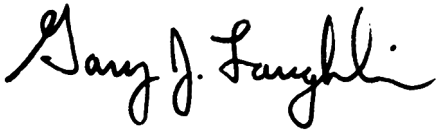
Microscopy includes any instrument or technique that enables the microscopist to characterize, identify and study microscopic substances. This includes all light and electron microscopes, microspectroscopes, microprobes, automatic image analyzers, and other microscopes based on X-rays, sound, protons, etc.

Inter/Micro presentations from some of the world's leading microscopists will cover new techniques for improving contrast, increasing resolution, and obtaining and recording more characterization data. You will also learn how new techniques and new instruments are used to solve important problems.

This year marks the 68th anniversary of the Inter/Micro conference, which was introduced by Dr. Walter C. McCrone in 1948 and is now held annually at McCrone Research Institute in Chicago. Inter/Micro gives all of us the opportunity to come up-to-date on new instruments, new techniques and new applications of microscopy and microanalysis.

We encourage all speakers to submit research papers based on their Inter/Micro presentations for publication in *The Microscope*, the official journal of this conference. Papers will be peer reviewed and published in the order they are received. Inter/Micro 2016 attendees can take advantage of an introductory one-year subscription for $38.50 (regular rate is $75).

Thank you for participating at Inter/Micro 2016.



Gary J. Laughlin
Chariman, Inter/Micro

Cover image by Katie M. White, Microtrace LLC
This fluorescence photomicrograph shows buccal (cheek) cells stained with DAPI under ultraviolet light excitation. White's image was voted best overall winner of the Inter/Micro 2015 Photomicrography Competition, sponsored by pH2, LLC.

Monday, June 6
Techniques and Instrumentation

8:00 a.m.–5:00 p.m. Registration and packet pickup, McCrone Front Desk

9:00 a.m.–12:10 p.m. Morning Session, McCrone Lecture Room

Chair: Peter D. Zoon, Netherlands Forensic Institute

Microanalysis of Some Mineral Elements of Selected Indian Honey Using SEM-SDD-EDS Standardless Method
S. Balasubramanian — Kalasalingam University, Krishnankoil, Tamil Nadu, India

Fission Track Detection: from Acquisition to Analysis
Aryeh Weiss — Bar Ilan University, Ramat Gan, Israel

I Nailed It! Imaging Blunt-Force Fingernail Trauma Using Light Microscopy and Scanning Electron Microscopy Techniques
Martin Kocanda — Northern Illinois University, Department of Biomedical Engineering

Leeuwenhoek Meets the Scanning Electron Microscope
Brian J. Ford — Caius College, University of Cambridge, U.K.

Raman Imaging of Samples with Complex Surface Topographies
Mark Canales — Renishaw, Inc.

Characterization and Uses of Quarter-Wave Plates
Andrew A. Havics — pH2, LLC

It Came from Beneath the Sea: Evolution of a Fluorescence Adapter for Stereomicroscopes
Charles Mazel — NIGHTSEA

Dos and Don'ts of (Quantitative) SEM/EDX Analysis
Peter D. Zoon — Netherlands Forensic Institute

12:10–2:00 p.m. Lunch Break, McCrone Garden

2:00–5:10 p.m. Afternoon Session, McCrone Lecture Room

Chair: Brendan Nytes, Microtrace, LLC

Phase Identification and Electrical Properties of Metal/GaSb Junctions
Kun-Lin Lin — Metrology Analysis Division, National Nano Device Laboratories, Taiwan

Development of a far-Ultraviolet Microspectrophotometer ($_f$UV-MSP)
Dale K. Purcell — SSCI, a division of Albany Molecular Research Inc.

A Versatile Method for Correlated Imaging and Stitching the Outer Surface of Cylindrically Shaped Samples
Xuejun (Jun) Wang — Nalco

Pocket Microscopy: A Panacea for the Optically Curious or Just a Novel Trend?
Martin Kocanda — Northern Illinois University, Department of Biomedical Engineering

Machine Learning Applied to Digital Microscopy
Rick Smith — Sporecyte

Interference Microscopy of Fiber Structure and Its Relationship to Optical Properties
Robert Van Kavelaar

Is that Healthy Glow Really Diamond Dust?
Kathryn Mantz — Pennsylvania State University, Forensic Science Program

Applications of Glass Microspheres as Forensic Trace Evidence
Brendan Nytes — Microtrace, LLC

Monday, June 6

An Evening with Brian
"Magical Mystery Tour of the Cell"

5:30–7:00 p.m. Mediterranean/Persian cuisine dinner, McCrone Garden, $25. (You may pay for the dinner at the front desk if you did not pre-register.)

7:00–8:00 p.m. An Evening with Brian presentation with Brian J. Ford, McCrone Lecture Room, free

Within the living cell are exquisite patterns of behavior that nobody understands. Chromosomes chase around in the race to align in time, male and female cells tentatively explore each other before conjugating, and the cell membrane senses and adjusts to its surroundings. A complex web of movement and response exists that we cannot explain. Present-day models of cells often show them as mechanical balloons of gel that divide according to the laws of physics, but this evening's presentation reveals remarkable abilities that remind us how infinitely more complex life is when studied under the microscope.

***Brian J. Ford** is a leading authority on the microscope and a best-selling author who has presented his work on television and radio. Ford's research is widely quoted in journals and encyclopedias, and he is a popular keynote speaker around the world. He is the author of the Critical Focus column, published quarterly in* The Microscope *journal. Ford has served as a fellow of the Open University, fellow and president of past students at Cardiff University, visiting professor at Leicester University and an associate of Caius College, University of Cambridge, U.K. He has given his Evening with Brian presentations at Inter/Micro for more than 30 years.*

Tuesday, June 7

Environmental and Industrial Microscopy

8:00 a.m.–5:00 p.m. Registration and packet pickup, McCrone Front Desk

9:00 a.m.–12:10 p.m. Morning Session, McCrone Lecture Room

Chair: Wayne C. Isphording, University of South Alabama and Tulane University

Microscopical Look-Alikes, Type 3: Abstract Elements
Andrew A. Havics — pH2, LLC

Seldom Believe What Your Client Tells You and Inquire Carefully Before You Start
Thomas A. Kubic — John Jay College of Criminal Justice and The Graduate Center, CUNY

Microscopical Methods Used in the Development of Pharmaceuticals
Robert Carlton — Carlton Consulting

Anatomical Features from the Inner Bark of Pulpwoods
Walter J. Rantanen — Integrated Paper Services, Inc.

On the Development of New Microcrystal Tests for Drugs
Kelly M. Brinsko — McCrone Research Institute, Inc.

The Life-Changing Magic of Lorazepam and Tramadol
Meggan B. King — McCrone Research Institute, Inc.

Newly Developed Microcrystal Tests for Zolpidem and Alprazolam
Sebastian B. Sparenga — McCrone Research Institute, Inc.

The Michael Donald Murder Trial Revisited
Wayne C. Isphording — University of South Alabama and Tulane University

12:10–2:00 p.m. Lunch Break, McCrone Garden

2:00–5:10 p.m. Afternoon Session, McCrone Lecture Room

Chair: Richard S. Brown, MVA Scientific Consultants

Laser Toner Nanoparticles as Forensic Evidence
Katie M. White — Microtrace, LLC

How Coal Tips Collapse: Examining Slurry Under the Microscope
Brian J. Ford — Caius College, University of Cambridge, U.K.

Improper Mineral Identification in Cosmetic Talcum Powders by TEM Asbestos Testing Laboratories and the Common Errors Observed in Recent and Ongoing Litigation
Monica McGrath — RJ Lee Group

Automated Separation of Micro-Grains in a Mixed Solid Sample
Steven M. Barnett — Barnett Technical Services, LLC

Asbestos Product Identification: Origins
James R. Millette — Millette Technical Consulting, LLC

Product ID: Deformulation and Correlative Microscopy
Richard S. Brown — MVA Scientific Consultants

Tuesday, June 7

Exhibitor Booths

9:00 a.m.–5:10 p.m. Tuesday, June 7 and Wednesday, June 8, McCrone Classroom

Learn about the latest microscopy innovations and products from our exhibitors: Barnett Technical Services, NIGHTSEA, and Renishaw.

SMSI Silent Auction

12:10–5:10 p.m. Tuesday, June 7 and 9:00 a.m.–3:50 p.m. Wednesday, June 8, McCrone Classroom

Bid on microscopy equipment and other related items of interest at the annual silent auction benefitting the State Microscopical Society of Illinois (SMSI). Winners will be announced Wednesday afternoon after the speaker presentations.

Reggie's Rock Club Rooftop Dinner

5:30–8:30 p.m. Reggie's Rock Club, 2105 S. State Street, $30

Unwind on a pleasant evening with fellow Inter/Micro attendees, exhibitors, and sponsors for refreshments and dinner on Reggie's rooftop patio, located just a few blocks away from McCrone Research Institute. Back by popular demand, a trivia contest will follow dinner. Transportation to Reggie's from McCrone will be provided by Reggie's colorful bus. The rooftop dinner is sponsored by Cargille and the American Society of Trace Evidence Examiners (ASTEE).

Wednesday, June 8

Chemical and Forensic Microscopy

8:00 a.m.–5:00 p.m. Registration and packet pick up, McCrone Front Desk

9:00 a.m.–12:10 p.m. Morning Session, McCrone Lecture Room

Chair: Larry Peterson, Defense Forensic Science Center, U.S. Army Criminal Investigation Laboratory

Good Vibrations: Examination of a Lucky Vibratory Crystal
Andrew Bowen — U.S. Postal Inspection Service

Forensic Science and the Amazing Multicolor Fur Coat
Michelle D. Miranda — Farmingdale State College, SUNY

A Microscopical Assessment of Substitute Fibers in Commercial Jute Goods
Barb Fallon — Oak Ridge Institute for Science and Education and Federal Bureau of Investigation

Veterinary Forensics: The Application of Trace Evidence to an Animal Cruelty Case
Jason C. Beckert — Microtrace, LLC

A Generalized Approach to Forensic Dye Identification
Ethan Groves — Microtrace, LLC

Dye Identification in Casework: How Far Can You Go?
Christopher S. Palenik — Microtrace LLC

Forensic Dye Analysis by HPLC-DAD-MS: An Overview of Recent Cases and the Added Value for Forensic Fiber Analysis
Tom Schotman — Netherlands Forensic Institute

Discrimination of Pencil Marks on Paper in Forensic Analysis
Larry Peterson — Defense Forensic Science Center, U.S. Army Criminal Investigation Laboratory

12:10–2:00 p.m. Lunch Break, McCrone Garden

2:00–5:10 p.m. Afternoon Session, McCrone Lecture Room

Chair: Thomas A. Kubic, John Jay College of Criminal Justice and The Graduate Center, CUNY

Frangible Ammunition, Part 2: A Revolutionary New Bullet Design
Peter Diaczuk — D&H Criminalistics Agency

The Wondrous World of Sand
Thomas J. Hopen and Kate Clover

Exploring the Ultrastructure of Human Hair: Preliminary Results from Transmission Electron Microscopy and Fluorescence Microscopy
Sandra Koch — Pennsylvania State University, Department of Anthropology

The Role of Fluorescence in the Examination and Analysis of Dust Traces
Skip J. Palenik — Microtrace, LLC

Co van Ledden Hulsebosch: Notable Cases from the Dutch Pioneer in Forensic Trace Evidence Analysis
Tom Schotman — Netherlands Forensic Institute

Soil Microscopy for Evaluating Differential Sampling of Footwear to Separate Alternative Particle Signals
Andrew Bowen — U.S. Postal Inspection Service

Characterization of Aluminum Powders in Explosives Using Particle Micromorphometry
JenaMarie Baldaino — FBI Laboratory, Counterterrorism and Forensic Science Research Unit, Visiting Scientist Program

The Use of a Fiber Optic Microspectrophotometer to Measure Color in Blue Glass Chips and Dyed Fibers
Thomas A. Kubic — John Jay College of Criminal Justice and The Graduate Center, CUNY

See presentation abstracts on page 14.

Wednesday, June 8

State Microscopical Society of Illinois 2016 Awards Dinner and Live Auction

Presented at Harry Caray's Restaurant, 33 W. Kinzie Street, $70

6:30–7:30 p.m. Social hour and live auction hosted by Brian J. Ford
7:30–8:30 p.m. Dinner
8:30–9:30 p.m. Award announcement and presentation

Join Inter/Micro and the State Microscopical Society of Illinois as they honor **Dr. Wilfried Stoecklein** with the 2016 August Köhler Award.

Stoecklein has a distinguished career in forensic science and materials analysis. In 1973, he joined the Forensic Science Institute of the Bundeskriminalamt (BKA), the federal investigative police agency of Germany, and became head of the Materials Analysis Section in 1976. Six years later, he became head of the BKA's Physics-Chemistry Division. In 1974, Stoecklein was appointed chairman of the German Working Group for Materials Analysis, a post he held for nearly 25 years.

In 1982, Zeiss introduced a new generation of microspectrophotometers that incorporated many ideas from Stoecklein and Peter Adolf. These instruments are still used today in many laboratories for analyzing paints and fibers and remain highly regarded for their precision and reproducibility. Stoecklein helped found a central automotive paint collection in 1985, fulfilling his interest in building sample and data collections for the examination of paint and glass frequencies.

Born in 1939 in Berlin, Stoecklein studied chemistry at the Free University (FU) of Berlin, where he received a diploma degree (Dipl. Chem.) in 1967 and a Ph.D. in 1970.

Thursday–Friday, June 9–10

Workshop: Microscopy of Sand

9:00 a.m.–5:00 p.m., McCrone Classroom and Laboratory

This two-day workshop, taught by Thomas J. Hopen and Kate Clover, will introduce attendees to the fascinating world of sand collecting and show them how to identify sand constituents. Sand collecting is not a new hobby, and psammophiles (*psammo* = sand; *philes* = lovers of) over the years have searched out sand's unique qualities such as the wide variety of colors, textures, components, grain shapes and other attributes. Workshop lectures and individual hands-on laboratory exercises will emphasize the macroscopic and microscopic characteristics of mineral grains and carbonate sediments found in sands from around the world.

Thom Hopen *was first introduced to sand collecting by Dr. Walter C. McCrone in the late 1970s, and since then he has never stopped collecting and studying sand. Hopen has worked for more than 40 years as a forensic microscopist and is currently the president of The International Sand Collectors Society and a member of various professional organizations, including the State Microscopical Society of Illinois (SMSI).*

Kate Clover *brings to the Inter/Micro workshop more than 30 years experience in collecting and studying sands. Clover is co-author of the recent book* Secrets of Sand*, and is a program manager, geoscience educator, and sand curator at the Science Museum of Minnesota in St. Paul. She serves on the board of the Minnesota Geological Society and is a longtime member of The International Sand Collector's Society.*

Monday, June 6

Techniques and Instrumentation

Microanalysis of Some Mineral Elements of Selected Indian Honey Using SEM-SDD-EDS Standardless Method

S. Balasubramanian — Kalasalingam University, Krishnankoil, Tamil Nadu, India

Minerals in honey from different parts of the world vary in terms of presence and concentrations due to influence of geographical, floral nature, and environmental conditions. Ash residue obtained from honey is used to determine the minerals using spectrometry techniques, e.g., AAS, ICP-MS and ICP-OES, etc. This study reports on the microanalytical technique using SEM-EDS to determine the presence of some minerals and their composition in honey obtained from the Indian market as well from hills adjoining the Western Ghats of South India. Honey ash residue typically < 0.60% (allowable limit) obtained from completely burning the honey at temperature of 550°–600° C was used for the analysis. Zeiss EVO 18 Research SEM with Bruker EDS-SDD 6 30 Series X-ray spectrometry with PB-ZAF correction and QUANTAX200 system built-in software deconvolution algorithm, produced spectra to compare the mineral presence and its composition from four honey samples. A total of 11 elements were detected from the spectra and the order of concentration levels are K << O < C < Cl < Mg < Al < Ca< P < S < Si < Na. X-ray diffraction analysis of ash residue confirmed the above results.

Fission Track Detection: from Acquisition to Analysis

Aryeh Weiss — Bar Ilan University, Ramat Gan, Israel
Uri Admon and Itzhak Halevy — IAEC-NRCN, Beer-Sheva, Israel
Ernesto Chinea-Cano — IAEA-Seibersdorf, Vienna

Automation and digital image acquisition and processing enable high throughput screening and analysis of large sample sets that produce large quantities of data. Fully motorized, computer-controlled

microscopes can be combined with high-resolution digital imagers to either acquire large datasets for statistical analysis, or to look for "needles in a haystack," which may often be missed by the observer.

This presentation will focus on fission track (FT) analysis of uranium-containing environmental particles in the micrometer-size range, which is part of an ongoing joint project with the IAEA-Vienna. The method involves scanning a large area "detector" (e.g. polycarbonate sheet, approximately 100–200 mm^2) in order to detect and locate fission tracks, which may be sparse, and distinguish them by their characteristic star-shaped patterns from background artifacts and dirt. The fission track patterns in the "detector" (typical size ≤ 50 μm) are exposed by chemical etching and show the local damage caused by the energetic fission fragments emitted as a result of neutron irradiation of particles containing fissile isotopes such as U-235.

This talk will explain the acquisition and subsequent image processing workflow and will address the following topics: 1) problem specification; 2) microscopy and large-area image acquisition; 3) image enhancement, stitching, and noise reduction; 4) identification of objects of interest (segmentation); and 5) analysis and data reduction.

I Nailed It! Imaging Blunt-Force Fingernail Trauma Using Light Microscopy and Scanning Electron Microscopy Techniques

Martin Kocanda — Northern Illinois University, Department of Biomedical Engineering

Human fingernails are often pampered with color polish, manicures and fiberglass extensions, but otherwise they are taken for granted and are rarely thought of as a type of epidermal tissue. However, accidental nail trauma forces one to assess the significance of the biological processes that occur in a nail's normal and injured states. Fingernail trauma can vary from mild to severe, depending on the circumstances of the injury. The most common fingernail injuries occur from blunt force while using a hammer or similar objects, which damages the tissue surface. In this work, light microscopy and SEM are employed to examine a single-event trauma over a three-month period to show the injury and tissue regeneration process.

Leeuwenhoek Meets the Scanning Electron Microscope
Brian J. Ford — Caius College, University of Cambridge, U.K.

The worldwide interest in the discovery of previously unknown Leeuwenhoek microscopes has given rise to a new approach for the appraisal of antique scientific instruments: scanning electron macrography. This novel application of low magnification imaging at high resolution reveals details of manufacture that replace subjective opinion with objective criteria of authenticity. An extensive program of SEM studies has now given us unique insights that are here presented as indicators in the quest for factors that unambiguously point to forgery.

Raman Imaging of Samples with Complex Surface Topographies
Pierre Negri, Tim Prusnick, Tim Batten, and Tim Smith — Renishaw, Inc.

We will present recent advancements in hardware and software that have been made to enable micro-Raman focus to be maintained over large areas during data collection. These developments allow analysis of samples that, in the past, were impractical or even impossible because of variations in surface topography.

When collecting micro-Raman data the focus of the microscope objective is vital as it determines both the collection volume and the signal strength. This is particularly important when conducting Raman imaging because the sample moving in and out of focus may result in artifacts in the images or erroneous data. We will present data on a range of extremely difficult samples including:

- Graphene on a copper foil, a sample that is inherently rough on a micrometer length scale
- Unprepared pharmaceutical tablets where the sample surface is both curved and has a complex surface geometry, which contains indented logos and lettering
- A snapped pharmaceutical tablet section demonstrating the ability to map an extremely rough sample
- A semiconductor sample being annealed at a range of temperatures in a hot/cold cell — a worst-case scenario as the samples surface is moving as a result of the scientific experiment.

Characterization and Uses of Quarter-Wave Plates
Andrew A. Havics — pH2, LLC

There are a number of compensators that have been used since the time of the origin of the polarized light microscope. These include the quarter-wave (de Sénarmont or Richartz) compensator plate and a first order (Red I) full-wave plate. The de Sénarmont compensator is rarely used for determining retardation up to about 546 nm, but usually less than 300 nm. It can also be used for determining retardation at higher orders (direct and multi-color), extinction angle, and ellipticity. Other applications include determining fibrillar angle in wood, the use of two quarter-wave plates to create full-field maximum birefringence viewing, and de Sénarmont differential interference contrast (DIC) (the addition of well-controlled bias), and reflection contrast microscopy. All of these applications presume the quarter-wave plate is aligned properly and is actually a quarter-wave at the selected wavelength of light to be used. Methods of evaluating these assumptions will be reviewed, such as the simple orientation check, two-compensator method (generalized de Sénarmont method), flux method, spectrophotometric method, and mirror method. Given the ability to correct for inaccuracies in quarter-wave plates through numerical means, an off-the-shelf, inexpensive polymer-based alternative will also be examined.

It Came from Beneath the Sea: Evolution of a Fluorescence Adapter for Stereomicroscopes
Charles Mazel — NIGHTSEA

Fluorescence is a powerful and versatile technique, with applications across many disciplines: biological, forensic, industrial, environmental, and more. But fluorescence microscopy can carry a hefty price tag, limiting its availability for many potential users. As part of a research program in developing methods for marine biologists to locate juvenile corals (~1 mm diameter), both underwater and in the laboratory, we demonstrated the advantages of fluorescence over white-light stereomicroscopy. While this was a good and true answer, it was not a practical one. Coral reef marine biologists are woefully

underfunded, purpose-built fluorescence microscopes do not fare well with repeated shipment to far-flung locations, and the heat and humidity of tropical marine stations are not ideal conditions for sensitive optics and electronics. This conflict led me to develop a prototype add-on to an existing low-end stereomicroscope, which converted it into a fluorescence microscope that could address this one problem, with just one excitation/emission combination. The general approach turned out to be applicable to virtually any fluorescence application, and it has now evolved into a modular system that can be non-invasively added to virtually any stereomicroscope of any vintage, with multiple excitation/emission combinations. While it can't do everything that a high-end system can, it addresses a large fraction of fluorescence needs at a small fraction of the cost and complexity. In this presentation, I will describe the origin and development of this system, including examples of how it is being used in diverse disciplines.

Dos and Don'ts of (Quantitative) SEM/EDX Analysis

Peter D. Zoon and Martin H.E. Janssen — Netherlands Forensic Institute

Advances in X-ray detectors and software have made current electron microscopes into turnkey solutions that can be operated with minimal training. This eliminates the need for dedicated operators, which has a lot of benefits. However, there are some drawbacks, e.g. automatic peak detection and labeling has improved, but it is still not without flaws. Luckily, most users can easily be trained to spot missed or mislabeled peaks.

Quantitative elemental composition of analyzed samples can also be obtained with just a push of a button. Although pressing a button is easy, the path towards obtaining correct results is a tedious and more difficult path than might be expected as can be seen in the various publications in which basic mistakes like auto-normalization and/or selected-elements-only options have been used. In this presentation, the authors will give an overview of some of the dos and don'ts of (quantitative) elemental analysis with SEM-EDX from literature and from their own experiences, including analyses of different stainless steels.

Phase Identification and Electrical Properties of Metal/GaSb Junctions

Kun-Lin Lin and Szu-Hung Chen — Metrology Analysis Division, National Nano Device Laboratories, Taiwan

The interfacial phases with nanoscale in the metal/gallium-antimony (GaSb) interface are a challenge to characterize for researchers, until now. This study will introduce the microstructural characterization of the interfacial phases in the Ti/GaSb contacts after annealing with various temperatures using transmission electron microscopy (TEM) in conjunction with energy-dispersive spectrometry (EDS), nanobeam electron diffraction (NBD), selected area diffraction patterns (SADPs), and grazing incidence X-ray diffraction (GIXRD). The titanium (Ti) will be selected as metal to contact with GaSb substrate and annealed at 300°, 400°, 500°, and 600° C, respectively, in a N_2 atmosphere. Using TEM analysis, only the Ga_3Ti phase is formed at the interface of Ti/GaSb when the annealing temperature is at 400° C. Increasing the annealing temperature to 500° C, Sb from the GaSb diffused toward to the Ti and accumulated at the interface to form as Sb-rich layer, excepting the Ga_3Ti phase. Moreover, three phases (TiSb(Ga), Sb_2Ti, and Ga_3Ti) are formed simultaneously at the interface between Ti/GaSb when the annealing temperature is increased to 600° C, which causes a significant increase in the sheet resistance R_S of the Ti-GaSb alloy. These results indicate that the annealing temperature of the Ti/GaSb structure should be maintained below 500° C for the successful formation of low-resistance metal Ti/GaSb contacts in GaSb-based p-type metal-oxide-semiconductor field-effect transistors (pMOSFETs).

Development of a far-Ultraviolet Microspectrophotometer ($_f$UV-MSP)

Dale K. Purcell — SSCI, a division of Albany Molecular Research Inc.

The development and construction of a far-UV-microspectrophotometer ($_f$UV-MSP) will be presented and discussed. The $_f$UV-MSP is based on an Olympus BH2-UMA vertical illuminator customized with fused silica lenses. The deuterium light is directed onto the sam-

ple using a parabolic catadioptric objective, which in turn collects the light to be imaged onto the entrance of a fiber optic connected to a Horiba VS-140 mini-spectrometer. This unique system was used to evaluate automotive clear-coat paint samples for the presence of UV-absorbers, down to 200 nm.

A Versatile Method for Correlated Imaging and Stitching the Outer Surface of Cylindrically Shaped Samples

Xuejun (Jun) Wang — Nalco

It is challenging to stitch entire outer surfaces of cylindrically shaped samples, a procedure that often requires a rotating motor with specialized instrumentation. This talk describes a simple but versatile method to image and stitch the whole outer surface of cylindrically shaped samples. In principle, any microscope with a motorized stage and stitching capabilities can utilize this method. As an example, a corroded cylindrical sample was imaged and stitched using a Keyence digital microscope. The high quality color image reveals much better sample detail than a regular digital camera. The same sample was cleaned and the images were stitched with white light interferometry to provide 3-D topographical information. The color image before cleaning and the 3-D topographical image after cleaning were correlated using ImageJ software.

Pocket Microscopy: A Panacea for the Optically Curious or Just a Novel Trend?

Martin Kocanda — Northern Illinois University, Department of Biomedical Engineering

Electronic communications, especially cellular phones, have proliferated extensively since the early 2000s. The advancement of low-cost optical technology integrated into smartphones has driven consumers to use various camera and video applications. Now, a recently introduced microscope peripheral can be carried in a pocket and subsequently attached to a cellphone to provide limited magnification microscopy. Features, limitations, various images and some speculations on this new trend will be presented.

Machine Learning Applied to Digital Microscopy
Rick Smith — Sporecyte

Recent advances in digital microscopy scanners and machine learning make it possible to classify red blood cells, white blood cells, mold spores, and air particulate based on their color and morphology. While challenges exist, these technologies hold promise to automate the classification of pollen, silica dust, asbestos, and other tests requiring manual microscopy. Estimated labor reduction is on the order of two and a half to six times. Although the accuracy of classification has yet to be evaluated rigorously, the precision i.e., coefficient of variation, is expected to be substantially reduced.

Interference Microscopy of Fiber Structure and Its Relationship to Optical Properties
Robert Van Kavelaar

Modern interference techniques are capable of detecting local textural nuances of fiber morphology by measurement of the optical properties at points within the fiber. This has come about by developments culminating in the automated digital analysis of fiber interferograms. However, the full potential of this technology can only be realized by modifying traditional views relating fiber structure to optical properties. Some new ideas, which may better describe the state of chain alignment are outlined. The Hermans orientation factor is discussed and its applicability to fiber structure investigations is evaluated. It is concluded that usefulness of the Hermans orientation factor is limited by theoretical considerations. The theory describing molecular polarizability is not yet fully understood, and there is an asymptotical restriction governing the response of optical properties to increasing chain extensions. What is proposed is to consider the parallel refractive index ($n_{||}$) instead of birefringence, assess orientation, and assign as a limiting value of orientation the measure $n_{||}$ of a maximally drawn fiber. This nullifies the influence of densification effects, which confound the interpretation of birefringence data for processes like high-speed spinning or post-treatment such as annealing.

Is that Healthy Glow Really Diamond Dust?
Kathryn Mantz — Pennsylvania State University, Forensic Science Program

Diamond dust has become a popular ingredient in beauty products. Cosmetic companies say it causes the person wearing it to glow or shine like a diamond. The manufacturers claim that their products will cause diamond dust to cling to the body, which then imparts a diamond glow or shine due to the optical properties of the diamond and its interaction with light. Components of these products appear shiny when viewed macroscopically. However, when examined with the stereo light microscope and polarized light microscope, the components appear to be fine particles of glitter, apparent mica, or another similar-appearing mineral.

Applications of Glass Microspheres as Forensic Trace Evidence
Brendan Nytes, Katelyn Hargrave, and Christopher S. Palenik — Microtrace, LLC

Microspheres are used in an increasing variety of applications, from personal care products to food and industrial applications. Glass microspheres represent a significant subset of the microsphere market and are encountered in cosmetics, paints, plastics, building materials, and other applications. While they are used in a variety of consumer-grade products, their size, transparency, and shape can make them difficult to find or easy to overlook. For example, in solution, an isotropic, glass microspheres may be confused with an immiscible phase. Despite such difficulties, the size range (~5–1,000 μm) and composition (glass), make them accessible and potentially useful indicators of products, activity, or associations. This presentation will cover the range of physical, optical, and elemental characteristics of reference microspheres obtained from manufacturers and the ways in which glass microspheres can be located and characterized in industrial and consumer applications, e.g., cosmetics, spackle, and polymers. When present in dust, microspheres may be encountered as free particles, where they may be the sole basis of an association, or they may be encountered in a matrix, e.g., a polymer or ceramic,

where they could be used to improve the significance of an association. The results from these analyses illustrate some of the ways in which microspheres can be located, characterized, and interpreted in the context of a forensic investigation.

Tuesday, June 7

Environmental and Industrial Microscopy

Microscopical Look-Alikes, Type 3: Abstract Elements
Andrew A. Havics — pH2, LLC

Microscopists often encounter images of objects under the microscope that look like other objects. These look-alikes, or microscopical doppelgängers, come in three varieties: objects of similar size, within a order of magnitude (type 1); objects of different size scales but similar morphologies (type 2); and objects of abstract elements (type 3). The third type may be better characterized as loosely connected or artistically correlated structures. Examples include the school of fish habit of TNT crystallization, Bousfield's four horsemen of the apocalypse, "crosses" in various objects from glass spheres to air bubbles to starch, Gray's Snoopy and the Red Baron, *Taraxacum officinale* pollen and the Eye of Sauron, crystals forming iconic images serendipitously, the fringe cell from the intestinal villus of the mouse looking like the cratered surface of the moon, etc.

Seldom Believe What Your Client Tells You and Inquire Carefully Before You Start
Thomas A. Kubic — John Jay College of Criminal Justice and The Graduate Center, CUNY

This talk is the result of my attending a presentation by Jason Beckert at Inter/Micro 2015, where he mentioned that the most valuable information for a final determination of the cause of an accident was present before and visible prior to the technical investigation being conducted — but you first had to have all the information from the client and look carefully at the evidence. In this presentation, I will discuss a few situations I encountered over the years that taught me *not* to necessarily believe what the client tells me, and to inquire more diligently into the client's real requirements before beginning any extensive examination.

Microscopical Methods Used in the Development of Pharmaceuticals

Robert Carlton — Carlton Consulting

Every drug that people take is delivered in a physical form: tablet, capsule, inhaler, topical, etc. Drugs are composed of various components, which can be categorized as active drug substances (APIs — active pharmaceutical ingredients) or excipients. Excipients, which can be either organic or inorganic, are used for a variety of purposes, such as bulking agents, disintegrants, lubricants, etc. Drug substances and drug products are influenced by material properties — particle size, polymorphism, particle morphology, crystallography, etc. — and can be studied with different microscopical techniques, including polarized light microscopy, thermal microscopy, electron microscopy, microspectroscopy, digital image analysis, and other specialized techniques. In pharmaceutical research, development, and manufacturing, microscopy is principally used for three purposes: solid-state form analysis, size and shape analysis, and for the identification of contaminants. Examples of how microscopy is applied to the development and manufacturing of drugs will be presented in this talk.

Anatomical Features from the Inner Bark of Pulpwoods

Walter J. Rantanen — Integrated Paper Services, Inc.

This is a partial review of the cellular features of macerated bark cells. In pulping wood chips, occasionally part of the bark (most likely inner bark) still adheres to the wood. In large commercial operations, debarking systems are not always effective in totally removing all of the bark. This can be caused by the mechanics of the operation and also the weather conditions. These bark cell types can cause defects or visual specks in the paper sheets, which will trigger customer complaints. Some additional species and interesting features observed from defects in the finished paper product will be presented.

On the Development of New Microcrystal Tests for Drugs

Kelly M. Brinsko — McCrone Research Institute, Inc.

Microcrystal tests are used in forensic science laboratories worldwide to identify controlled substances. Typically, microcrystal

tests are performed by adding a specific reagent to an aqueous solution of the drug on a microscope slide; the formation of a characteristic crystalline precipitate with recognizable morphology viewed through the microscope confirms the presence of the drug. Hundreds of microcrystal tests for drugs and other substances are known, and most have been in use for many decades. However, newer pharmaceutical drugs and certain street drugs, including the so-called "bath salts," have no known microcrystal tests and are not included in the literature. McCrone Research Institute recently was awarded a federally funded research grant from the National Institute of Justice (2015-IJCX-K010) to develop new microcrystal tests for 12 such drugs where no microcrystal tests are currently known or available.

Charles Fulton authored the preeminent manual *Modern Microcrystal Tests for Drugs*, published in 1969, in which he provides numerous lists of precipitating reagents. These lists form the basis for the reagents that will be evaluated and tested on the 12 drugs in order to develop new microcrystal tests. This presentation will discuss Fulton's reagent lists and present the testing scheme adopted by McCrone Research Institute.

The Life-Changing Magic of Lorazepam and Tramadol

Meggan B. King — McCrone Research Institute, Inc.

Lorazepam and tramadol are pharmaceutical prescription drugs that are commonly abused or diverted from their intended recipients. Currently, there are no published microcrystal tests for these drugs. McCrone Research Institute was awarded a grant from the National Institute of Justice (2015-IJCX-K010) to develop new microcrystal tests for a number of drugs. This presentation will discuss our current findings on lorazepam and tramadol.

Newly Developed Microcrystal Tests for Zolpidem and Alprazolam

Sebastian B. Sparenga — McCrone Research Institute, Inc.

There are currently no microcrystal tests for many recently developed new drugs, including pharmaceutical prescription drugs that are abused or diverted from their intended recipients, and con-

trolled substances commonly found in new designer street drugs. In 2015, McCrone Research Institute proposed to research and discover microcrystal tests for these types of drugs and was awarded a grant by the National Institute of Justice (2015-IJ-CX-K010) to meet this need in the forensic science community. This presentation will discuss the progress that we have made on developing microcrystal tests for zolpidem and alprazolam.

The Michael Donald Murder Trial Revisited

Wayne C. Isphording — University of South Alabama and Tulane University

On Oct. 17, 1981, a 19-year-old black male, Michael Donald, was abducted at random from a street in downtown Mobile, Alabama and taken to a site across Mobile Bay, where he was beaten and murdered in apparent revenge for the mistrial of a black man accused of killing a white Birmingham police officer. Two members of the Ku Klux Klan, Francis Hayes and James "Tiger" Knowles, were charged with the murder, and a third person, Benjamin Cox, was charged as an accomplice. All three were found guilty of capital murder in 1983, and Hays was executed in the electric chair in 2000. The others are currently serving life sentences for the crime. In 1987, the mother of Michael Donald successfully filed a civil suit against the Invisible Empire, Knights of the Ku Klux Klan, and a jury awarded her $7 million, the Klan's national headquarters building in Tuscaloosa and other miscellaneous Klan property. This was the largest legal blow ever rendered against the Klan, and it left the organization effectively bankrupt in Alabama.

Despite the fact that justice was apparently served, it is ironic to note that the three perpetrators were nearly successful in having the prosecution's major evidence thrown out of court because of errors made in presenting evidence from soil and clothing that linked the men to the murder site. However, two of the defendants, in an effort to avoid a possible death sentence, admitted they had been involved in the crime and that Hays was the chief conspirator. Hence, conclusive forensic evidence of the guilt of the three men was never presented during the trial. This evidence did exist (however, the district

attorney was unaware of it), not only by the use of proper statistical tests comparing the soil chemistry of samples collected at the Baldwin County crime scene and the defendant's property 25 miles away in Mobile, Alabama, but also in the pollen content of samples and heavy minerals present on soil and clothing samples from the two sites.

Laser Toner Nanoparticles as Forensic Evidence

Katie M. White and Christopher M. Palenik — Microtrace, LLC

Although they are abundant and commonplace, nanoparticles are rarely utilized as forensic evidence. The majority of forensic trace evidence laboratories focus exclusively on larger particles and ignore subvisible and nanoscale particles and features. While such particles are not typically exploited as evidence, they are readily found in nature, generated as dusts in various anthropogenic processes and are engineered for a growing variety of applications in consumer and industrial products.

Modern toners used in laser printers represent a prime example of subvisible particles that can be common to our environment. Toner consists of a loose powder containing a mixture of polymeric resin, colorant, and various additives with specific formulations that vary among manufacturers. Toner powder is easily transferred to hands, clothing, and other surfaces during handling of the cartridge and during printing. This can leave behind subvisible particles. Recovery and characterization of these particles by methods such as polarized light microscopy, micro-infrared and Raman spectroscopy, and electron microscopy coupled with energy dispersive X-ray spectroscopy can provide information about the micromorphology (e.g., size, shape, and texture), pigment and polymer content, and elemental composition. Such features may serve as points of comparison in a forensic analysis or be used to potentially place constraints on the source of a particular toner particle. This presentation will discuss characteristics of toner particles, their microanalytical features, and approaches for the recovery, handling, and analysis of these materials.

How Coal Tips Collapse: Examining Slurry Under the Microscope

Brian J. Ford — Caius College, University of Cambridge, U.K.

Human tragedy is often the result of a collapsing tip of industrial waste. Recent examples include Manila, the Philippines, with 150 killed (2000); Shenzhen, China, where 80 died (2015); and Hpakant, Myanmar, with 20 dead (2015). Conventional models of a slipping, spoil heap rely on mechanisms like subsoil lubrication and thixotropic clays. An alternative concept is based on the change of relative density of particulates within the waste consequent upon the ingress of water. Fifty years ago, 116 children and 26 adults lost their lives when a coal tip in Aberfan, Wales, collapsed onto a village school. Looking back at the event reminds us that the search for mechanisms behind such tragedies can usefully involve unconventional interpretations of well-known phenomena.

Improper Mineral Identification in Cosmetic Talcum Powders by TEM Asbestos Testing Laboratories and the Common Errors Observed in Recent and Ongoing Litigation

Matthew S. Sanchez — RJ Lee Group

Allegation of amphibole asbestos contamination in cosmetic talcum powders have been increasing in the past few years. These allegations are made by experts representing plaintiff's law firms and are primarily being driven by litigation. The primary analytical method used by plaintiff experts is transmission electron microscopy (TEM) equipped with both energy dispersive spectrometry (EDS) and selected area diffraction (SAED). Unfortunately, many of the methods that have been adopted by commercial asbestos laboratories for amphibole identification — for example, the measurement of 5.3Å layer line spacings — are inadequate to reliably differentiate many of the minerals found in talcum powders. When these experts are challenged with this approach in mineral structural identification and asked to apply zone axis diffraction and indexing, they make fundamental errors in indexing that also lead to misidentification of the elongated minerals in these products. In each case, the plaintiff experts cite the work done by Dr. Shu-Chun Su for the National Voluntary Laborato-

ry Accreditation Program (NVLAP) in providing zone axis look-up tables to commercial asbestos laboratories as the basis of their work. This presentation will highlight these fundamental errors, which involve improper assumptions of twinning in both anthophyllite and tremolite, high-index zone solutions, failure of dual-zone axis interaxial angle consistency, and the failure to compare observed measurements to either calculated diffraction or standard-zone axis tables.

Automated Separation of Micro-Grains in a Mixed Solid Sample
Steven M. Barnett — Barnett Technical Services, LLC

Current methods for the separation of mixed solid grains are slow and laborious. A system for the automated separation of mixed solid grains based on size, color, and/or shape has been developed by combining a computer-controlled micromanipulator with image-analysis software that classifies grains by color, size, and shape. The system has been used to separate thousands of grains in a typical overnight run.

Asbestos Product Identification: Origins
James R. Millette — Millette Technical Consulting, LLC

In the late 1980s, after President Reagan signed into law the Asbestos Hazard Emergency Response Act (AHERA) to address the problem of asbestos in building materials in the nation's schools, several school systems and state attorney generals sued the manufacturers of asbestos-containing building products to get money to pay for removal of the materials in their buildings. While the manufacturers of some asbestos-containing building materials (ACBM) could be determined from sales receipts and building specifications, the provenance of many products such as sprayed-on fire proofing, acoustical plaster, pipe insulation, ceiling tiles and floor tiles, required a compositional analysis by microscopy and comparison with known exemplars or manufacturers' formulae. In one of the first cases, Maryland's attorney general obtained through court order thousands of pages of formula documents from former asbestos product manufacturers. These documents had been redacted and the name of each company had been replaced with a specific code number. In addition, the

Maryland attorney general had obtained several samples of product materials for which the manufacturer was known; these were also coded. Although it was a daunting task to organize the thousands of pages of information in a way that could be used efficiently, it soon became apparent that the majority of the products could be classified on the basis of the type of asbestos present and which, of about two-dozen binders and fillers, were used to construct the products.

Ultimately, an Excel-type spreadsheet database was created with columns for the code number information of the product, dates it was manufactured, types of asbestos (chrysotile, amosite, crocidolite), and percentages of 23 possible constituents (perlite, vermiculite, mineral wool, bentonite clay, kaolin clay, Portland cement, precipitated lime, gypsum, sand, limestone, diatoms, talc, starch, cellulose, mica, wollastonite, titanium dioxide, lithapone, sodium silicate, calcium silicate, magnesite, and sodium nitrate). In a few situations, where two products were virtually identical, a small amount of different additives such as their surfactants could be used to differentiate the two. Eventually through other cases, including those of the attorney generals of Massachusetts, Hawaii, West Virginia and Illinois, and EPA public documents and court documents published by legal groups, information was released that linked a specific manufacturer with particular formula information. We were able to construct a comprehensive database of the ACBM product compositions. This database could be used with microscope analysis and chemical testing to identify the manufacturer of the majority of asbestos-containing building products.

Product ID: Deformulation and Correlative Microscopy
Richard S. Brown — MVA Scientific Consultants

Asbestos-containing products were analyzed using a combination of polarized light microscopy (PLM), scanning electron microscopy with energy dispersive X-ray spectrometry (SEM-EDS), and analytical electron microscopy (AEM) or transmission electron microscopy (TEM) and EDS with selected area electron diffraction (SAED). The procedures developed to perform the analysis were dependent upon correlating the findings from each technique. The

microscopists were in constant communication to ensure that all ingredients were found by each technique; and when they weren't, the reason for the discrepancy was investigated. The products themselves contained an interesting array of materials: diatoms, cooked diatoms, starch, cooked starch, Portland cement, and many others. The diversity of ingredients required us to follow and study many paths with multiple branches to produce protocols that would result in reliable and reproducible data. The author will distribute a summary of the analysis protocol developed and present a few of the more interesting products that we were asked to analyze.

Wednesday, June 8

Chemical and Forensic Microscopy

Good Vibrations: Examination of a Lucky Vibratory Crystal
Andrew Bowen — U.S. Postal Inspection Service

The U.S. Postal Inspection Service's National Forensic Laboratory (NFL) is a full-service forensic laboratory located in Dulles, VA. This presentation will share a recent case example from the NFL involving an alleged lucky "vibratory crystal" submitted as an unknown substance. The crystal is related to one of the largest mail fraud cases in history. The case background will be shared along with a discussion of the challenges associated with answering several of the specific questions on the laboratory request.

Forensic Science and the Amazing Multicolor Fur Coat
Michelle D. Miranda — Farmingdale State College, SUNY
Jennifer Leonard and Thomas A. Kubic — John Jay College of Criminal Justice and The Graduate Center, CUNY

This talk presents the results of the microscopy and microanalysis of assorted dyed beaver pelt used for fur coats. Beaver furs ranging in color from vibrant hues of red, pink, yellow, green, and blue to neutral tones of white, beige, brown, and gray were obtained for this study. Fibers were examined using polarized light microscopy and microscopy with both reflected and transmitted light. In an effort to characterize the dyes utilized, the furs were examined using vibrational spectroscopic techniques (e.g. Raman spectrometry). The goals of this research project are two-fold: to develop a small guide to the microscopy of dyed beaver fur, and to evaluate the dyes used to produce colored beaver fur coats. It is proposed that by adding to the existing knowledge of mammal hairs used in garments, the forensic scientist will be better equipped to identify and compare samples encountered in casework.

A Microscopical Assessment of Substitute Fibers in Commercial Jute Goods

Barb Fallon — Oak Ridge Institute for Science and Education and Federal Bureau of Investigation

Natural fibers from jute (*Corchorus capsularis* and *C. olitorius*) are common in commodities such as cordage, sacking, and textiles. Jute can be identified and distinguished from other common vegetable and man-made fiber on the basis of its microscopic characteristics. Other natural fibers and some synthetic fibers may be substituted in commercial goods advertised as jute. Research done at the Michigan State University Forensic Science Program resulted in the finding that polyester was found to be the most common substitute fiber utilized in goods advertised as jute. Examples of these substitutions and possible explanations for the polyester trend will be presented in addition to ways in which polarized light microscopy was used to separate jute from its substitutes.

Veterinary Forensics: The Application of Trace Evidence to an Animal Cruelty Case

Jason C. Beckert — Microtrace, LLC

Trace evidence is commonly collected and examined in criminal cases involving human victims. Historically, limited resources have been devoted to animal abuse crimes; trace evidence, being one of the most labor-intensive disciplines, was not typically considered. However, as societal views and attitudes evolve, trace evidence is increasingly being utilized in investigations regarding animal cruelty. This presentation will focus on a case study involving the examination of physical evidence as it related to the prosecution of an individual suspected of abusing a puppy. It will also discuss the advantages of conducting a thorough trace evidence examination prior to submitting samples for DNA analysis.

A Generalized Approach to Forensic Dye Identification

Ethan Groves and Christopher S. Palenik — Microtrace, LLC

The identification of dyestuffs is often a challenging problem due

to the wide range of chemistries, low concentration (often < 2 wt-% of the total fiber mass), and limited amount of sample often available in forensic casework. While a significant body of literature regarding dye analysis exists, it is generally scattered and often applicable to either a specific analytical method or group of dyes. Here we present a generalized approach to dye identification that is broadly applicable to a wide range of dye chemistries, application classes, and fiber types that has the potential to be scaled to forensic casework-sized samples.

This approach is based on the characterization of 300 commercially relevant textile reference dyes using a variety of microanalytical methods (UV/VIS spectroscopy, visible microspectrophotometry, Raman microspectrophotometry, and high-performance thin layer chromatography). A set of 200 fibers from manufacturer prepared shade cards was used to develop and validate a generalized and reproducible analytical method for dye characterization and identification. While there is no single approach that is applicable to every dye on all fiber types, the combination of these analytical methods, applied according to a reproducible manner, permit the use of reference data to constrain and, in many cases, identify the dye (or dyes) present in a textile fiber sample.

Dye Identification in Casework: How Far Can You Go?

Christopher S. Palenik, Ethan G. Groves, and Skip J. Palenik — Microtrace LLC

Dye identification in textile fibers has been considered as a potentially useful method by forensic scientists for decades. However, the typically low concentrations (often < 2% in finished fibers) has limited the accessibility of this component to a comparison of color by comparison microscopy or microspectrophotometry. Here we present our progress in a multi-year NIJ-funded project aimed at the characterization of curated reference dyes of commercial significance by various microanalytical methods (including high-performance thin layer chromatography, Raman microspectroscopy, and visible microspectrophotometry), and the validation of these results through the analysis of fabrics dyed with known dyes (manufacturer-produced shade cards). While these empirical validations pro-

vide support for this approach, the true benefits of dye identification become apparent when applied to blind samples and casework. We will present several examples showing how a combination of literature research, well-curated reference samples and data, and a mature analytical approach provides a practical path to dye identification in real-world samples. The results illustrate that the extent of identification can range from the classification of a dye to a particular chemical group (e.g., azo dye) or application class (e.g., reactive dye), to the identification of a single dye in a fiber, to the identification of multiple dyes, and in one case, to the identification of the likely trade name of a dye and a reasonable estimation of its concentration on the fiber. The ultimate results depend on the sample, the dye(s) present, and the level of effort. However, these results illustrate that this generalized approach to dye identification shows promise on a practical level.

Forensic Dye Analysis by HPLC-DAD-MS: An Overview of Recent Cases and the Added Value for Forensic Fiber Analysis
Tom Schotman — Netherlands Forensic Institute

Evidential value of forensic fiber examinations are dependent on the discrimination power of the techniques used by the examiner. In 2013, we proposed high performance liquid chromatography-diode array detection-mass spectrometry (HPLC-DAD-MS) as a means to improve discrimination by identifying the fiber dyes present.

This method allows the identification of individual components in a mixture of dyes due to the combination of chromatographic separation and characterization by high-resolution mass spectrometry. Since then, the method has been applied in several cases involving reactive, direct, disperse, acid, and basic dyes. In many of these cases we were able to relate dyes used in fiber traces and a known source, or understand subtle color differences observed by microscopy or microspectrophotometry (MSP) by discriminating the dye mixture.

In this presentation, we will discuss a number of these cases and the added value of dye identification. In addition, we will present the dye analyses of samples provided as part of quality assurance tests (Collaborative Testing Services and European Textile and Hair Group ring tests).

Discrimination of Pencil Marks on Paper in Forensic Analysis

Larry Peterson — Defense Forensic Science Center, U.S. Army Criminal Investigation Laboratory

Non-colored, graphite-based pencil marks occasionally have forensic significance in cases for which the determination of whether a mark was produced by a particular pencil has probative value. This study is an attempt to provide a method for the discrimination of such marks. Various samples of pencils of differing origin were analyzed elementally using a combination of X-ray fluorescence spectroscopy (XRF) and scanning electron microscopy with energy dispersive X-ray spectroscopy (SEM-EDS). A novel method for the recovery of samples from paper using an industrial adhesive was employed. The samples analyzed were obtained from commercial sources and generally designated as No. 2 or HB graphite hardness.

Frangible Ammunition, Part 2: A Revolutionary New Bullet Design

Peter Diaczuk and Jack Hietpas — D&H Criminalistics Agency
Xiao Shan Law — John Jay College of Criminal Justice, CUNY

The frangible bullet market has blossomed in the past several years. The increasing concern over lead exposure, whether airborne or leaching into the water table has encouraged bullet smiths to conjure up an increasing number of new designs. The latest entry into lead-free bullet design is not marketing their bullets as frangible in spite of being comprised of metal particles held together in a polymer. Unlike traditional bullet manufacture, these bullets are made with an injection-molding process. The ammunition made with the injection molded bullets has some very interesting ballistic properties. This presentation examines the construction and microscopy of the new injection molded bullets, their ricochet characteristics, barrier penetration ability, and resultant fragmentation. Recovered bullets and bullet fragments were examined microscopically to determine if striae were present and, if so, were they useful for comparison purposes.

The Wondrous World of Sand

Thomas J. Hopen and Kate Clover

Whether you are walking along a beach, up a mountain trail, next to a river stream, or on a sand dune, you can reach down to scoop up a handful of sand and be captivated by the diversity of the individual sand grains. Sand is everywhere and means different things to different people. A general non-technical dictionary definition for sand is "loose particles of hard broken rock." Sand may consist of small (usually 0.06–2 mm) detrital fragments (rock or mineral particles liberated by weathering processes of parent rock material), biogenic particles (shells, corals or barnacle fragments) or grains formed by chemical precipitation (evaporites or oolites) and is distinguishable by the naked eye or low magnification. When looking at a sample, it can be described in terms of grain size, color, composition, morphology (angularity and shape) and surface texture. Sometimes, you will find man-made artifacts mixed with natural sand grains. This presentation will provide an insight into why sand is studied and collected as a learning tool, forensic tool, industrial tool, academic tool, artistic tool, and most importantly, just for fun!

Exploring the Ultrastructure of Human Hair: Preliminary Results from Transmission Electron Microscopy and Fluorescence Microscopy

Sandra Koch, Nina Jablonski and Mark D. Shriver — Pennsylvania State University, Department of Anthropology

Human scalp hair varies considerably in form and color within and among human populations. Known patterns of variation in hair form are used in forensic contexts to help resolve questions of ancestry and identity. With the technological advances available in microscopy, it is important that the morphological diversity in scalp-hair forms within and between populations be thoroughly described at the ultrastructural level to generate additional characteristics that can inform human hair examinations.

Electron microscopy and light microscopy were used in this research to investigate morphological features that contribute to varied human scalp-hair forms. Using light microscopy, significant differ-

ences in cross-sectional index and cuticle thickness were measured in hairs from diverse human populations. Hair samples associated with known genetic ancestry from persons of European, East Asian, and African ancestry were analyzed. Transmission electron microscopy (TEM) revealed variation in the ultrastructure of scalp hair, specifically in the distribution of melanosomes and in the thickness of the cuticle. Fluorescence microscopy revealed that salient differences in patterns of ortho-cortical and para-cortical cells could also be distinguished. Future work on melanosome characteristics and distribution, cuticle thickness, and patterns of ortho- and para-cortical cells will explore correlations between patterns of morphological and genetic variation.

The Role of Fluorescence in the Examination and Analysis of Dust Traces

Skip J. Palenik — Microtrace, LLC

The analysis of dust has practical applications to both forensic and environmental problems. Because almost anything can become dust under the proper conditions, its complete analysis can range from straightforward to downright challenging. In addition, the task is frequently complicated by the substrate on which the material for analysis is received. While solutions to many of these analytical and technical problems have been developed during the course of analyzing thousands of samples, this experience has demonstrated the importance of always being on the lookout for new methods or techniques that can provide either new information or provide the same information easier.

Although the presenter purchased his first fluorescence microscope in the 1980s, it has only been in the last decade or so that he has come to really begin to appreciate the extent to which it has become an important part of his analytical approach to the study of dust traces. This has come about in part by finding, in the literature or by experiment, chemicals or other substances that emit characteristic fluorescence either through autofluorescence or after reaction with certain reagents. This increased interest in applying fluorescence excitation to the task of dust analysis has also been stimulated

by the commercial availability of new products that not only aid in analysis but also in the sample preparation, sorting, and particle isolation phases. Examples of these techniques and equipment will be presented to illustrate their application to real-life cases.

Co van Ledden Hulsebosch: Notable Cases from the Dutch Pioneer in Forensic Trace Evidence Analysis

Tom Schotman — Netherlands Forensic Institute

Since the early 1900s, there have been several pioneers in forensic trace evidence. Co van Ledden Hulsebosch, who followed the path of his father, became the most important pioneer in the history of Dutch trace evidence analysis. Ledden Hulsebosch was in frequent contact with his European colleagues and was part of forming the International Academy of Criminalistics. He analyzed traces on the scene and in the laboratory and tried to gain as much information as possible using microscopy, light sources, and microchemical tools. Whether he was analyzing someone's last meal or glass and fiber traces, he could derive a wealth of information from the traces given to him. Besides his forensic work, he was also involved in the analysis of industrial cases and consumer questions. Some of his work is self-narrated in a Dutch book from which I will discuss my choices, together with a short history of him and his father.

Soil Microscopy for Evaluating Differential Sampling of Footwear to Separate Alternative Particle Signals

Andrew Bowen — U.S. Postal Inspection Service

Criminals routinely track soil and dust to and from crime scenes on their footwear. Despite the ubiquitous nature of this type of evidence, it is rarely used in criminal investigations. One of the reasons for this may be the fact that shoes typically contain mixtures of particles that were acquired before, during, and after the crime. This research was designed to separate the evidentiary particle "signal" from those particles acquired before or after an event. Several successively more aggressive sampling methods were tested in an attempt to separate loosely, moderately, and tightly held par-

ticles from footwear surfaces. These methods were used to recover dust from two different types of shoes, namely athletic shoes with flexible soles and work boots with hard soles. Pairs of each type of footwear were sequentially exposed to three different environments by walking in each environment. Adhering particles were recovered and the fine sand-size fraction was separated for examination. Particle types and abundances were determined by point counting with a polarized light microscope. These data were used to determine whether the separately recovered particle populations (loosely, moderately, and tightly held) correspond primarily to the first, second, or third environment to which the shoes were exposed.

Characterization of Aluminum Powders in Explosives Using Particle Micromorphometry

JenaMarie Baldaino[1], Danica M. Ommen[1,2], Christopher P. Saunders[2], Joshua Dettman[1], Raleigh Parrott II[3], Jack Hietpas[1], and JoAnn Buscaglia[4] — [1]FBI Laboratory, Counterterrorism and Forensic Science Research Unit, Visiting Scientist Program; [2]South Dakota State University, Department of Mathematics and Statistics; [3]FBI Laboratory, Explosives Unit; [4]FBI Laboratory, Counterterrorism and Forensic Science Research Unit

Aluminum (Al) powders are commonly added to improvised explosive devices (IEDs) to increase heat of detonation. This presentation will demonstrate the forensic potential of automated particle micromorphometry to aid in making comparisons between questioned and known Al powders and provide insight into the method of Al powder manufacturing. Al powder samples were obtained from legitimate industrial manufacturers, seized IEDs, and "in-house" production from Al flake-containing commercial spray paint and ground Al foil. Transmitted light microscope images ($n \approx 2{,}800$ images/sample) of the Al samples were acquired using an automated stage and z-focus. The large multidimensional data sets ($n \approx 200{,}000–900{,}000$ particles/sample) were analyzed using an open-source statistical package; the results from the multivariate statistical methods will be presented. Al particle morphologies were also investigated at high magnification with scanning electron

microscopy and energy dispersive X-ray spectroscopy (SEM-EDS) to observe differences in surface characteristics and elemental compositions.

The Use of a Fiber Optic Microspectrophotometer to Measure Color in Blue Glass Chips and Dyed Fibers

Thomas A. Kubic — John Jay College of Criminal Justice and The Graduate Center, CUNY
Alex Comanescu and Tiffany Millet — The Graduate Center, CUNY

Microspectrophotometry has long been employed as a technique for adding evidential value to the microscopical forensic examination of micro-transfer evidence. While a number of commercial units are and have been available over the years to make transmission, reflectance, and fluorescence measurements, these units are costly and varied in terms of capability and performance. This presentation reports on the use of an Ocean Optics USB-2000+ fiber optic array detector spectrometer, which physically measures less than 4 × 3 × 1 inches and is connected to an existing laboratory microscope and laptop computer. This spectrometer performed more than adequately for the determination of visible spectra on glass chips and dyed fibers.

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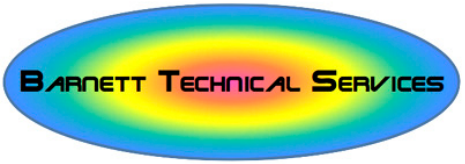

Jan Burmeister — **Taka Instructional Agency**

Fay Goldblatt — **Millette Technical Consulting, LLC**

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