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Inter/Micro 2011

Gary J. Laughlin
McCrone Research Institute*

McCrone Research Institute held the 63nd annual Inter/Micro microscopy conference on July 11-15 in its lecture rooms and laboratories on Chicago's South Side, drawing more than 60 attendees and speakers from around the world.

Participants heard in-depth research presentations by leading microscopists, who covered advancements in instrumentation, techniques and applications in various fields of microscopy and microanalysis. Presentations focused on PLM, SEM, EDS, Raman, hot stage, X-ray diffraction and infrared microspectroscopy; microchemistry; forensic trace evidence and criminalistics; pharmaceutical sciences; materials analysis; art authentication; environmental health; food and air quality.

Niloufar Nouri Mahdavi of the University of Illinois-Chicago College of Dentistry discusses an SEM analysis of damage to tooth enamel after the removal of metal brackets.

During the first three days of the conference, speakers gave research presentations on such diverse topics entitled, "A Review of Some Contrast-Based Light Microscopy Techniques," "Gluten Free or Free Gluten?" "Dates of First Use of Artists' Pigments," "Microscopical Analysis of Some Unusual Volcanic Soils," "Microanalysis of Limestone Blocks from the Pyramids of Egypt," "A Comparison of Sampling Techniques for the Determination of Accelerants in Arson Investigations," and "The Microscopy of Bullet Impacts." In his annual Evening with Brian talk, "Microbe Meals," Prof. Brian J. Ford revealed new insights into how microbes and cell cultures can help feed the world's expanding human population.

Inter/Micro attendees enjoyed a Brazilian churrascaria-style buffet dinner in the McRI garden and also participated in a silent auction held by the State Microscopical Society of Illinois (SMSI). A wine and cheese reception featured products from conference exhibitors, including Foster + Freeman, Leica, Santec, Cargille and Microscope Publications.

This year's SMSI Awards Dinner was held at The Berghoff restaurant in Chicago's downtown Loop district. The SMSI 2011 Émile Chamot Award went to the late Lucy B. McCrone (1923-2011), co-founder of McRI. Skip Palenik, founder of Microtrace, LLC, accepted the award on her behalf. Mrs. McCrone, who died on February 10, was also remembered by friends and colleagues during a memorial service and celebration of her life at McRI on July 10, prior to the start of Inter/Micro 2011. Brian Bracegirdle, editor of the *Quekett Journal of Microscopy*

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Brian Bracegirdle received the SMSI 2011 August Köhler Award. Dr. James B. McCormick (right) accepts the award on Bracegirdle's behalf from SMSI President Sebastian Sparenga.

and author of numerous publications on microscopical topics such as "A History of Microtechnique," "Microscopical Mounts and Mounters" and "A History of Photography with the Light Microscope," received the SMSI 2011 August Köhler Award. Dr. James B. McCormick, a pathologist and founder of the Histoslide and McCormick Scientific companies, accepted the award on Bracegirdle's behalf.

The winners of the Inter/Micro 2011 Photomicrography Competition were also announced at the dinner: Thomas Hopen, Best Overall Photomicrograph; Laren Cyr, Best SEM Photomicrograph; and Kelly Brinsko, Most Unique Photomicrograph (see winning images on page 114.)

A two-day workshop on food identification in McRI's classrooms highlighted the second half of Inter/Micro 2011. Skip Palenik, a leading forensic microscopist, taught the hands-on course and introduced participants to the microstructure of food and the microscopy techniques used for studying it. Participants examined the structure of vegetables, cereal grains and starches, meat and fish, and prepared food products.

Inter/Micro, the premier International/Microscopy conference, was initiated by McCrone Research Institute founder Walter C. McCrone and Charles Tufts, and was first held in Chicago in 1948. Each year, the conference attracts professional and amateur microscopists from all areas of light and electron microscopy.

McCrone Research Institute would like to thank all speakers, exhibitors, sponsors and participants for making Inter/Micro 2011 an overwhelming success.

Program

MONDAY, JULY 11: TECHNIQUES AND INSTRUMENTATION

Morning Session – Thomas Hopen, Chair

Fiber Samples from a Human Source – Sebastian Sparenga, McCrone Research Institute

A Review of Some Contrast-Based Light Microscopy Techniques – Tony Havics, pH2, LLC

Chemometric Discrimination of Visible Absorption Spectra Obtained from Dyed Textile Fibers – Katie White, Microtrace, LLC

Enamel Surface of Teeth after Debonding Metal Brackets Using Various Debonding Burs – Niloufar Nouri Mahdavi D.D.S., UIC College of Dentistry

Gluten Free or Free Gluten? – Jennifer Herb, Microtrace, LLC

A Unique Column for Density Gradient Separations – Thomas Hopen, ATF Forensic Science Laboratory; Natasha Neel, ATF Forensic Science Laboratory

Afternoon Session – Jason Beckert, Chair

Dates of First Use of Artists' Pigments – Nicole Pizzini, McCrone Research Institute

A Look into Mislabeled Pigments: Their Confusion and Candid Identification – Ethan Groves, Microtrace, LLC

A Procedure for Recovering Fine Particles from Carpet Fibers – Andrew Bowen, Stoney Forensic, Inc.

An Evaluation of Methodologies for Assessing Particulate Emissions from Wildfires – Lawrence Wayne, Forensic Analytical Laboratories, Inc.

Inter/Micro 2011 attendees enjoy lunch and each other's company under the tent in the McRI garden.

Using Microscopy to Answer Complaints and Questions – Jim Millette, MVA Scientific Consultants

There's More than One Way to Scan a Fiber – Jason Beckert, Microtrace, LLC

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Evening with Brian: "Microbe Meals" – Brian J. Ford, Gonville & Caius College, Cambridge University

TUESDAY, JULY 12: ENVIRONMENTAL AND INDUSTRIAL MICROSCOPY

Morning Session – Andrew Bowen, Chair

Early Age of Autogenous Healing in Strain-Hardening Cementitious Composites – Aaron Richard Sakulich, National Institute of Standards and Technology; Victor C. Li, University of Michigan

Microscopical Survey of Paperboard – Walter J. Rantanan, Integrated Paper Services

Microscopy in Roof Damage and Failure Analysis – Tony Havics, pH2 LLC

Microanalysis of Limestone Blocks from the Pyramids of Egypt – Aaron Richard Sakulich, National Institute of Standards and Technology; Michael W. Barsoum, Drexel University

A Microscopical Journey to the Center of the Earth – Bill C. Mikuska, MicroChem Consulting, LLC

Microscopical Analysis of Some Unusual Volcanic Soils – Andrew Bowen, Stoney Forensic, Inc.

Afternoon Session – Eric Chatfield, Chair

An Encounter with 4 Vesta and the Celestial Police – Bill C. Mikuska, MicroChem Consulting, LLC

Polarized Light Microscopy (PLM) Differentiation of Erionite from Other Fibrous Zeolites: Part Two – Lou Solebello, International Asbestos Testing Laboratories, Inc.

Standard Method for Polarized Light Microscopy (PLM) Analysis of Cosmetic and Pharmaceutical Talk for Asbestos Content: ASTM D22.07 WK30024 Task Group Purpose and Progress – Lou Solebello, International Asbestos Testing Laboratories, Inc.

Blood Through the Ages – Brian J. Ford, Gonville & Caius College, Cambridge University

Fibrous Talc and Amphibole Identification Issues Revisited – Randy Boltin, MVA Scientific Consultants

Reduction of Amphibole Fiber Lengths During Residence in Human Lungs – Eric Chatfield, Chatfield Technical Consulting Limited

Tony Havics shares his fond memories of McRI co-founder Lucy B. McCrone (1923-2011) during a memorial service and celebration of her life on July 10, prior to the start of Inter/Micro 2011.

Skip Palenik (seated) leads the two-day Inter/Micro workshop on Food Identification in which students were introduced to the microstructure of food and the basic techniques for studying it.

WEDNESDAY, JULY 13: CHEMICAL AND FORENSIC MICROSCOPY

Morning Session – Wayne Moorehead, Chair

Glowing Glass – Meggan King, McCrone Research Institute

The Microscopy of Bullet Impacts – Peter Diaczuk, John Jay College of Criminal Justice

Plumbum Microraptus Via Ballistic Penetration – Chris Palenik, Microtrace, LLC

Illegal Coinage – Brian J. Ford, Gonville & Caius College, Cambridge University

Recognizing Textured Fibers – Kelly Brinsko, McCrone Research Institute

Vectran Fibers – Thomas Hopen, ATF Forensic Science Laboratory; Natasha Neel, ATF Forensic Science Laboratory

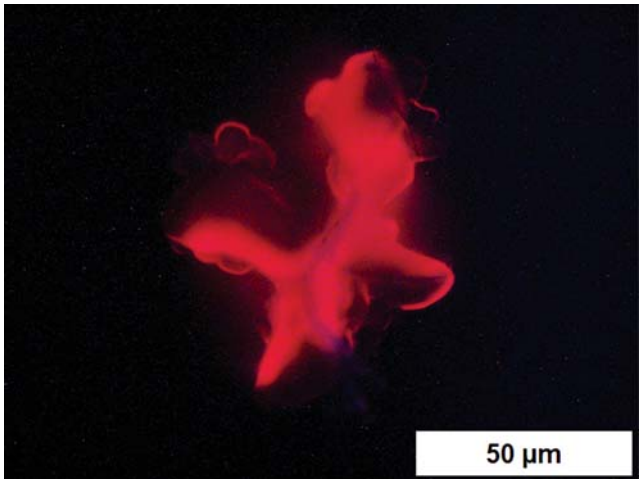

Photo courtesy of Jennifer Herb, Microtrace, LLC

Jennifer Herb of Microtrace explained how to determine if "gluten free" foods on store shelves are living up to their labels. This image shows material from a pretzel known to contain gluten, viewed with fluorescence microscopy and stained with Fast Green FCF.

An Update on Refractive Index Liquid $n_D = 1.580$ – Wayne Moorehead, forensicTRACE

Afternoon Session – John A. Reffner, Chair

Use of the "Poor Man's Hot Stage" to Solve a Unique Indoor Dust Problem – Rich Brown, MVA Scientific Consultants

Forensic Dissection of "Misrepresented" Testimony – Wayne C. Isphording, Tulane University

Creation and Accomplishments of a Forensic Internship Program – Wayne Moorehead, forensicTRACE

Can You Hear Me Now? An Investigation into Mobile Telephone Screen Glass – Brendan Nytes, Microtrace, LLC

A Comparison of Sampling Techniques for the Determination of Accelerants in Arson Investigations – Mark E. Palenik, Microtrace, LLC

Forensic Applications of Infrared Microprobe Analysis Using Diamond Internal Reflection Technology – John A. Reffner, John Jay College of Criminal Justice

Closing Remarks – Gary J. Laughlin, McCrone Research Institute

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State Microscopical Society of Illinois 2011 Awards Dinner

Èmile Chamot Award Recipient: **Lucy B. McCrone**

August Köhler Award Recipient: **Brian Bracegirdle**

THURSDAY AND FRIDAY, JULY 14 AND 15: WORKSHOP

Food Identification Workshop

Taught by Skip Palenik, Microtrace, LLC

In this two-day workshop, students will be introduced to the microstructure of food and the basic techniques for studying it. Lectures, demonstrations, and laboratory exercises will introduce the participants to the structure of vegetables, cereal grains and starches, meat and fish, as well as prepared food products. This workshop is inspired by McCrone Research Institute's popular "Microscopy of Food and Foreign Body Identification" course.

Abstracts

MONDAY, JULY 11: TECHNIQUES AND INSTRUMENTATION

Fiber Samples from a Human Source

Sebastian Sparenga, McCrone Research Institute

A small plastic bag labeled "Fiber Samples – from Human Source" was received for analysis. The submitted sample came from a person suspected of having Morgellons disease. This presentation will discuss the analysis of these human fibers, as well as a brief dialogue about this condition.

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A Review of Some Contrast-Based Light Microscopy Techniques

Tony Havics, pH2, LLC

The technique of accentuating contrast in transmission-based light microscopy has been available for many years. The first use of oblique lighting was probably applied shortly after the first microscope was assembled. Darkfield, another contrast technique, is reported as early as 1832. More complex techniques came later and perhaps some are not recognized as contrast techniques. These include Rheinberg illumination, Zernikes Phase Contrast Microscopy (PCM), Nomarskis Differential Interference Contrast (DIC), Cherkasovs annular stop-based dispersion staining, and Hoffman Modulation Contrast (HMC) arriving in 1896, 1934, 1954, 1957 and 1975, respectively. Some lesser known contrast microscopy types are Schlieren, variable Darkground, variable amplitude PCM, Khler DIC, PlasDIC, Mertons Interferometric Microscopy (aka Curtis Intereference Reflection Microscopy (IRM)) and modified oblique or Foucault techniques, e.g., Nodas

annular oblique phase microscopy, Smarts point diffraction, Yis Graded-Field microscopy, etc. A description of the optics as well as example images for these techniques will be presented as a review.

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Chemometric Discrimination of Visible Absorption Spectra Obtained from Dyed Textile Fibers

Katie White, Microtrace, LLC

This presentation will examine the application of chemometric and statistical methods to current analytical techniques in fiber analysis. Hypothesis testing is used to evaluate the similarity of known and questioned fiber populations based on an assessment of p-value distributions from questioned-known fiber comparisons with those of known fiber self-comparisons. Sets of p-values are generated by comparison of visible absorption spectra using a nonparametric permutation method. Statistical calculations were performed using commercial software packages and software written in-house. Electrospray ionization mass spectra of the dyes extracted from the same fibers provide an additional comparison between fibers.

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Enamel Surface of Teeth after Debonding Metal Brackets Using Various Debonding Burs

Niloufar Nouri Mahdavi D.D.S., UIC College of Dentistry

Orthodontic treatment involves bonding of brackets to the surface of teeth by using different kinds of bonding resins. After completion of treatment and removal of brackets, the residual resin must be removed in such a way as to restore the tooth surface close to its original condition. Most clean-up procedures involve using different types of debonding burs that can cause damage to enamel surface. The decision to choose one of several available burs is clinician-dependent, and currently there is no universal protocol for this step of treatment. The purpose of this study is to compare enamel surface of teeth that have been debonded using one of four commercially available burs: 1) 12 fluted universal, 2) 20 fluted carbide, 3) 30 fluted carbide, and 4) white stone.

Eighty extracted human premolar teeth were used for the study. Sixty teeth were used for profilometric analysis (15 in each bur group) and 20 for scanning electron microscopy (SEM). Initial profilometric analysis of profilometery group teeth was performed. Initial SEM images of the 20 SEM group teeth were also taken. Teeth were bonded with brackets according to standard bonding protocol and stored in water. One week after bonding, brackets were removed from the teeth. The corresponding bur in each group was used to remove the brackets. Final profilometric analysis and SEM pictures were taken. Final results are pending.

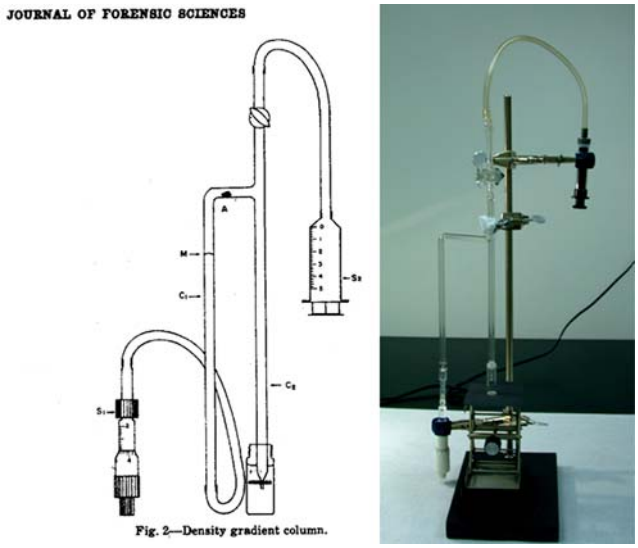

Photo courtesy of Thomas Hopen, ATF Forensic Science Laboratory

Thom Hopen of ATF Forensic Science Laboratory showed how a density gradient column is used to isolate and separate light and heavy minerals from soil or sand samples.

Gluten Free or Free Gluten?

Jennifer Herb, Microtrace, LLC

Gluten-free diets are unquestionably on the rise and manufacturers have been quick to seize upon the opportunity. In the past few years, we've seen a raft of new products hitting restaurants and supermarket shelves voluntarily labeled "Gluten Free." In this presentation, I will briefly look at grains labeled as "prohibited" by the FDA and alternate sources of flour. Finally, I will use Fast Green FCF stain to determine if the "Gluten Free" foods we are purchasing live up to their labels.

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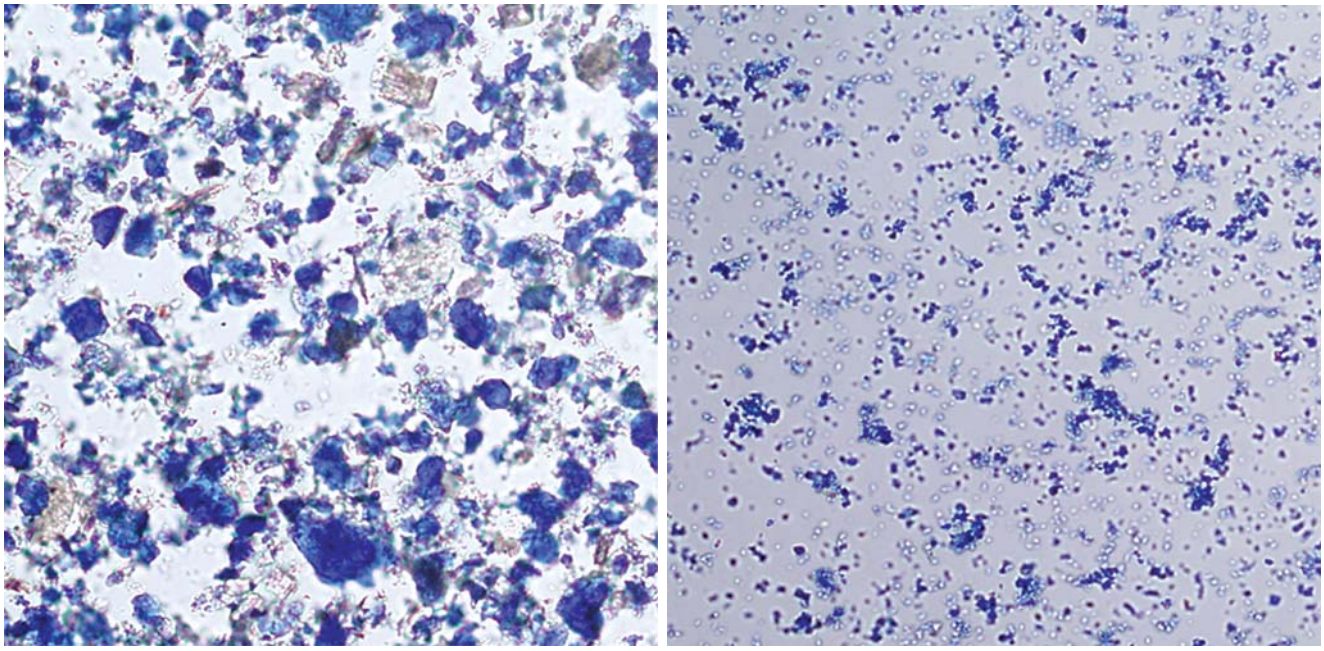
A Unique Column for Density Gradient Separations

Thomas Hopen, ATF Forensic Science Laboratory; Natasha Neel, ATF Forensic Science Laboratory

In the past few years, I have attended a number of meetings in which talks were given on various topics that had been presented in conferences some 20 years ago. I find it interesting how each generation tries to reinvent the wheel. In keeping with this trend, I would like to give a presentation on a unique liquid density column that Dr. Walter McCrone presented at the 24th annual meeting of the American Academy of Forensic Sciences in March 1969. His talk was later published in the *Journal of Forensic Sciences* in July 1969. The co-author of the presentation and the published paper was Warner Hudson, who was with Walter C.



Photos courtesy of Nicole Pizzini, McCrone Research Institute

Nicole Pizzini of McCrone Research Institute discussed how microscopy can identify different artists' pigments, such as natural ultramarine (left) and synthetic ultramarine, to help analysts date paintings and determine periods of use.

McCrone Associates, Inc. at that time.

After seeing a unique density gradient column for the first time while attending a class at the McCrone Research Institute in the early 1980s, I had one made by a glass blower at Auburn University's Chemistry Department. Even though a trained microscopist can identify numerous particles, usually in mixtures, it is sometimes helpful to conduct a fractionation of the original sample to isolate and identify an unknown component or a minor component being masked by the other constituents. I have used my column mainly for separation of mineral grains from soil/sand samples, but the density column can be used in the separation of mixed glass particles, pollution particles, or separating out a contaminant in a powder sample. What is unique about this column, besides providing a reproducible density gradient, is that one can collect each isolated fraction in a micro vial or on a microscope slide so the captured fraction can be identified by PLM or another analytical technique. Either organic or aqueous liquids can be used in the column for density separations. In this presentation, the design of the column will be discussed and a demonstration will be given on its ease of use, which will show why this technique should not be forgotten.

This presentation is a tribute to Dr. McCrone, founder and past director of McCrone Research Institute and Walter C. McCrone Associates.

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Dates of First Use of Artists' Pigments

Nicole Pizzini, McCrone Research Institute

Through trade and technological development, the pigments available to artists have changed throughout history. New pigments come into manufacture and methods of creating traditional pigments improve. Most pigments have a recorded history and their periods of use can be found in literature. Miscroscopy can identify which pigments are in use on a painting, and if the pigments first-use date is known, microscopists can help to date the painting itself. Dr. Walter McCrone had a working list of pigments first-use dates (found in his book, *Judgement Day for the Turin Shroud*) that he used as a quick reference when he microscopically analyzed paintings. Recent efforts have been made to verify and update this list with modern literature. This updated, comprehensive timeline will be discussed together with examples of historically significant changes in the pigments available to artists.

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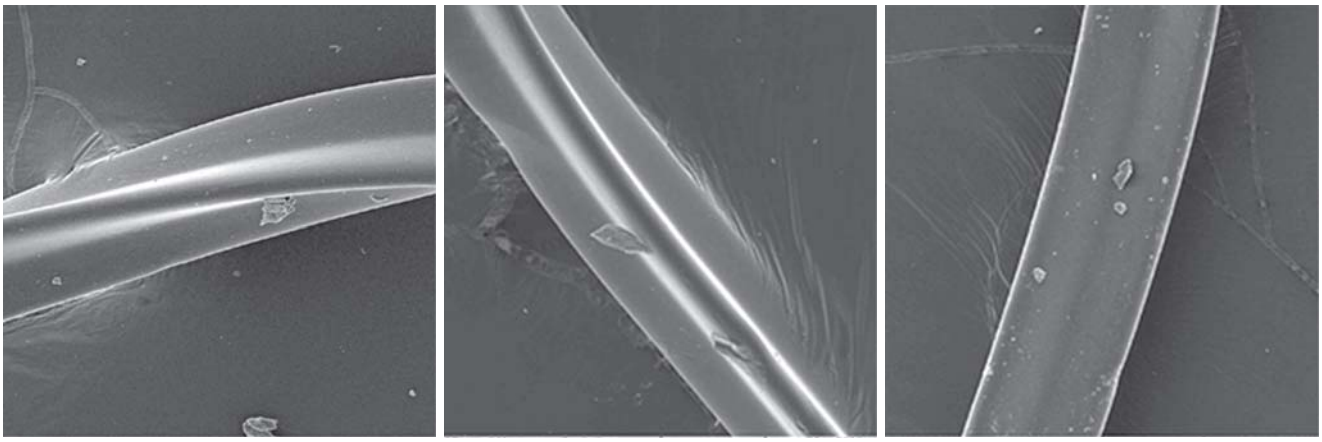
A Look into Mislabeled Pigments: Their Confusion and Candid Identification

Ethan Groves, Microtrace, LLC

Hundreds of commercially available pigments are in use today. As the history of pigments has evolved



Photos courtesy of Andrew Bowen, Stoney Forensic, Inc.

Andy Bowen of Stoney Forensic showed a procedure for removing fine particles from carpet fibers and preparing them for analysis by computer-controlled scanning electron microscopy. These SEM images show fine particles adhering to carpet fibers.

from natural to synthetic, many pigments have been given multiple names, some of which are not specific and can be confused for the names of other pigments. With an increasing number of pigments being produced, the Society of Dyers and Colourists and the American Association of Textile Chemists and Colorists developed and maintain the Colour Index. Through the Colour Index, manufacturers can register their pigments and each pigment is given an identifying number (i.e., a constitution number). Even with this institutionally organized system, there are inconsistencies and ambiguities. Some pigments are given multiple Colour Index designations, or in other cases, multiple pigments are assigned the same identifier (e.g., Pigment Brown 6: C.I. 77491; 77492; 77499).

Even with an identifying number, ambiguity and mislabeling is surprisingly common, as was determined during a recent project in which we were compiling a Raman spectral database of reference pigments. In the course of characterizing the Microtrace pigment reference collection, which contains over 1,000 organic and inorganic pigments and more than 250 unique pigments, several such cases were encountered. Most of the issues arose during the course of our interpretation of Raman spectra and subsequent characterization by SEM/EDS. At a most basic level, some pigments with the same label showed visibly different hues of color. In other cases, the SEM/EDS spectra contained different elemental compositions than would be expected from the published chemical structures. For certain Colour Index entries, a single chemical formula can be represented by different polymorphs. In many cases, a pigment manufacturer or distributor does not specify the polymorph of a particular product. In such cases, X-ray diffraction was used to confirm the difference and, when possible, assign a specific polymorph. In some cases, known reference patterns were not available and we could only surmise that a different polymorph was present based on differences in the powder diffraction patterns.

In the end, it must be understood that pigment production is a commodity business, ultimately driven by cost. While this is expedient for distributors and end users, such tenuous identifications are not suitable for forensic purposes. Rigorous, scientifically supportable identification of a pigment to a specific chemical structure, supported by multiple orthogonal analytical methods, is not only needed as a consistency check, but is often required for basic identification of a reference pigment. This presentation will demonstrate the necessity for collection of reference samples and verification of their content.

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A Procedure for Recovering Fine Particles from Carpet Fibers

Andrew Bowen, Stoney Forensic, Inc.

Fibers are a commonly encountered type of trace evidence in forensic investigations, and comparisons between questioned fibers found as evidence and control fibers taken from potential source materials are routinely conducted by trace evidence examiners. When the characteristics of a questioned fiber and known fiber source (such as a carpet at a crime scene) correspond in all aspects, the probative value of the evidence is limited because the characteristics compared are determined by the manufacture of the fibers and would be similar for any other fibers produced by the same manufacturing process. In other words, the

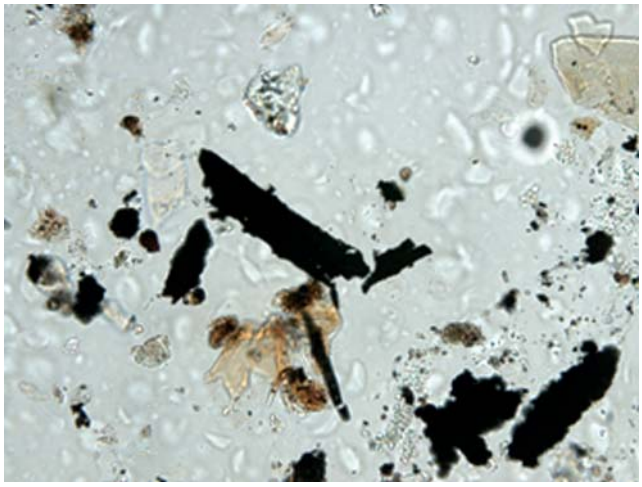

Photo courtesy of Lawrence Wayne, Forensic Analytical Laboratories, Inc.

Larry Wayne of Forensic Analytical Laboratories, Inc. offered guidelines and methodologies for accurate and consistent analysis of char (above), smoke, soot and ash from wildfires.

questioned fiber could have come from the carpet at the crime scene, or from any other carpet produced by the same manufacturing process and using the same fiber type. It would be of value for the forensic community to be able to further test the hypothesis that the questioned fiber originated from the specific carpet of interest (i.e., the one at the crime scene), as opposed to another, similar carpet from the same manufacturer. One possible means of testing this hypothesis is by analyzing the fine dust particles adhering to the surface of the carpet fiber. Carpet fibers are typically covered with fine particles from the environment in which the carpet resides. If a questioned fiber originated from a specific carpet, it is possible that the assemblage of particles present on the questioned fiber would correspond to the assemblage of particles present on fibers from the potential source carpet. If these particle assemblages are in fact determined to correspond, it would provide evidence, independent of the manufactured characteristics, that the questioned fiber came from the carpet at the crime scene.

This talk will describe a procedure that has been developed for removing fine particles from carpet fibers and preparing them for analysis by computer-controlled scanning electron microscopy (SEM) with energy dispersive spectroscopy (EDS). Ongoing research is testing the within-item variability and between-item variability of particle assemblages from a number of carpets in different environments. The full results of this research will be presented at a later date.

This project was supported by Award No. 2010-DN-BX-K244 awarded by the National Institute of Justice, Office of Justice Programs, U.S. Department of Justice. The opinions, findings and conclusions or recommendations expressed in this presentation are those of the author and do not necessarily reflect those of the Department of Justice.

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An Evaluation of Methodologies for Assessing Particulate Emissions from Wildfires

Lawrence Wayne, Forensic Analytical Laboratories, Inc.

In recent years, much attention has been paid to the characterization and quantitation of smoke, soot, char and ash resulting from wildfires. Currently, no official standard method is available for this type of analysis. Differing methods are being employed by differing laboratories, resulting in widely varied results and important questions about data interpretation. One important issue is the quantitation of components in samples that contain particles differing in size by several orders of magnitude. This paper addresses this issue, and will suggest guidelines and methodologies for an accurate, repeatable analysis.

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Using Microscopy to Answer Complaints and Questions

Jim Millette, MVA Scientific Consultants

For the last 20 years, the combination of polarized light microscopy (PLM), scanning electron microscopy coupled with X-ray analysis (SEM-EDS), transmission electron microscopy (TEM-SAED-EDS), infrared microspectroscopy (FTIR) and/or Raman have provided the tools for solving a number of clients' questions about materials including particles. A number of interesting complaint samples collected from surfaces where a concern existed that an industrial plant might be contributing particles have been analyzed to determine if they are consistent with the industry. In one project from an electric power company, a pair of samples collected from cars at a complaining resident's house showed very different results when analyzed by PLM and SEM. One sample contained small particles of a calcium-phosphorous containing material together with a few bone fragments. Why a dust consistent with bone ash would appear on a car was not determined. By PLM, the other sample appeared to be comprised of grains of deteriorated pollen. SEM and FTIR data were consistent with biological material. The morphology of the pollen was consistent with a birch. Neither sample contained any particles that were consistent with a power plant source.

Currently, the ASTM Method D6602 is being revised. Although this method has a title that relates to

fugitive emissions from carbon black plants and is under the ASTM subcommittee on carbon black, it is very useful for the analysis of many types of outdoor surface samples. Initially the method required only TEM analysis for characterizing aciniform carbon particles as consistent with carbon black. A PLM analysis was included as an option. Unfortunately, this allowed some analysts to claim that a sample was positive for carbon black when in fact the majority of the particles were not aciniform carbon; some were nearly 100% fungal material. The new revised version will contain a mandatory PLM analysis. TEM analysis will still be mandatory to positively confirm the presence of carbon black. Some examples of particles that might be found during the analysis of surface complaint samples include biofilm (fungal material, mold, algal), coal/coke, coal ash, rubber, soil minerals, plant fragments, rust, paint flakes, pollen and a variety of soots.

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There's More than One Way to Scan a Fiber

Jason Beckert, Microtrace, LLC

This presentation will demonstrate the ability to analyze a single fiber using numerous analytical methods. Beginning with stereomicroscopy, this talk will follow the examination of a group of fibers using a variety of microscopical, instrumental and chromatographic techniques. Focus will be placed on the utility of employing multiple, orthogonal approaches in order to develop a thorough understanding of the fibers being studied.

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Evening with Brian: "Microbe Meals"

Brian J. Ford, Gonville & Caius College, Cambridge University

The concept of food is of something solid and appetizing; yet the fruit, vegetables and meat we consume is composed of communities of cells. Once we consider food in this way remarkable new insights can emerge—is it possible to manufacture food? Could we create synthetic vegetables? Can meat be mass-produced in factories? In this presentation, Brian J. Ford takes us through the microscope to show that microbes and cell cultures could help feed the world's rapidly increasing human population.

TUESDAY, JULY 12: ENVIRONMENTAL AND INDUSTRIAL MICROSCOPY

Early Age of Autogenous Healing in Strain-Hardening Cementitious Composites

Aaron Richard Sakulich, National Institute of Standards and Technology; Victor C. Li, University of Michigan

Autogenous self healing in cementitious systems occurs when cracks expose unhydrated cement grains and $Ca(OH)_2$ to the environment, producing healing products that fill the crack. Resonant frequency analysis and compression/tensile tests have shown that healing leads to the recovery of substantial mechanical properties after a cracking event. Robust autogenous healing occurs only when the crack width can be limited to roughly 150 micrometers and possibly lower under field conditions. The micromechanical design of Engineered Cementitious Composites (ECC), a class of fiber-reinforced cement-based composites, allows for such crack width control.

Electron microscopy, complimented by X-ray diffraction and infrared, energy-dispersive and Raman spectroscopies, have been used to show that the healing products are an intimate mixture of low-Ca C-S-H and calcite, and that the surfaces of the fibers exposed by cracking act as nucleation sites for the healing product. Nanoindentation was used to determine that the modulus of the healing product is roughly equivalent to that of hydrated cementitious matrix. Finally, 3D X-ray microtomography (MicroCT) was used to investigate ECC and shows promise as a method by which to investigate autogenous self healing.

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Microscopical Survey of Paperboard

Walter J. Rantanen, Integrated Paper Services

An overall examination of the variation in paperboard in structure, composition and utilization will be presented. Macroscopical and microscopical methods can determine the nature and construction of the

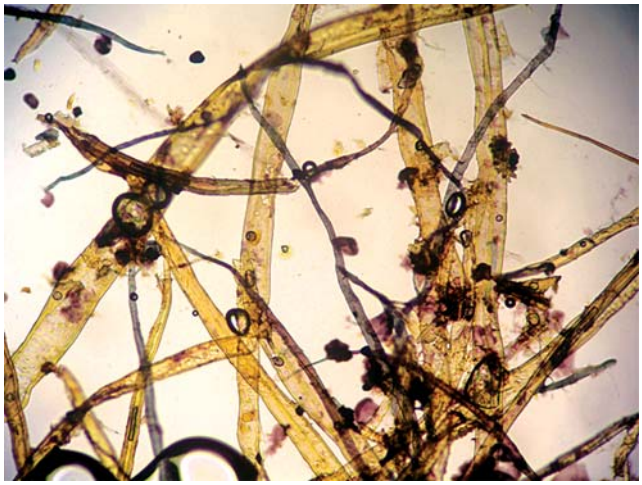

Photo courtesy of Walter Rantanen, Integrated Paper Services

Walter Rantanen of Integrated Paper Services explained the methods for determining the construction of various types of commercial paperboard, including brown liner fiber shown at 100x.

Photo courtesy of Tony Havics, pH2, LLC

Tony Havics of pH2, LLC gave various examples of why roofs sustain damage, including weather damage as shown by this impact test of a 2-inch iceball striking a piece of roof material.

various types of board in commercial production and, in many cases, their source. Some additional features and events related to the board composition will also be presented.

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Microscopy in Roof Damage and Failure Analysis
Tony Havics, pH2, LLC

Roofs fail and are damaged by a number of mechanisms: poor design, faulty or sub-par installation, weather damage, corrosion, human use, etc. Light and electron microscopy are useful, together with physical and mechanical testing, in analyzing these types of damage and/or failure. A set of four diverse cases of actual or purported damage/failure from human use, weather damage and corrosion will be presented where the microscopy was critical to evaluating the material effects. These cases highlight the insight provided by more than one instrument. They also emphasize the need to consider a variety of preparation techniques from freeze fracture to cross-sectioning during the assessment process.

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Microanalysis of Limestone Blocks from the Pyramids of Egypt
Aaron Richard Sakulich, National Institute of Standards and Technology; Michael W. Barsoum, Drexel University

The Great Pyramid in Giza is not only the last surviving wonder of the ancient world, but was the tallest man-made structure for nearly 4,000 years. Conventional wisdom holds that quarry workers cut and dressed the 2.3 million limestone blocks of the Great Pyramid, hauled them to the construction site and somehow hoisted them into place. However, the details of this carve-and-hoist theory are not entirely clear.

In 1988, Joseph Davidovits, a French chemist, proposed an alternative theory: that local clays had been mixed with water and alkali salts to create geopolymers, which were then poured into molds in much the same way as modern concrete. Microanalysis of both inner and outer casing samples from a variety of pyramids, using electron microscopy, energy dispersive and infrared spectroscopies, X-ray diffraction, and thermal analysis, failed to locate the alkali aluminosilicate geopolymers proposed by Davidovits. More recent results, including those from radiocarbon dating, indicate that although geopolymers were not used, there may, in fact, be a synthetic origin for some of the blocks.

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A Microscopical Journey to the Center of the Earth
Bill C. Mikuska, MicroChem Consulting, LLC

There are five locations in our solar system where basalt exists as evidenced directly or indirectly: the earth, our moon, the planets Mars and Venus, and the asteroid 4 Vesta. Polarized visible light examination studies of earth's basaltic suite rocks and minerals will be presented with respect to current structural models and ongoing experimentation.

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Microscopical Analysis of Some Unusual Volcanic Soils
Andrew Bowen, Stoney Forensic, Inc.

The speaker recently had the pleasure of analyzing a number of soil samples that contained a variety of unusual and interesting alkaline volcanic rocks and minerals. This talk will describe several of these soils with a focus on how polarized light microscopy provided useful insights into their likely source rocks. Information regarding the structural state and composition of certain minerals can be inferred by determination of appropriate optical properties. In addition, mineral morphology and the textural relationships between minerals in small rock fragments can only be determined by microscopical methods and are important for interpreting source rock characteristics. Typical tectonic settings in which alkaline volcanic rocks form will be briefly addressed.

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An Encounter with 4 Vesta and the Celestial Police
Bill C. Mikuska, MicroChem Consulting, LLC

On 27 September 2007, NASA launched the DAWN Spacecraft on a journey to the asteroids 4 Vesta and 1 Ceres (small planet?). The orbiting encounter with 4

Vesta begins late July 2011 and continues through March 2012. Polarized light microscopical evidence from thin sections of the HEDO meteorites for 4 Vestas structure will be presented together with a brief description of the DAWN Spacecraft and Mission.

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Polarized Light Microscopy (PLM) Differentiation of Erionite from Other Fibrous Zeolites: Part Two

Lou Solebello, International Asbestos Testing Laboratories, Inc.

Erionite is a fibrous zeolite that is difficult to differentiate from other fibrous zeolites by polarized light microscopy (PLM). Erionite is a complex aluminosilicate that is not intentionally added to commercial products, but is found in many volcanic and sedimentary deposits. Potential exposure risks can arise during roadway excavation and mining of volcanic deposits for use as aggregate, or during beneficiation to concentrate industrial minerals for end use. Mesotheliomalike cancers associated with erionite exposure have been documented in the Cappadocian region of Turkey. Epidemiologic research performed on erionite as a result of the Cappaodocian occurence suggests that fibrous mineral carcinogenicity may be a function of habit not restricted to the six minerals currently classified as asbestos. Although classified as an IARC Group I carcinogen, erionite is currently not regulated by the U.S. Environmental Protection Agency (USEPA) in the same manner as asbestos. The USEPA has, however, stated that erionite causes lung cancer in lab rats, and is conducting studies with the North Dakota Department of Health. These and future studies may lead to inclusion of erionite into the asbestos mineral classification. This presentation is a continuation of research efforts focused on differentiation of erionite from other fibrous zeolites by PLM techniques. Specimens of offretite, perlialite, mazzite and mordenite were procured and analyzed by XRD for species validation. A 1.480HD high dispersion refractive index liquid was used to evaluate the potential for differentiating these fibrous zeolites from erionite using central stop dispersion staining. Results of the XRD analysis and PLM comparison will be discussed.

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Standard Method for Polarized Light Microscopy (PLM) Analysis of Cosmetic and Pharmaceutical Talk for Asbestos Content: ASTM D22.07 WK30024 Task Group Purpose and Progress

Lou Solebello, International Asbestos Testing Laboratories, Inc.

The function of ASTM air quality subcommittee D22.07 is to promote knowledge and develop standard test methods for the sampling and analysis of asbestos. There are currently no ASTM standard methods for the analysis of asbestos content in cosmetic and pharmaceutical talc or talc ores. An ASTM D22.07 task group was formed for development of X-ray diffraction (XRD), polarized light microscopy (PLM) and transmission electron microscopy (TEM) methods for the analysis of asbestos content in talc. The methods under development by the task group are ultimately intended to be useful for the cosmetics and pharmaceutical industries, talc suppliers and independent laboratories for evaluation of raw material and talc products. These methods will be valuable to regulatory agencies for providing guidance to ensure public safety of talc end users. Goals of the task group are to address harmonization, and to enhance and improve existing methods currently used by cosmetic and pharmaceutical trade associations (CTFA/PCPC, USP, etc). Methods currently in use by trade organizations do not provide adequate guidance for analysis of all types of asbestos, particularly the amphibole varieties. Task group efforts are currently focused on the unique challenges associated

Photo courtesy of Aaron R. Sakulich, National Institute of Standards and Technology

Aaron Sakulich of the National Institute of Standards and Technology described microanalysis and other methods involved in trying to determine the origin of the limestone blocks used in building the pyramids of ancient Egypt.

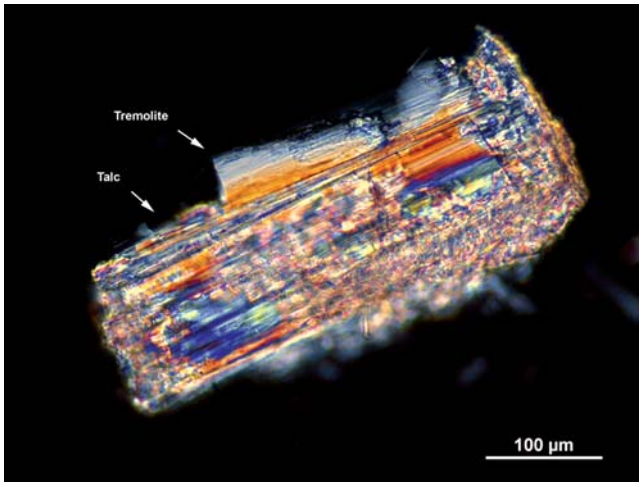

Photo courtesy of Randy Boltin, MVA Scientific Consultants

Randy Boltin of MVA Scientific Consultants discussed the identification of fibrous talc for commercial purposes. This PLM image shows the replacement of tremolite fragment by talc.

with analysis of finished pharmaceutical and cosmetic talc products. The task group goals, objectives and current WK30024 collaboration draft protocols for the PLM method will be presented. Information and method development perspectives provided in the presentation are intended for open discussion and do not reflect the view points of ASTM International.

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Blood Through the Ages

Brian J. Ford, Gonville & Caius College, Cambridge University

Ever since the recognition in the 1600s that blood was comprised of corpuscles, the microscope has been used to reveal the true nature of blood. We will look back at the earliest observations and compare them with some recent controversies. A highlight of this presentation will be a recreation of exactly what was seen by the earliest microscopists.

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Fibrous Talc and Amphibole Identification Issues Revisited

Randy Boltin, MVA Scientific Consultants

Talc occurs as a product of metamorphism of ultramafic igneous bodies or sedimentary dolomitic limestones, while commercial talc deposits contain impurities associated with the metamorphic assemblages derived therefrom. Talc fibers are typically attributed to pseudomorphic replacement of tremolite or anthophyllite and the degree of completeness of this transition has been an important issue in characterizing commercial talcs for regulatory purposes.

Commercial talc from the Gouverneur district of upstate New York has been the subject of much scrutiny because products ranging from acoustic insulation to crayons have incorporated this material in their formulations. Gouverneur talc contains considerable tremolite and fibrous talc. The tremolite is easily characterized as non-asbestiform by polarized light microscopy (PLM), even though microscopic fibers exhibiting aspect ratios of 10:1 and greater are observable. Asbestiform vs. acicular habit cannot be differentiated in the smallest fibers as observed by transmission electron microscopy (TEM), which are normally thin particles of moderate to high aspect ratio (>5:1) and are preferentially segregated during TEM sample preparation.

Limited replacement of tremolite by talc has been noted in the Gouverneur talc. Most fibrous talc occurs as the result of pseudomorphic retrograde replacement of asbestiform anthophyllite. Optical properties indicate that all but a trace of this asbestiform material has undergone sufficient transition to be identified as talc by PLM. TEM and X-ray diffraction analyses, however, indicate that a wide range of transitional phases are present, including pure talc and pure magnesio-anthophyllite.

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Reduction of Amphibole Fiber Lengths During Residence in Human Lungs

Eric Chatfield, Chatfield Technical Consulting Limited

It has generally been considered that amphibole fibers are durable in human lungs after inhalation. Although there is some initial clearance after an inhalation exposure to amphibole fibers, many of them remain in the lung tissue permanently. Analysis of human lung tissue from individuals with mesothelioma is frequently performed in support of personal injury litigation. Plaintiffs' attorneys may request such analyses in order to support claims of past exposure to particular manufactured products, and defense attorneys request analyses to contest claims against their particular clients. In addition to confirming the type of amphibole fibers present in the lung tissue, which can be pivotal in some cases, the measured amphibole fiber concentrations can be compared with internationally accepted criteria to determine the probability of mesothelioma causation due to occupational exposure.

During TEM analysis of human lung tissue samples obtained at autopsy from individuals exposed to crocidolite and amosite, evidence was found that some of the long fibers appeared to have been weakened at various points along their lengths, and that these fibers had fractured at some point to give rise to larger numbers of short fibers.

WEDNESDAY, JULY 13: CHEMICAL AND FORENSIC MICROSCOPY

Glowing Glass

Meggan King, McCrone Research Institute

Short wave UV light can be used to potentially detect surface coatings on container glass. Is there a way to detect these commonly used coatings using the microscope and microanalytical techniques? What does the preliminary investigation tell us?

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The Microscopy of Bullet Impacts

Peter Diaczuk, John Jay College of Criminal Justice

In the course of a shooting, bullets may pass through (perforate) or remain imbedded in (penetrate) a variety of materials. This presentation will examine several common materials discovered while investigating a shooting scene where a bullet or bullets have interacted with intermediate targets or terminal targets. These interactions may reveal valuable clues about the event, if examined microscopically.

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Plumbum Microraptus via Ballistic Penetration

Chris Palenik, Microtrace, LLC

The transfer of lead and related gunshot residues to objects penetrated during bullet travel is well documented at the macroscopic level. This phenomenon is termed "bullet wipe" and is used to describe the transfer that is visible on clothing or other surfaces following gunshot penetration. At the microscopic level, evidence of bullet transfer can be identified, even when no "bullet wipe" is visible to the unaided eye. This microscopical investigation stemmed from two, somewhat unusual, cases questioning whether bullets had penetrated certain objects. In one case, debate surrounded a bullet that had allegedly passed through an item of clothing without hitting the individual wearing it. The second case focused on fragments of a suspected potato that allegedly had been used as a "poor man's" silencer. This talk focuses on the practical microscopical solutions to these problems and the scientific demonstration that the transfer of a) energy, and b) particles, leaves distinct evidence of bullet contact at a microscopic level.

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Illegal Coinage

Brian J. Ford, Gonville & Caius College, Cambridge University

Although paper money has been most frequently considered in the study of counterfeit money, coins are also being forged in growing numbers. In some countries, the value of the metallic components used to make coins have made them worth more money than their face value. This presentation centers on the microscopy of faked coins and accounts for the increased occurrence of forged money in our daily lives. Will cashless purchases end the problem?

Photo courtesy of Meggan King, McCrone Research Institute

Meggan King of McCrone Research Institute showed how short wavelength ultraviolet light can detect surface coatings on container glass used to increase glass strength and facillate faster production.

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Recognizing Textured Fibers

Kelly Brinsko, McCrone Research Institute

During the manufacturing process and shortly after a polymer is extruded as a fiber, a number of texturing processes may be performed in order to achieve certain desired effects. Texturing a fiber imparts bulk or stretch to the final product by crimping, twisting, or otherwise modifying the yarn. The ability to recognize whether a fiber has been textured may be important, especially in forensic analyses and fiber comparisons. This presentation will discuss the various texturing methods used today, including false-twist, air jet, knit-de-knit and stuffer box. Known standards of textured fibers will be examined longitudinally using the stereomicroscope and polarized light microscope. Fiber cross-sections will also be observed, because they can often be indicative of the texturing procedure that was used.

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Vectran Fibers

Thomas Hopen, ATF Forensic Science Laboratory; Natasha Neel, ATF Forensic Science Laboratory

Vectran is a relatively new aromatic polyester fiber that was first developed by Celanese Acetate, LLC in the 1990s and is now manufactured by the Kuraray Co., Ltd. Vectran is spun from a liquid crystal polymer

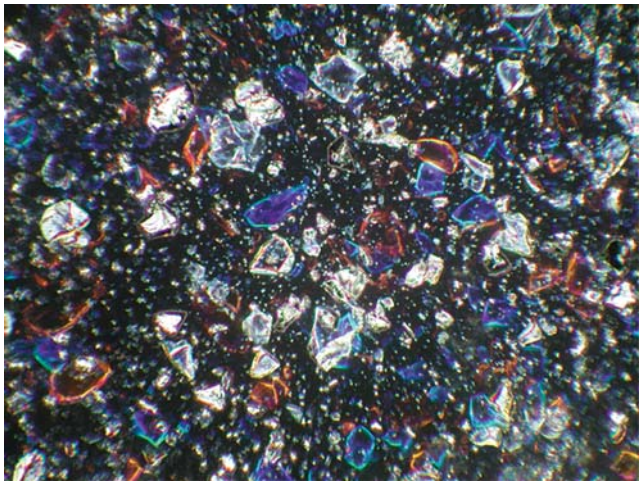

Photo courtesy of Wayne Moorehead, forensicTRACE

Wayne Moorehead presented his findings on the value of a specially formulated n_D=1.580 high dispersion refractive index liquid in identifying four isotropic low-explosive oxidizers.

(LCP) which gives rise to its exceptional high performance characteristics of strength, rigidity and chemical resistance. Vectran is the only fiber being produced today that is a melt spun fiber (thermotropic liquid-crystal polymer) from a highly ordered liquid crystal phase (mesophase) as compared to Kevlar, which is a solvent drawn high-performance fiber (lyotropic liquid-crystal polymer). Airbags made with Vectran woven fabric were used by NASA on the Mars Pathfinder spacecraft. Everyday products made with Vectran fiber include rope/cordage and protective clothing so this fiber may now be encountered in forensic casework. A review of literature for Vectran failed to find identification characteristics commonly relied on by forensic fiber analysts. To fill this void, the microscopical optical properties, in addition to infrared and Raman microspectroscopy data, will be presented for the characterization and identification of Vectran fibers.

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An Update on Refractive Index Liquid n_D = 1.580
Wayne Moorehead, forensicTRACE

After using nearly all of the n_D = 1.580 high dispersion refractive index liquid in the laboratory, a new sample of the liquid was purchased. Upon use with known standards, the new liquid was observed to have different (lesser) dispersion properties from the previous bottle. In 1997, a paper was presented by the author at Inter/Micro, "Dispersion Changes in Some Cargille Refractive Index Liquids," demonstrating how the dispersion in the more recent high-dispersion liquids in the n_D=1.570 to 1.605 range had values that were representative of standard dispersion liquids. The manufacturer made a specially formulated n_D=1.580 liquid and asked that it be evaluated. Last year, during a low-explosives analysis course, the liquid was evaluated and found to work as well as or better than the old formula. At Inter/Micro 2010, the manufacturer reportedly provided free samples of the liquid to those in attendance, who indicated that they performed low-explosives analysis. The value of this high dispersion liquid in identifying four isotropic low-explosive oxidizers will be presented.

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Use of the "Poor Man's Hot Stage" to Solve a Unique Indoor Dust Problem
Rich Brown, MVA Scientific Consultants

A customer was concerned about a heavy build-up of "dust" on the rigging used to support spotlights in a large movie studio. Although the dust could be removed, its location and the fact that it returned after cleaning created some concern with the crew tasked to maintain the lights. The building had suffered a fire and water damage and had been renovated, suggesting that mold or fungal growth was a possibility.

Examination of exemplar lamps, props used near the lamps, and the gel filters used at the face of the lamps, revealed materials that were all chemically similar to the dust. This suggested numerous possibilities for the dust source but no insight into the mechanism of dust formation. Applying a modified "poor man's hot stage," the suspected sources were examined one at a time over many hours to determine that none of the suspected items were the source of the dust. All this good information lead to an experiment with a new lamp and subsequent analysis of the lamp-housing coating using the hot stage. The dust, and the environment surrounding it, was recreated using a small sample of the lamp coating, the hot stage, and 300 °C for 24 hours.

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Forensic Dissection of "Misrepresented" Testimony
Wayne C. Isphording, University of South Alabama

Not infrequently, a task that falls to an expert witness in litigious situations involves the critical review of information supplied by the "opposition." Where sworn testimony is involved, either from examination of earlier acquired depositions or from direct examination of witnesses in the actual trial environment, the expert must identify any inconsistencies, inaccuracies, or apparent contradictions that are germane to the case being litigated. While it is presumed that witnesses speak the truth, the whole truth and nothing

but the truth, it is not unknown for witnesses to provide testimony that they almost certainly know is "inaccurate" (or downright false). In the modern trial environment, however, scientific procedures and techniques are available that, when properly used, can refute such testimony and provide a jury with information critical for their consideration.

A case is described where information supplied by a plaintiff in a damage suit against a major motorcycle manufacturer was clearly "misrepresented." The plaintiff alleged that he had purchased a new visor for his helmet and, on the following day, was involved in an accident that cost him his leg. His contention was that he was unaware that the visor could not be easily raised and, as a consequence, when he entered a curve on a foggy stretch of highway early the next morning, was not able to raise the "fogged" visor in time to see an oncoming car. Examination of the visor by the defense expert witness indicated that there were problems with the plaintiffs testimony. Initially, the defense expert became suspicious as to the date of purchase of the visor. When removed from the visor a few days after the accident, the visor was distinctly curved. When identical visors were placed on the helmet it was shown that several months of constant attachment would have been required to attain the curvature noted (not less than 24 hours).

Detailed optical, chemical, X-ray and SEM analysis further supported this conclusion. The refractive indices of the plaintiffs visor were noticeably different from those for visors supplied by the defendant's store, as was also the chemistry, as determined by XRF analysis. Final "proof" that the plaintiff had misrepresented the facts was provided by the discovery by SEM analysis of feldspar in cracks on the visor itself. No feldspar exists in the sediments and soils in the area where the accident took place and, in fact, is absent in indigenous materials for a distance of over 50 miles. Each of these points was provided to the defense attorneys to refute the contention that the visor had been purchased at the defendant's store the night before the accident. The final outcome of the trial, however, was a testament to the vagaries of the judicial system and the fact that nothing is certain in a court of law.

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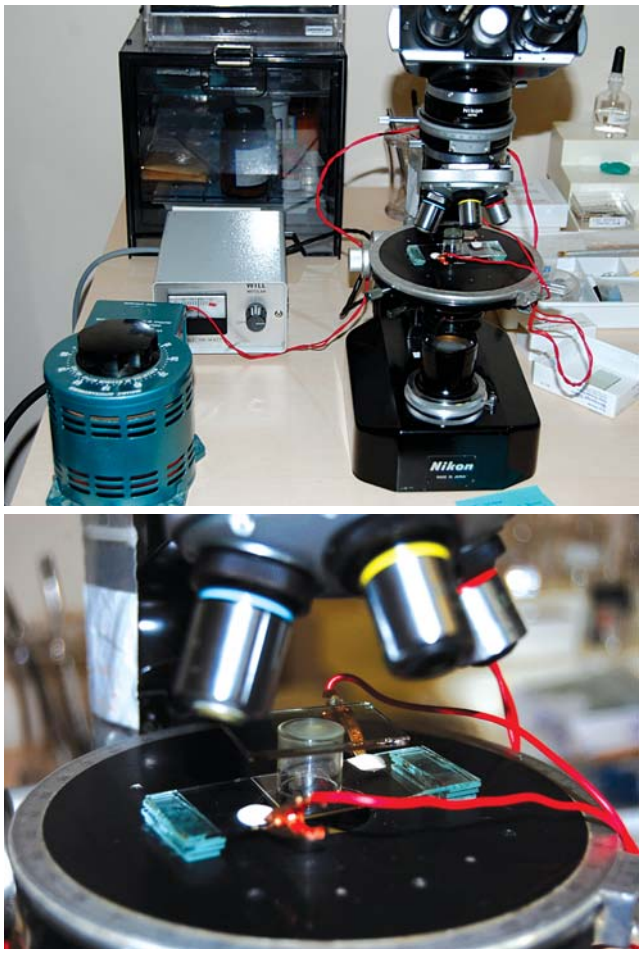
Creation and Accomplishments of a Forensic Internship Program

Wayne Moorehead, forensicTRACE

Over the past 26 years, the Orange County Crime Lab has accepted a number of interns to help accomplish projects typically outside the ability of the working forensic scientist to complete. Pressure to reduce a backlog of cases, court testimony, training and other issues often inhibits the scientist from initiating or completing a project. After selection, the intern is provided adequate training for their project. As the project successfully progresses, the intern is permitted to "job shadow" in each laboratory section, attend an autopsy, listen to forensic scientists provide testimony, observe forensic specialists perform routine crime scene investigations, read criminalistics journals and texts, attend local professional meetings, and be mentored by a forensic scientist. Some of the projects are presentation- or publication-worthy, and the intern may be included as an author, while other projects simply provide better resources to the laboratory. The ratio of time the intern spends com-



Photos courtesy of Rich Brown, MVA Scientific Consultants

Rich Brown of MVA Scientific Consultants showed the setup of a "poor man's hot stage" used in determining suspected sources of indoor dust in a movie studio.

Inter/Micro 2011 Photomicrography Competition Winners

Three winners were selected in the Inter/Micro 2011 Photomicrography Competition. Thomas Hopen, Best Overall Photomicrograph; Laren Cyr, Best SEM Photomicrograph; and Kelly Brinsko, Most Unique Photomicrograph. The winners were announced at the SMSI 2011 Awards Dinner, held at The Berghoff restaurant in Chicago.

What makes up a winning photomicrograph? Entrees were judged by a number of factors, including:

- Even, well-distributed illumination in the field of the image.
- Placement of specimen within the image (centered or artistically offset).
- Uniqueness or originality of the specimen.
- Information revealed.
- Beauty or impact of the image.
- Subject matter and composition.
- Beauty or impact of the image.

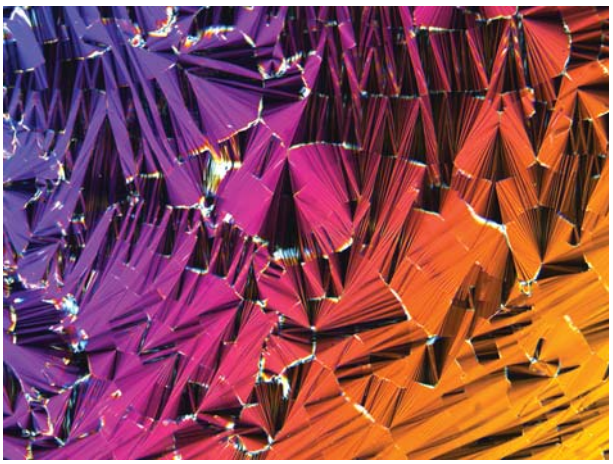


Photo courtesy of Thomas Hopen, ATF Forensic Science Laboratory

Thomas Hopen: Best Overall Photomicrograph

"Intal Liquid Crystalline Phase" shows a preparation of Intal (cromolyn sodium oral inhalation) in a droplet of water with a cover slip, viewed under crossed polars at 100x.

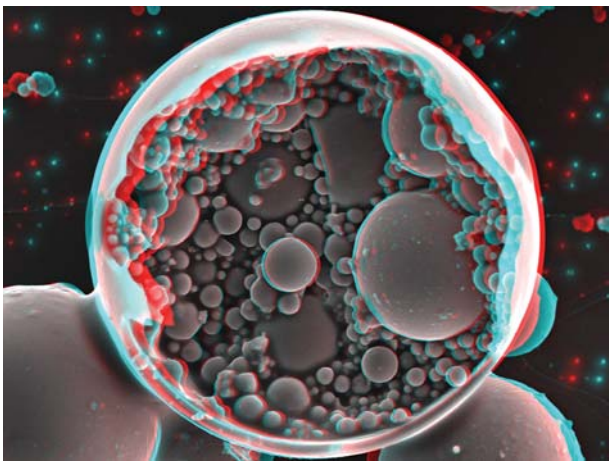


Photo courtesy of Laren Cyr, MVA Scientific Consultants

Laren Cyr: Best SEM Photomicrograph

"Celestial Spheres" shows fly ash suspension drop mounted onto carbon tape using alcohol dispersion. The sample was gold coated and then analyzed and photographed at 1,000x with a JEOL JSM-6490LV scanning electron microscope.

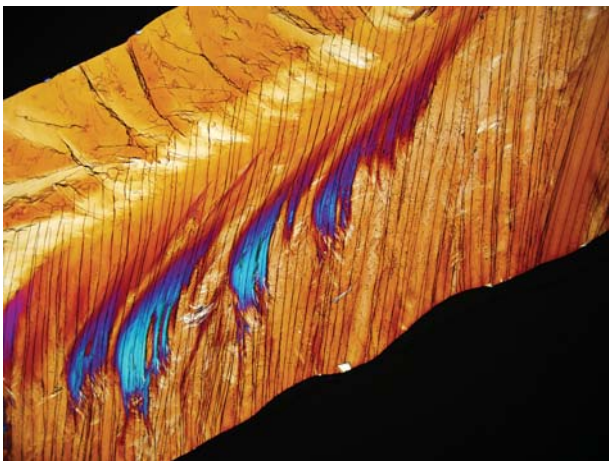


Photo courtesy of Kelly Brinsko, McCrone Research Institute

Kelly Brinsko: Most Unique Photomicrograph

The image shows a mixed fusion preparation of TNB and picric acid viewed between crossed polars at 200x. The solids were melted under the coverslip sequentially and then recrystallized; the photo was taken of the picric acid portion of the preparation.

pleting a project compared to the time the forensic scientist spends training and evaluating their work can range anywhere from 3:1 to 35:1. With this, the question is not, "who has time for an intern?" but, "who doesnt have time for an intern?"

Can You Hear Me Now? An Investigation into Mobile Telephone Screen Glass

Brendan Nytes, Microtrace, LLC

Glass is commonly encountered as forensic evidence. Typically the glass originates from flat glass (i.e.,

windows) or containers that have subsequently become the most heavily researched area of forensic glass comparison. Now with mobile phones and other portable electronic devices becoming commonplace in our society, glass from the screens of these devices is likely to become more commonly encountered in crime scenes. It is not clear how much this glass varies from device to device or how easily it can be distinguished from other types of glass. This talk investigates the glass from the screens on mobile phones and compares a subset of mobile electronic device glasses to each other and other types of glass. The screen glasses have been classified by their bulk elemental composition (via micro-XRF), surface coatings (through elemental or fluorescence characteristics), optical characteristics (refractive index) and physical characteristics (such as thickness).

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A Comparison of Sampling Techniques for the Determination of Accelerants in Arson Investigations
Mark E. Palenik, Microtrace, LLC

Laboratory analysis of fire debris for the presence of residue from ignitable liquids is common in arson investigations. In 1969, the normal testing of debris for ignitable liquids involved steam distillation followed by fractional distillation and various determinations of physical properties. Paul Kirk suggested the use of heated headspace with gas chromatography as a method of analysis. In the past, poor sampling techniques led to false negatives and a distrust of the method. Today, gas chromatography is still used; however, new and more sensitive sampling techniques have been implemented. The use of carbon strips is common today; however, solid phase microextraction (SPME) has also been shown to be a sensitive technique. The advantages and disadvantages of these sampling techniques are compared and discussed.

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Forensic Applications of Infrared Microprobe Analysis Using Diamond Internal Reflection Technology
John A. Reffner, John Jay College of Criminal Justice

The infrared microprobe has an important role in the scientific examination of physical evidence. Physical evidence is pivotal in the investigation and prosecution of criminal cases; the probative value of evidence is dependent on the forensic scientist's ability to extract, interpret and communicate information from this evidence. While direct microscopical examination is of primary importance, the ability to determine chemical composition is an important addition to morphological characterization. Because the infrared microprobe combines light microscopy with molecular spectroscopy, the molecular chemistry of an evidence sample can be linked to its microscopical morphology. The microstructure may be documented photographically and the molecular chemistry recorded by mid-infrared spectral analysis. The development of diamond internal reflection microscope optics makes it possible to collect spectra of molecular species by making optical contact between the sample and the diamond internal reflection element. Unlike transmission spectral measurements, mid-infrared ATR spectra can be obtained from thick or thin specimens, and they are thickness-independent. These features make it possible to collect ATR spectra from a wide variety of samples, including polymers, minerals, paints, glass, drugs and other molecular compounds commonly recovered as evidence. In this presentation, examples of the analysis of soil minerals and glass will demonstrate the versatility of this technology for the examination of physical evidence.

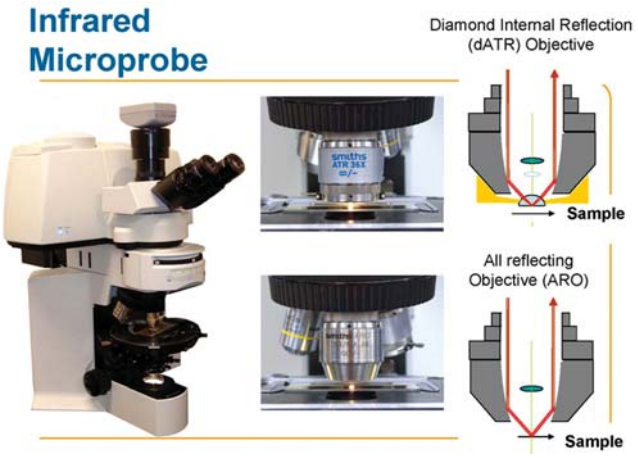

Photo courtesy of John Reffner, John Jay College of Criminal Justice

John Reffner of John Jay College of Criminal Justice explained how an infrared microprobe with diamond internal reflection microscope optics can collect spectra of molecular species that are important in the examination of physical evidence.

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Closing Remarks
Gary J. Laughlin, McCrone Research Institute