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GSR Transfer To Paper Bag Hand Covers: A Case In Point

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The recent article by Jennifer Kimmett relating to the incidence of gunshot residue that can be transferred to paper bag hand covers (*IAMA Newsletter*, Vol. 1, Issue 3) described the frequency and factors associated with GSR transfer to various bag types for both test and actual firearms cases. A real-world case submitted to the Maryland State Police Crime Lab serves as a case in point with respect to GSR particles that were recovered from paper bags used to cover the hands of a suspect.

To summarize the events surrounding the case, in July 1999, a man brandishing a semiautomatic handgun and wearing a ski mask and other clothing to hide his identity, proceeded to rob a Maryland supermarket of over $2000 in cash. The suspect fled the store on foot and left the immediate area of the scene in his work truck. Unfortunately, a gentleman who was walking his dog at the time witnessed the suspect get into and drive away in the truck. Rather than leave the area, however, the suspect drove toward the man walking the dog, stepped out of the truck and, in cold blood, maliciously shot the man three times. The victim subsequently died from these gunshot wounds.

When the police arrived, a high speed chase involving the truck, driven by the suspect, ensued. The driver subsequently bailed out of the vehicle, continuing to attempt to avoid capture by crawling on his hands and knees and hiding in the bushes. Upon arrest, the suspect was handcuffed and his hands were "bagged" prior to being sampled for possible GSR residue using a standard "sticky lift" collection kit (Tri Tech Inc.).

The examination of the sticky lift stubs from the suspect's hands was negative, i.e. no GSR-type particles were detected. While the absence of GSR did not necessarily mean that the suspect had not fired a weapon (e.g. loss of GSR particles due to delay in collection, vigorous hand movements during high speed chase/bail out/ crawling in bushes), the state was left with these explanations to hold the suspect (who blamed an alleged phantom accomplice for the shooting). It was only during pre-trial consultation that the Crime Lab learned of the existence of the paper bags which had been used to cover the suspect's hands. The bags were subsequently submitted to the Lab for analysis.

The interior surfaces of the two bags (approximate surface areas of 72 sq. in. per bag) were sampled using sticky-lift stubs (approx. 15-20 stub "dabs" per bag, stub area = 0.25 sq. in.). The analysis results were surprising. For the bag which covered the suspect's right hand, a total of 351 particles were detected by the computerized SEM/EDS package, two of which were "consistent" (Sb- and Ba/Si-containing) with GSR. The analysis of the bag associated with the left hand identified a total of 707 particles, including one which was unique (PbBaSb) to GSR.

At trial, when presented with the GSR evidence, the suspect reversed his initial denial of the shooting, now claiming that he had shot the victim "accidentally" after a confrontation and struggle for the handgun. The jury rejected this implausible scenario and convicted the suspect on first-degree murder and all other submitted counts.

This case history brings to light several issues associated with the bagging of a

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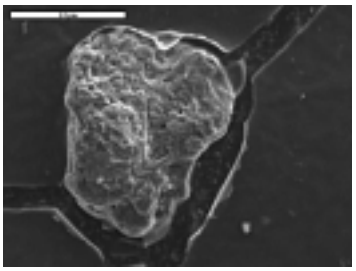
GSR Transfer To Paper Bag Hand Covers: A Case In Point...*Continued*



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suspected shooter's hands and the subsequent analysis of the sample stubs for GSR: (1) the likelihood of transfer of GSR particles is directly related to the number of particles remaining on the hands after the post-discharge "activity" of the shooter; (2) the "masking" of GSR particles by residue (e.g. dirt, sweat) acquired prior to bagging/sampling is possible; and (3) the need exists for a more thorough sampling of bags by "sticky lift" stubs (approx. 7% of the total surface areas for both bags was sampled in this case prior to the loss of effective "dabbing").

The instrumental parameters used were as follows: JEOL 5800 SEM/Oxford Link ISIS EDS Oxford Automated GSR package Accelerating Voltage: 20kV Magnification(s): (400X), 800X Working distance: 10mm Backscatter threshold: Manually set (Mn, Pd standard)

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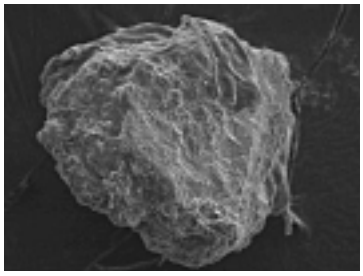
The Retention of Gunshot Residue on Clothing After Laundering

Mastering the lawless science of our law,-- That codeless myriad of precedent, That wilderness of single instances.

Aylmer's Field.



Abstract

Criminal investigators have long used the detection of gunshot residue (GSR) as evidence of an individual's association with a firearm. Previous studies have been conducted to determine the duration of time GSR is retained on a person's skin. How long gunshot residue can remain on clothing has yet to be determined. In this study, articles of clothing worn during the discharge of a firearm and then washed in a routine manner were sampled and analyzed by scanning electron microscopy with energy dispersive spectroscopy. GSR-related particles were detected on some of these laundered articles of clothing, which illustrates the difficulty in the interpretation of positive results on inanimate objects.

Introduction

The expulsion of a bullet from a firearm is initiated by the ignition of the primer compound. In center-fire ammunition this compound is contained in the primer cup located within the base of the cartridge case. Most primers contain lead styphnate as the explosive initiator, barium nitrate as the oxidizer and antimony sulfide as the fuel. [1,2,3] Gunshot residue (GSR) particles originate from this primer compound and form as condensates from the cloud of gas which is generated when a firearm is discharged. This cloud contains vaporized components from the primer, mainly lead, barium and antimony. These elements condense and coalesce to form GSR particles having a characteristic spheroidal morphology.[4,5,6]

When a firearm is discharged, GSR particles may be deposited on nearby surfaces including the skin of the person who fires the weapon. Additionally, particles may be deposited on the skin of a person who is in the vicinity of a firearm when it is discharged. Deposition can also occur on inanimate objects, such as the weapon itself, or other objects in close proximity at the time of discharge. Contact with such an item may result in GSR deposition.

The deposition and retention of GSR particles are dependent upon many variables. The amount of residue deposited is affected by the type of ammunition, the type of firearm and the location of the shooting (indoors versus outdoors). The type of activities following deposition influence retention of residue. Previous research has shown that GSR particles deposited on the skin are easily removed in the course of normal activity.[7,8,9] Consequently, the detection of gunshot residue on the hands or face of a living person generally indicates a fairly recent association with a firearm. It indicates the person discharged a firearm, was in close proximity when a firearm was discharged, or came in contact with an item with gunshot residue deposition.

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The Retention of Gunshot Residue on Clothing After Laundering...*Continued*

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When GSR particles are deposited on the skin it is also possible that particles are deposited on a person's hair. Other studies have considered the retention of GSR on head hair and found that residue may be detected for up to twenty-four hours following a discharge of a firearm. It was also shown that shampooing the hair removed the residue.[10,11]

If GSR particles can be deposited on skin and hair, it is reasonable to conclude that they can also be deposited on a person's clothing. Some research has reported with respect to GSR analysis on clothing. Zeichner, Andrasko and Wallace have reported various sampling techniques for the collection of residue from clothing.[12,13,14] Research has also shown clothing can be contaminated with GSR. Residue was detected on a clean laboratory coat after it was hung in a closet next to a jacket previously worn while shooting.[13] Although it is believed that GSR may become embedded in fabric and therefore remain on clothing for longer periods of time, the authors found no research dealing specifically with the issue of just how long GSR can be retained on clothing.

Experimental

A variety of clothing items were selected in an effort to include different types of fabrics and items that were loosely as well as tightly woven. A list of each item and a description of the fabric is given in Table 1. In actual case samples the history of an item can never be known. For this reason, the clothing chosen for this study have unknown histories, i.e., these pieces of clothing may or may not have had GSR deposition in the past. An initial study of 5 articles of clothing was followed approximately one year later by a second study of 14 pieces of clothing. Data for all 19 items are included in this report. Each item was sampled and analyzed at three stages.

Stage I: Blanks Each item was first washed in a standard top loading washing machine using warm water and detergent.

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Table 1: Clothing Items Sampled

Item Number	Description	Fabric Type
#1	White, long-sleeved dress shirt	65% polyester-35% cotton
#2	Sheer Energy glove- right hand	81% nylon-19% spandex
#3	Sheer Energy glove- left hand	81% nylon-19% spandex
#4	Black long-sleeved sweat shirt	50% cotton-50% polyester
#5	Gore-Tex jacket	Gore-Tex
#6	Black stocking cap	100% acrylic
#7	Sheer Energy glove- left hand	81% nylon-19% spandex
#8	Sheer Energy glove- right hand	81% nylon-19% spandex
#9	Black knit stretch glove- left hand	acrylic
#10	Black knit stretch glove- right hand	acrylic
#11	Brown gardening glove- right hand	cotton
#12	Brown gardening glove- left hand	cotton
#13	White T-shirt	50% cotton-50% polyester
#14	White/grey knit glove- right hand	acrylic
#15	White/grey knit glove- left hand	acrylic
#16	Blue shaker knit sweater	100% acrylic
#17	Brown windbreaker jacket	100% nylon
#18	Grey sweatshirt	40% acrylic-30% cotton-30% polyester
#19	Plaid flannel shirt	100% cotton

SEM/EDX Training Courses

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The Electron Microscope Unit and The Australian Key Centre for Microscopy and Microanalysis. The University of Sydney in Australia. www.usyd.edu.au/su/emu/courses/course.html

The National Center for Electron Microscopy (NCEM). Lawrence Berkeley National Laboratory in California. http://ncem.lbl.gov/ncem.html

MVA, Inc. Training in Microscopy and Microanalysis. http://mvainc.com/

Geller MicroÅnalytical Laboratory. www.gellermicro.com/

Ross Electron Optics Consulting & Services (REOCS). http://web.missouri.edu/~geosclmr/lou.html

EVEX Analytical. www.evex.com/

San Joaquin Delta College offers a Certificate Program in Microscopy in Stockton, California. www.deltacollege.org/dept/electmicro/

Lehigh Microscopy School, Lehigh University in Bethlehem, Pennsylvania. www.lehigh.edu/~inmatsci/shortcourses/Microscourses.html

The McCrone Research Institute Courses in Chicago, Illinois. www.mcri.org/Courses_about.html

Media Cybernetics. www.mediacy.com/training.htm

The Retention of Gunshot Residue on Clothing After Laundering...*Continued*

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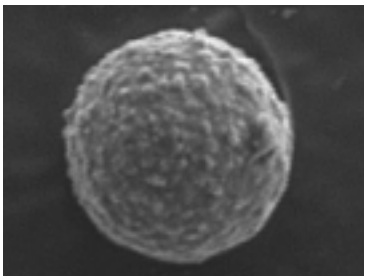

Items #1-5 were laundered using phosphate free Amway brand detergent. Items #6-19 were laundered using Clout brand detergent. All items were dried in a dryer at low heat. Sampling was done by placing the item on a clean piece of white butcher paper and dabbing it with a 13 mm diameter aluminum scanning electron microscope (SEM) stub with double sided adhesive tape. Gloves were sampled in much the same way as are hands. Sampling was done on the web area, back of the hand area and the cuffs. The stocking cap samples were collected from the brim, middle and top front area. All other items were sampled at the chest, collar and cuff area, if applicable. Dabbing continued until tackiness of the adhesive was minimal. Disposable gloves were worn and changed between each item sampled. These samples are designated blanks.

Stage II: Post-firing -To achieve deposition of GSR, each item was worn while firing two rounds from a Dan Wesson Arms, 357 magnum caliber revolver. For safety reasons, the barrel had been plugged and the firings were of cartridge cases with primer only. Plugging the barrel also decreased the venting of residue through the barrel and enhanced deposition of GSR. Firings were done in an indoor range. The air flow fan was off during test firings to reduce dissipation of particles and further enhance GSR deposition. One of the analysts would put on a particular article of clothing, fire two rounds, then remove the item and place it directly into a clean paper bag. The next piece of clothing would then be put on and the process repeated until each item had been worn during the discharge of two rounds. To verify that deposition had occurred, a limited area was sampled on each item in the manner described above. Only small areas were sampled to ensure that only a small amount of GSR present was being removed by the sampling process. These samples are designated post-firing.

Stage III: Post-washing -All articles of clothing were then laundered in the same manner previously described in Stage I. Each article was sampled using aluminum SEM stubs to dab the same areas indicated in Stage I. Sampling was conducted in a room different from that where the post-firing samples were obtained. Gloves and butcher paper were again changed between each sample. These samples are designated post-washing.

Control samples were also run. Stubs were opened and the tape surface exposed to the air for 24 hours in 3 different laboratory locations where sampling and analysis occurred. These stubs were then analyzed to establish that no airborne contamination existed within the laboratory. Butcher paper was also sampled and analyzed for GSR particles.

Analysis

Analysis was done by the scanning electron microscope and energy dispersive x-ray analysis (SEM/EDX) technique. Analysis by SEM/EDX has been widely reported as an effective technique for locating and identifying GSR particles.[15, 16] In this study a gunshot residue particle is defined as a particle containing lead, barium and antimony. Particles containing two of these three elements are considered supporting particles. These are characteristic of, but not unique to, GSR.[16]

In preparation for SEM analysis, the sample stubs were coated with vaporized carbon using a Denton Vacuum Desk II cold sputter etch unit with a carbon evaporation accessory. Analysis of samples was conducted on a Jeol JSM-5200 SEM equipped with a Tracor Northern Series II x-ray analyzer. Scanning of each sample was conducted manually at a magnification of 1500X, a working distance of 20 mm and an acceleration voltage set at 20 kV. The scans were conducted in the backscatter mode. In casework, laboratory protocol requires that each stub is scanned a minimum of 5 times across its diameter before an inconclusive result is reported. A random sampling procedure is followed since it is not feasible to manually scan the entire surface of a stub. Therefore, in this study as in casework, the failure to detect a GSR particle is considered inconclusive rather than negative. Scanning stops once a positive result is achieved which sometimes requires less

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The harder the conflict, the more glorious the triumph. What we obtain too cheap, we esteem too lightly; it is dearness only that gives everything its value. I love the man that can smile in trouble, that can gather strength from distress and grow brave by reflection. 'Tis the business of little minds to shrink; but he whose heart is firm, and whose conscience approves his conduct, will pursue his principles unto death.

Thomas Paine

The Retention of Gunshot Residue on Clothing After Laundering...*Continued*

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than 5 scans. The stubs used to sample items #1-5, (blanks and post-washings) were scanned ten times across their diameter, a protocol more stringent than the five scans generally conducted on casework. For items #6-19 (blanks and post-washings) the standards applied to casework were used, conducting 5 scans on each stub, unless a GSR-related particle was found, in which case extra scans were performed. The total number of scans on each stub is given in Table 2. The samples collected from all items after deposition (post-firing) were scanned until GSR deposition was verified. Typically less than one full scan was required.

For this study, the presence of any number of GSR or supporting particles was considered significant and is reported in our results. Results are given in Table 3.

Results

No GSR-related particles were detected on the control samples collected within the laboratory or from the butcher paper. There was no evidence of GSR contamination due to airborne GSR particles.

In Stage I, the initial blanks, 3 items were found to have GSR-related particles. All three of these items were gloves. After 10 scans on item #3, one barium/antimony particle was found. After 15 scans on item #9, one GSR particle was identified. Item #14 was examined for a total of 9 scans with identification of one lead/antimony particle. Positive results were obtained from each post-firing sample (Stage II). Items #1-5 were scanned until one GSR particle was found. Only item #3, a glove, required 2 scans to achieve this positive result. A positive result was obtained in the first scan on all other items. Items #6-19 were scanned until at least two GSR particles were identified. This was done in a single scan on all items except #6, a stocking cap, and #17, a windbreaker. Two scans were done on item #6 and four scans on item #17. After laundering, Stage III Post-washing, five items were found to have GSR-related particles remaining. A pair of gloves (#2 and #3) were found to have one GSR particle on both the right and left hand gloves. Two supporting particles were also found. On item #16, a sweater, a single GSR particle was identified. A total of 16 scans were done on this item. After 13 scans, two GSR particles were found on item #17, a wind-

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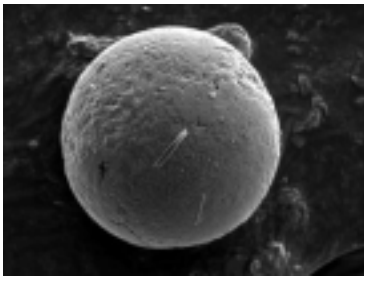


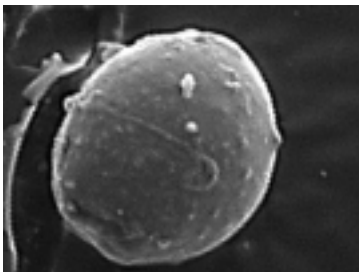
Table 2: Number of Scans Done on Each Stub

Item #	Item Type	Blank	Post-firing	Post-washing
#1	Shirt	10	1	10
#2	Glove- right hand	10	1	8
#3	Glove-left hand	10	1	4
#4	Sweatshirt	10	1	10
#5	Jacket	10	2	10
#6	Stocking cap	5	2	5
#7	Glove-left hand	5	1	5
#8	Glove-right hand	5	1	5
#9	Glove-left hand	15	1	5
#10	Glove-right hand	6	1	5
#11	Glove-right hand	5	1	5
#12	Glove-left hand	5	1	5
#13	Glove-right hand	5	1	5
#14	Glove-left hand	9	1	5
#15	T-shirt	5	1	5
#16	Sweater	5	1	16
#17	Jacket	5	4	13
#18	Sweatshirt	7	1	13
#19	Flannel shirt	6	1	5

There are no crimes and no criminals in these days. What is the use of having brains in our profession? I know well that I have it in me to make my name famous. No man lives or has ever lived who has brought the same amount of study and of natural talent to the detection of crime which I have done. And what is the result? There is no crime to detect, or, at most, some bungling villainy with a motive so transparent that even a Scotland Yard official can see through it.

"A Study in Scarlet"; Sherlock Holmes

The Retention of Gunshot Residue on Clothing After Laundering...*Continued*



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breaker. Two supporting particles, one barium/antimony particle and one lead/antimony particle, were found on item #18, a sweatshirt.

Discussion

As mentioned in the introduction, Andrasko and Pettersson reported on contamination of clothing by transfer.[13] They detected GSR on a clean lab coat that was hung next to a jacket with GSR on it, illustrating that particles can be transferred from one item to another. Although laundering appeared to effectively remove gunshot residue from many items tested, the presence of GSR particles on some items both in Stage I (Blanks) and in Stage III (Post-washing) indicates that laundering clothing does not always completely remove gunshot residue. Consequently, when GSR-related particles are detected on an article of clothing the possibility exists that the residue was deposited long ago or is the result of transfer.

This study raises many interesting and as yet unanswered questions demonstrating the need for additional research in this area. The clothing used here was separated as one typically separates laundry. Some GSR-contaminated items were washed with each other as well as with items that had no known exposure to gunshot residue. Samples were not collected from any of those items. It is not known whether or not a transfer of particles can occur during the actual washing and drying of clothing. Additional studies are needed to determine if this can occur. Repeating this study using a

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As far as the laws of mathematics refer to reality, they are not certain; and as far as they are certain, they do not refer to reality."

Albert Einstein

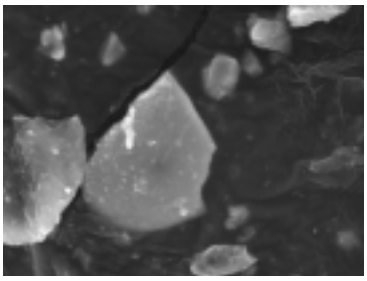

Table 3: Number and Type of GSR-Related Particles Detected**

Item #	Item Type	Stage I: Blank	Stage II: Post-firing	Stage III: Post-washing
#1	Shirt	0	Ba/Sb-1, GSR-1	0
#2	Glove-right hand	0	Ba/Sb-2, GSR-1	Pb/Ba-1, GSR-1
#3	Glove-left hand	Ba/Sb-1	Ba/Sb-1, GSR-1	Pb/Sb-1, GSR-1
#4	Sweatshirt	0	Ba/Sb-3 Pb/Ba-1,GSR-1	0
#5	Jacket	0	Ba/Sb-1 GSR-1	0
#6	Stocking cap	0	Ba/Sb-2 Pb/Sb-2, GSR-2	0
#7	Glove-left hand	0	Ba/Sb-3 GSR-2	0
#8	Glove-right hand	0	Ba/Sb-1 Pb/Sb-1, GSR-2	0
#9	Glove-left hand	GSR-1	GSR-4	0
#10	Glove-right hand	0	Ba/Sb-1, GSR-3	0
#11	Glove-right hand	0	Ba/Sb-2, GSR-2	0
#12	Glove-left hand	0	Ba/Sb-1, GSR-2	0
#13	Glove-right hand	0	Ba/Sb-1, GSR-2	0
#14	Glove-left hand	Pb/Sb-1	GSR-3	0
#15	T-shirt	0	Ba/Sb-1, GSR-2	0
#16	Sweater	0	GSR-3	GSR-1
#17	Jacket	0	Ba/Sb-5 Pb/Sb-11,GSR-3	GSR-1
#18	Sweatshirt	0	Ba/Sb-3, GSR-2	Ba/Sb-1
#19	Flannel shirt	0	Ba/Sb-1, GSR-2	0

** Key
GSR-2: Indicates 2 particles containing Pb, Ba, and Sb.
Ba/Sb-1: Indicates 1 particle containing Ba and Sb.
Pb/Sb-11: Indicates 11 particles containing Pb and Sb

The Retention of Gunshot Residue on Clothing After Laundering...*Continued*

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variety of firearms and different live ammunition may also provide a more realistic situation and additional information. The instrument used by this lab for this study was, as mentioned previously, a manual search system. It has since been replaced by an SEM with an automated GSR search program, which we hope to utilize in the future for a repeat of this study.

Because GSR particles have been shown to be readily removed from skin[7, 8, 9], it is reasonable to conclude that the presence of GSR on a living person's hands or face indicates a recent association with a firearm or recent contact with an item with gunshot residue on it. This study indicates that the same is not true when analyzing clothing for GSR. No conclusions can be drawn with respect to time of deposition based on the presence of gunshot residue on clothing.

Acknowledgement

The authors wish to thank Mary Kelly Floyd and Margie K. Bopp for the many hours spent at the electron microscope.

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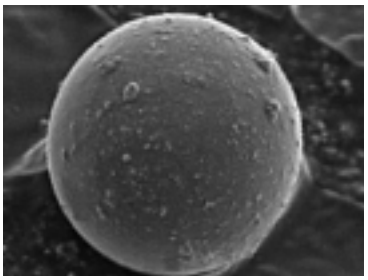
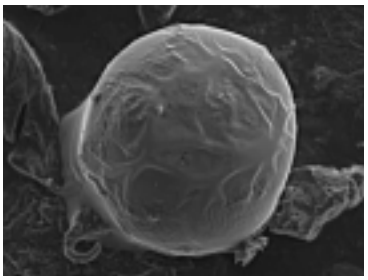


Every great advance in science has issued from a new audacity of imagination.

John Dewey



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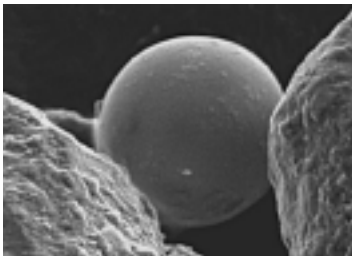
A Survey of Titanium and Zinc Particles in Samples Collected from Suspects (*)



Keywords:
Gunshot Residue (GSR) Particles, Primer Discharge Residue (PDR) Particles, Sintox® Ammunition, SEM/EDX.

The analyses of gunshot residue (GSR) particles in samples collected from suspects, using SEM/EDX, are based on the empirical findings that particles having certain elemental compositions (e.g. Pb, Sb and Ba, or Pb, Ba, Si, Ca and Sn) were found so far only in percussion primers discharge residues. Such particles are referred to as **Gunshot Residue-(GSR)** or **Primer Discharge Residue-(PDR) Particles.** Other particles, originating from primer discharge, have compositions similar to those found also in other sources unrelated to firearms' discharge. Such particles are referred to as **Consistent with Gunshot Residue Particles.** In recent years, new lead-free primer types have been developed, in order to lower the amount of lead emitted to the environment. One such primer type is the Dynamite-Nobel Geco Sintox®.

The Sintox® primer composition is Dinol (Diazodinitrophenol), Zinc Peroxide, Titanium powder and Nitrocellulose, and its discharge residue particles are composed mainly of Ti and Zn. In order to assess the evidential value of Ti+Zn particles, found in samples collected from suspects, the present survey was conducted. Particles containing Ti and/or Zn, found in 128 samples analyzed during routine casework in the laboratory, were studied using SEM/EDX. Out of 963 particles, defined by the software as "Titanium" or "Zinc", only 16 particles (found in 6 of the samples) contained both Ti and Zn, and none had the characteristic features of Sintox® GSR particles. Based on these findings it is suggested to regard spherical Ti+Zn particles as being **Consistent with Sintox® Ammunition GSR particles.**

(*) – Based on: Levin N., Tsach, T., Bergman, P. and Springer, E., "A Survey of Titanium and Zinc Particles in Samples Collected from Suspects," presented at the 2nd EAFS (ENFSI) Meeting, Krakow, Poland, September 12 – 16, 2000.

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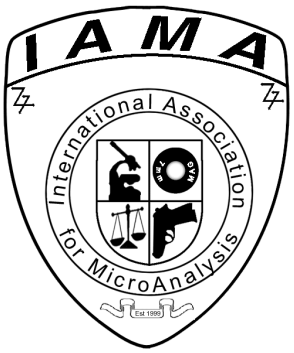
Taceant colloquia. Effugiat risus. Hic locus est ubi mors gaudet succurrere vitae.

(Let conversation cease. Let laughter flee. This is the place where death delights to help the living)

Latin Proverb (Quoted in Bernard Knight's "Forensic Pathology" at the Title Page.

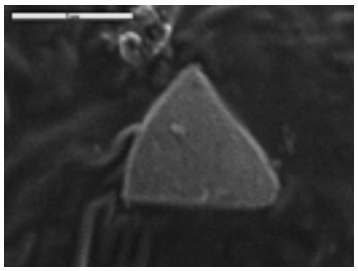
Yes, We Have Changed Our Logo!

We went back to the drawing board and came up with our new logo. As much as I would like to take credit for the new design, it was through the tireless efforts of Ricardo Guerrero A bit of trivia: Did you know that the symbols just below the IAMA header is what ancient alchemist used to represent lead. Lead was named after Saturn (Kronos) the dull, slow-moving god, often pictured as an old man carrying a scythe of hourglass, and whose symbol was the scythe. If you want to learn more, please visit http://chemsoc.com/viselements/pages/alchemist/alchemy.html



Articles and Books of Interest...

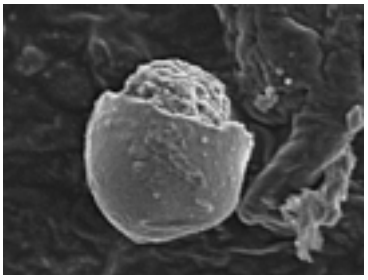
This section of the newsletter is dedicated to articles and books pertaining to P-GSR and SEM/EDX analysis. Further additions will be added in upcoming issues. If you would like to contribute to this section please contact us and we will add them to this section. List continued from ***IAMA Volume 1, Issue 2.***



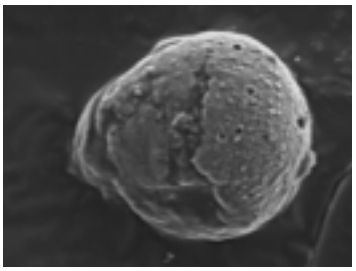
26. "Detection of Gunshot Residue Particles from Hands of a Shooter" JFS 1977;22(4):725-738 by Matricardi and Kilty.
27. "Casework Experience of GSR Detection in Isreal, on Samples from Hands, Hair, and Clothing Using an Autosearch SEM/EDX System" JFS 1995;40(6):1082-1085 by Zeichner and Levin
28. "Officers, Their Weapons and Their Hands: An Empirical Study of GSR on the Hands of Non-Shooting Police Officers" JFS 1995;40(6):1086-1089
29. "Primer Redisues Deposited by Handguns" American Journal of Forensic Medicine and Pathology 1994;15(4):325-327 by Cooper et.al.
30. "Characterization of Gunshot Residues by X-Ray Diffraction" JFS 1982;27(3):677-683
31. "An Unusual Source of gunshot Residue" AFTE Journal 1991;2(1):535-537 by W. Matty
32. "Analysis of Gunshot Residue Test Results in 112 Suicides" JFS 1990;35(1):62-68 by G.E. Reed et.al.
33. "American Lead-Free 9mm-P Cartridges" AFTE Journal 1995;27(2) by L.C. Haag
34. "Applications of Focused Ion Beam Systems in Gunshot Residue Investigations" JFS 1999;44(1):105-109 by L. Niewöhner et.al.
35. "The Detection of Gunshot Residue by Use of the Scanning Electron Microscope" JFS 1976;21 (3):595-610 by R.S. Nesbitt
36. "Final Report on Particle Analysis for Gunshot Residue Detection" Report ATR-77: 7915-3; The Aerospace Corporation, Washington D.C. 1977 by Walton et.al.
37. "Analysis of the Results of Gunshot Residue Detection in Case Work" JFS 1980; 25(4):839-846 by E. Rudzitis
38. "Use of Scanning Electron Microscopy and Energy Dispersive X-Ray Analysis (SEM-EDXA) in Identification of Foreign Material on Bullets" JFS 1987;32:38-47 by V.J.M. DiMaio et.al.
39. "Automated Gunshot Residue Particles Search and Characterization" JFS 1987;32:62-71 by W.L. Tillman
40. "Collection Efficiency of Gunshot Residue (GSR) Particles from Hair and Hands Using Double-Side Adhesive Tape" JFS 1993;38:571-584 by Z.A. Zeichner et.al.
41. "Automation of Gunshot Residue Detection and Analysis by Scanning Electron Microscopy/Energy Dispersive X-Ray Analysis (SEM-EDX)" JFS 1987;32:1595-1603 by R.S. White et.al.
42. "Characteristics of Firearms and Gunshot Wounds as Markers of Suicide" , The American Journal of Forensic Medicine and Pathology 1992;13(4):275-280 by I.C. Stone
43. "Formation of Gunshot Residue" JFS 1982;21(1):72-91 by S. Basu
44. "Percussion Primer Mixes" AFTE Journal 1990;22(1):1-25 by B.A. Bydal
45. "Identification of Burnt Matches by Scanning Electron Microscopy" JFS 1978;23(4):637-642 by J. Andrasko
46. "Identification of Match Head Residues in Post-Explosion Debris" JFS 1991;36(5):1360-1367 by B. Glattstein et.al.
47. "Barium and Antimony Distributions on the Hands of non-Shooters" JFS 1990;35:1096-1114
48. "Detection of Gunshot Residue on the Hands by Trace Element Analysis" JFS 1977;22(2):304-324 by S. Kishnan
49. "Semi-Autimatic Detection of Gunshot Residue by SEM/EDX" Scanning Electron Microscopy, Part 1, SEM Inc. AMF O'Hare, Il 1982:107-114 by H.Gansau et.al.
50. "A Comparison of particle transfer Efficiencies of Two Collection Methods fro the Identification of Gunshot Residue on Fabric Surfaces using Scanning Electron Microscopy Energy Dispersive Spectroscopy" Scanning, April 1999 by D.K. Shaffer et al.

I think that a particle must have a separate reality independent of the measurements. That is an electron has spin, location and so forth even when it is not being measured. I like to think that the moon is there even if I am not looking at it.

Albert Einstein



GSR: Keeping the Story Straight



Gunshot residue (GSR) evidence has been frequently underutilized and misapplied by Courts. The fault must lie with the testimony of poorly trained and inexperienced GSR technicians. True, the identification of GSR elements independent of other evidence is of limited value. But, and this is a big but, the skilled forensic scientist, based on his or her experience and independent study of GSR, has the ability to put the analytical results of GSR into the context of the crime scene, when combined with other court evidence and eyewitness testimony. This elevates GSR evidence in the minds of the members of the jury. An inexperienced analyst or technician is limited to confirming or denying the presence of GSR, hobbling the value of crucial evidence. Therefore, for the forensic expert to best assist the jury, he or she must learn more than instrumentation and rote data interpretation; he or she must learn the intricacies of GSR evidence as it relates to the whole crime scene.

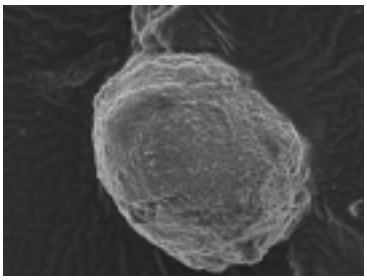
Every trial is adversarial by nature and both the prosecution attorneys and the defense attorneys have their stories to sell to the jury. The jury, in turn, relying mostly on unsophisticated common sense, must put the pieces of the puzzle together into one story on which to decide the verdict (from *verum dictum* – true word). GSR evidence is often one of the pieces, sometimes a big piece. Such analyses as muzzle to target distance determination and the presence and location of GSR are, not uncommonly, the glue that holds a good story together or the crucible that renders the bad story dross. While not commanding the high drama or media hype of other forensic technologies, GSR evidence is, more often than not, the workhorse that will support or refute the stories, which are promoted by one side or the other. The ultimate Court decision of guilt or innocence for a defendant is in reality based on which side tells the most convincing story to the jury or which side can develop a story that best fits the facts.

In what is, depending on your point of view, a strength or a weakness of our legal system, the opposing counsels push hard to convince the jury that the facts in evidence fit the story that each individual counsel is promulgating. Each counsel often wants the testifying forensic scientist to present the analytical results simply as data, that is, GSR is present or absent, without explaining how GSR evidence fits with other facts related to the alleged crime scene. Here the inexperienced analyst or technician is at particular disadvantage. Eager to be seen as impartial and unbiased, this neophyte will invariably produce impeccable technical data, testify with numerous terse "I don't know" and "Yes, it could" statements, and remain silent or unenlightening as the interrogating counsel twists the data to fit the counsel's particular take on the crime scenario. Given that most attorneys are loathe to admit ignorance of matters scientific, rare indeed is the counsel who, having done her homework, catches her adversary's verbal legerdemain, and with pointed and well thought out cross or rebuttal questioning, does grievous injury to her opponent's credibility. Rarer still are cases where GSR evidence so clearly supports one side's story that no explanation of the technical data is necessary. Consequently, for the sake of justice, the testifying forensic scientist bears the duty of, as much as possible, educating the jury to the deeper, less obvious meanings of the GSR evidence.

How does the forensic GSR expert guarantee that the jury will receive the straight story? How does the forensic GSR expert divine the less obvious meanings of the GSR evidence? Certainly, independent study and experience are crucial to an effective forensic scientist. Especially so with GSR evidence where the variables are so numerous that a forensic expert can only build credible confidence by studying every aspect of the dynamics of a discharging firearm. The GSR expert must study more than just ammunition and weapons; the expert must also examine effects of weapon positions, interposed targets and debris, target surface textures, shot sequencing, and crime scene evidence collection. In addition, to truly testify authoritatively, the GSR expert should examine

You work in forensics and you don't know what FUBAR means?

James (Jamie) Crippin, Colorado Bureau of Inv.



GSR: Keeping the Story Straight- *Continued*

(Continued from page 10)
the significance and weight of GSR evidence through contamination studies, including the presence of environmental false positives and the frequency of incidental GSR in selected populations.

The forensic GSR scientist has the power to determine how effectively GSR evidence will be presented in Court. Well-presented GSR evidence testimony with thought out implications will add weight to the most likely crime scenario. Courts will take notice and the forensic scientist can end the underutilization and misapplication of GSR evidence. The choice here is more clear cut than that usually presented to the Court: Have poorly trained forensic scientists and technicians testify only to the presence or absence of GSR, vulnerable to clever legalistic twists, or have the well-trained forensic GSR experts, flush with the knowledge gained from appropriate independent studies, help the jury decide the straight story.

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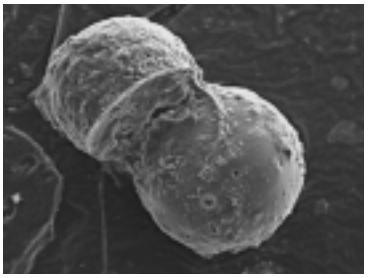

FYI!

A reminder of upcoming events:

SCANNING 2001 meeting will be held May 5-7, 2001, at The Roosevelt Hotel, New York, New York. The meeting will include short courses, scientific sessions, social events, and student awards. You can find more information by visiting http://www.scanning.org/scanning2001/travel.html

Southwestern Association for Forensic Scientist (SWAFS) will be held at the historic Sheraton Gunter Hotel in **San Antonio, TX** on **November 5-8, 2001** at a rate of $70.00 per night. You can find more information about **SWAFS** by visiting http://www.swafs.org. For additional information or reservation information please contact Gustavo De Leon at the Bexar County Criminal Investigation Laboratory at (210) 335-4148.

An expert, as the word imports, is one having had experience. No clearly defined rule is to be found in the books what constitutes an expert. Much depends upon the nature of the question in regard to which an opinion is asked.

Oil Co. v. Gilson, 63 Pa. St. 146, 150 (1869) (Quoted in "Scientific and Legal Applications of Bloodstain Pattern Interpretation" Ed. Stuart H. James, page 131)