S&B NONTOX Ammunition in Criminal Casework

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Typical Gunshot Residue Analysis

- Small Arms Percussion Primers
  - Explosive, initiator
  - Oxidizers
  - Fuel
  - Frictionators
  - Sensitizers
  - Binders
Typical Gunshot Residue Analysis

- Sinoxid “without rust” primer formulation
  - Lead styphnate
  - Tetrazene
  - Barium nitrate
  - Lead dioxide
  - Antimony trisulfide
  - Calcium silicide
Typical Gunshot Residue Analysis

- Bulk analysis
  - Elevated levels of the elements
  - In proper proportions

- Particle analysis
  - Elemental composition
  - Morphology
Experience with Atypical Primers

- 1996 MRP (Magtech Recreational Products)
  - Primers purchased from CBC (Companhia Brasileira de Cartuchos)
- 1987 – 1995 Various Calibers
  - Priming Mixture 5067
    - Barium nitrate 60%
    - Lead styphnate 38%
    - Tetrazene 2%
Experience with Atypical Primers

- Test results from typical case guns
  - Six different 9mm firearms test fired
    - 1 or 2 shots under ideal test fire conditions
  - All test results inconclusive
    - Lack of elements/unacceptable ratios
  - Discharged cartridge cases antimony free
    - AAS and SEM/EDX
Sellier and Bellot NONTOX

- Promoted as “green” ammunition
  - Discharge a large amount of toxic heavy metals… do not meet environmental standards.
- Sports, hunting, and practice shooting
- Pb/Ba/Sb/Hg free
“Non-toxic and non-corrosive ignition mixture”
- Initiator
  - Nitroesters or nitramines
- Sensitizer
  - Tetrazene or derivatives of tetrazoles
- Oxidizers
  - Oxides and peroxides of metals
- Fuel
  - Amorphous boron
“Non-toxic and non-corrosive ignition mixture”

20 different examples of formulations

- Tetrazene 25%
- PETN 25%
- Potassium nitrate 33.5%
- Boron 6%
- Nitrocellulose 0.5%
- Glass 10%
Availability

- Sellier and Bellot recently purchased by CBC
  - 7.65/.32 auto
  - 9x19 and 9x21
  - .357 magnum
  - .38 special
  - .40 S&W
  - .45 ACP
- Magtech Ammunition sole importers into US
- 9mm and 40 S&W available on-line
Loss of PGSR Particles

Number of shots fired

Total number of particles

Number of shots fired
Fundamental Questions

- How many discharges before false negative test results?
- How will a lead free primer affect the sodium rhodizonate test for distance determinations?
Typical Test Results

Automated test results

- Antimony 44
- Barium 362
- Ba-Sb 22
- Lead rich 19
- Lead-Antimony 5
- Lead-Barium 23
- Pb-Ba-Sb The “X” Factor
Eventual False Negative Results

- **X factor**
  - **X greater than 1**
    - None of the particles are confirmed
      - Don’t meet identification criteria
    - Don’t meet threshold values
    - Red flag
  - **X = 0**
    - No particle meets the sorting criteria
      - Confident negative lab report
“Gunshot Residue Analysis by Scanning Electron Microscopy/Energy Dispersive X-Ray Spectrometry”
7. Data Analysis

7.1.3 Particles *characteristic* of GSR (that is, most likely associated with the discharge of a gun) will have the following elemental composition:

7.1.3.1 Lead, antimony, barium
Characteristic PGSR Particle

Residue from a NONTOX discharge
Doesn’t Meet Criterion

Residue from NONTOX discharge
7. Data Analysis

7.1.3.2 It is common for additional elements to become incorporated into particles containing these elements. (Pb/Sb/Ba)

Potassium
Non-verified PGSR Particle

Residue from NONTOX discharge
Airbag Residue Particle

2003 Ford van passenger’s side

counts

2550

2040

1530

1020

510

0

0

1

2

3

4

5

6

7

8

9

10

11

12

keV

Pb

Pb

Pb

Ba

Ba

Ba

Sb

Sb

K

Si

Al

Cl

Si

Al

K

Sb

Sb

Ba

Ba

Ba

Pb

Pb

Pb

10 µm
Test Fire Technique

- Hands in “normal” condition
  - Relatively clean
- Ideal Sampling Conditions
  - Very thorough
  - “Willing” suspect
- Factors not taken into consideration
  - Particle loss/time
  - Environmental loss
Series 1: 9mm single shot

- Ruger model P89
- 1 round Sinoxid discharged as baseline.
- 1 NONTOX fired daily
  - Left hand sampled before as background
  - Right hand sampled immediately after discharge
Test Fire Results

- Typical PGSR particles

Residue from NONTOX discharge
Test Fire Results

- Clusters
  - Large, brittle conglomerates of particles
  - Source of sequential PGSR particles
Particle Clusters

Counts

Ba
Sb
Pb
K
Cu
Sb
Ba
Pb
Pb

50 μm
Particle Clusters

counts
0 510 1020 1530 2040 2550
Pb Pb Pb Ba Ba Ba Cu Cu Si K

keV
0 1 2 3 4 5 6 7 8 9 10 11 12

50 µm
Particle Clusters

Counts

Ba
Pb
Sb
Cu
K
Al
Zn

keV

0 1 2 3 4 5 6 7 8 9 10 11 12

50 μm
Last 10 Test Fires

![Graph showing the total number of shots fired and detected characteristic PGSR particles for 9mm NONTOX ammunition across 10 test fires.](image-url)
Last 10 Test Fires

9mm NONTOX

Verified characteristic PGSR particles

Total number of shots fired

38 39 40 41 42 43 44 45 46 47
Last 10 Test Fires

- Load = consistent PGSR particles/area
- Red flag

![Graph showing the total number of shots fired and consistent particles/area analyzed for 9mm NONTOX bullets over 10 test fires. The graph displays peaks and troughs in particle count over the shots fired, with a specific focus on the 9mm NONTOX ammunition.](image-url)
Last 10 Test Fires

9mm NONTOX

<table>
<thead>
<tr>
<th>Total number of shots fired</th>
<th>Number of lead particles detected</th>
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</thead>
<tbody>
<tr>
<td>38</td>
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<td>39</td>
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<td>46</td>
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<td>47</td>
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</tbody>
</table>
Cartridge Components

Brass primer cup  Nickel anvil
Cartridge Component

- Potassium coating on smokeless powder
Cartridge Component

- Potassium coating on smokeless powder
Cartridge Component

- Particulate lead in smokeless powder
- Present in 9mm, .40 S&W, 38 spl.
Series 2: 40 S&W 4 shot bursts

- 40 Smith and Wesson model SW40V
- 1 Sinoxid discharged
- 1 NONTOX discharged as baseline
- 4 NONTOX discharged daily
  - Left hand sampled as background
  - Right hand sampled immediately after discharge
Last 20 Test Fires

40 S&W NONTOX

Detected characteristic PGSR particles

Total number of shots fired

46-49 50-53 54-57 58-61 62-65
Last 20 Test Fires

40 S&W NONTOX

Verified characteristic PGSR particles vs. Total number of shots fired

46-49 50-53 54-57 58-61 62-65
Last 20 Test Fires

40 S&W NONTOX

Consistant particles/area analyzed

Total number of shots fired

46-49: 3.5
50-53: 3.5
54-57: 3.5
58-61: 3.5
62-65: 1.5
Last 20 Test Fires

40 S&W NONTOX

<table>
<thead>
<tr>
<th>Total number of shots fired</th>
<th>Number of lead particles detected</th>
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<tr>
<td>46-49</td>
<td>250</td>
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<tr>
<td>50-53</td>
<td>150</td>
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<td>54-57</td>
<td>50</td>
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<tr>
<td>58-61</td>
<td>50</td>
</tr>
<tr>
<td>62-65</td>
<td>50</td>
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</tbody>
</table>
Series 3: 38 special 5 shot capacity

- Ruger model SP101
- 1 Sinoxid discharged
- Gun “cleaned” by Intern
  - Dust-off, paper towels, Q-tips
- 1 NONTOX discharge as baseline
- 5 NONTOX fired daily
  - Left hand sampled as background
  - Right hand sampled immediately after discharge
Last 20 Test Fires

![Graph showing detected characteristic PGSR particles vs. total number of shots fired for .38 special NONTOX ammunition. The graph displays a downward trend from 27-31 to 42-47 total number of shots fired. The y-axis represents detected characteristic PGSR particles ranging from 0 to 1400.]
Last 20 Test Fires

.38 special NONTOX

Verified characteristic PGSR particles

Total number of shots fired

27-31
32-36
37-41
42-46
Last 20 Test Fires

.38 special NONTOX

Consistant particles/area analyzed

Total number of shots fired
Last 20 Test Fires

Total number of shots fired

Number of lead particles detected

.39 special NONTOX

27-31
32-36
37-41
42-46

0
100
200
300
400
500
600
Distance Determination

“A Versatile Technique for the Investigation of GSR Patterns on Fabrics and Other Surfaces: m-XRF” Berendes et al (BKA) JFS Sept 2006

- “Nontox ammunition containing only potassium as a detectable metallic composition of the primer.”
- Fired at 5 cm into target
Distance Determination

“The Sodium Rhodizonate Test: A Chemically Specific Chromophoric Test for Lead in Gunshot Residues” Dillon (FBI) AFTE Journal July 1990

- “primarily due to the lead compounds typically found in cartridge primer mixtures”
- “bullet/barrel interactions”
Distance Determination
Distance Determination
Distance Determination

- No visible soot
- No partially burnt smokeless powder
- Atypical vaporous lead results
- Problematic for Medical Examiners
  - Stippling and visual examinations
Series 4: 9mm with multiple shots

- Beretta Model 92D
  - Retired P.O.’s firearm
  - Not shot in 4+ years
- 150 shots fired rapidly
- 151st shot as test fire
- Additional shots fired
- Additional test fires
Last 40 Test Fires

Detected characteristic PGSR particles vs Total number of shots fired for 9mm NONTOX.

- Total number of shots fired: 151, 161, 171, 172, 181, 191.
- Detected characteristic PGSR particles range from 0 to 35.
Last 40 Test Fires

9mm NONTOX

Total number of shots fired

Verified characteristic PGSR particles

151 161 171 172 181 191
Last 40 Test Fires

9mm NONTOX

Total number of shots fired
Consistant particles/area analyzed

Consistant particles/area analyzed vs. Total number of shots fired.
Conclusions

- Positive PGSR test results possible with NONTOX ammunition
- False negative PGSR test results are possible with NONTOX in actual casework
- Difficult to remove all “memory effect” from weapon
- Distance determinations may be problematic
Acknowledgements

- ISP Forensic Science Command
- ISP Research and Development Laboratory
- Marc Pomerance – Firearms
- Radson Muradpejohi – Summer Intern
- Scott Rochowicz – Trace
- Kellen Hunter - Firearms
- Magtech Ammunition