

# **Sifting Through the Layers: The Application of Forensic Databases to Tape and Paint Analyses**



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# Use of Databases

- The Paints and Polymers Sub-Unit of the FBI Laboratory has multiple databases and sample collections to use to provide investigative leads to investigators.
- Duct Tape Collection archived in SLICE
- Paint Data Query for automotive paints

# Duct Tape Case

- Homicide, in which the victim had been wrapped in trash bags and duct tape
- Request: Attempt to determine the manufacturer of the tape





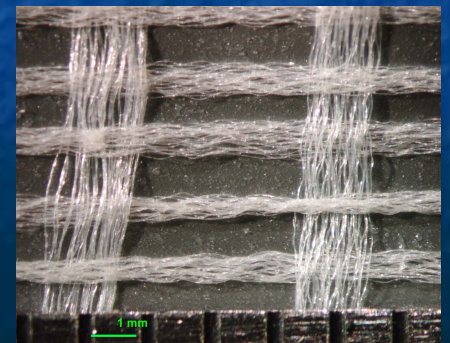
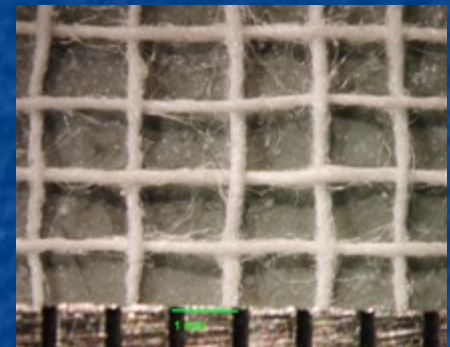
# Analytical Scheme

Visual and Microscopic Examinations

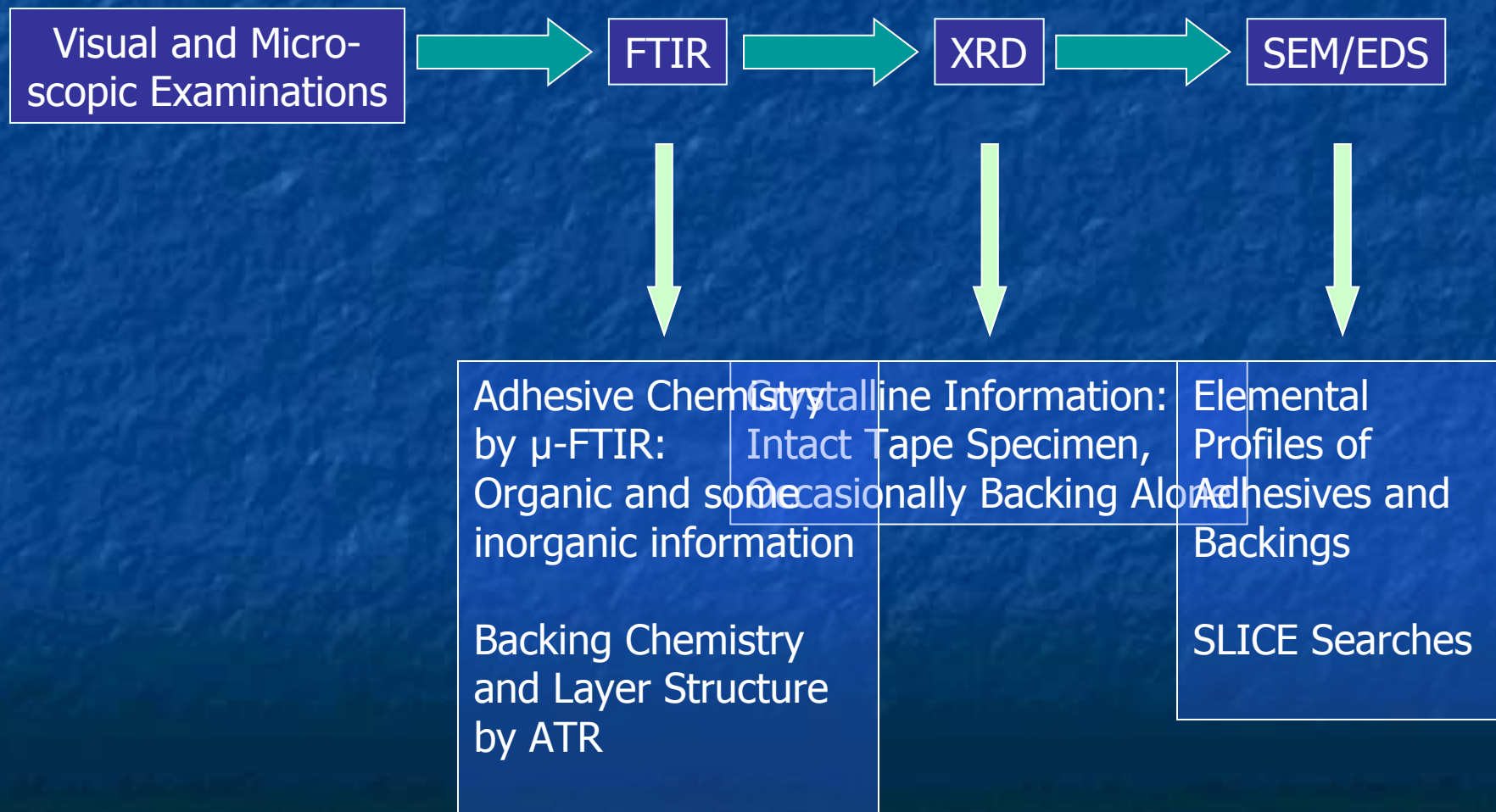


## Physical Characteristics:

- Backing and Adhesive Color
- Backing Appearance
- Backing Layer Structure
- Width
- Thickness
- Scrim Count
- Fabric Weave
- Yarn Construction
- Yarn Composition



# Analytical Scheme



# Duct Tape Collection

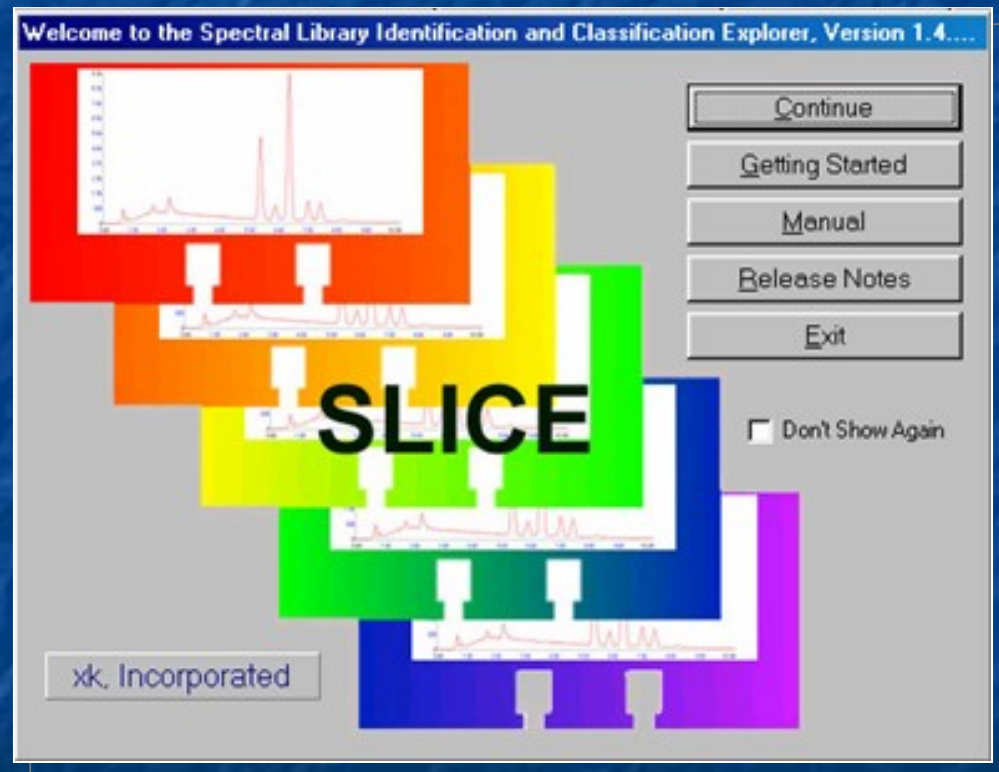
- 80+ tapes (now expanded to ~400)
- Acquired by FBI personnel
- Purchased at common retail stores or obtained from manufacturing plant visits
- Most marketed as general-purpose or economy-grade
- Variety of manufacturers





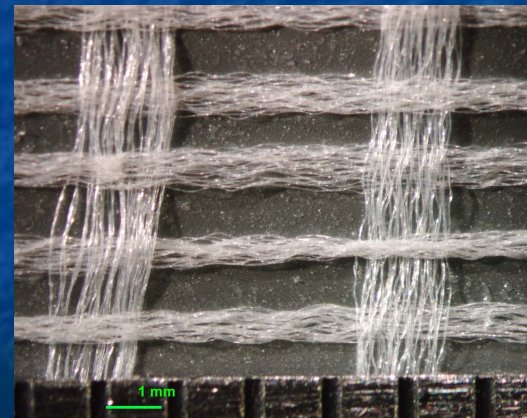
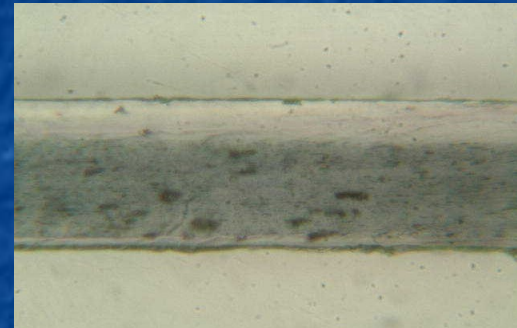
# SLICE Background

- Spectral Library Identification and Classification Explorer (SLICE)
- Archival program for storing EDS data with data entry capabilities
- Conventional format modified to allow for inclusion of specific characteristics of tape
- Collaboration between FBI, FDLE, and MSHP

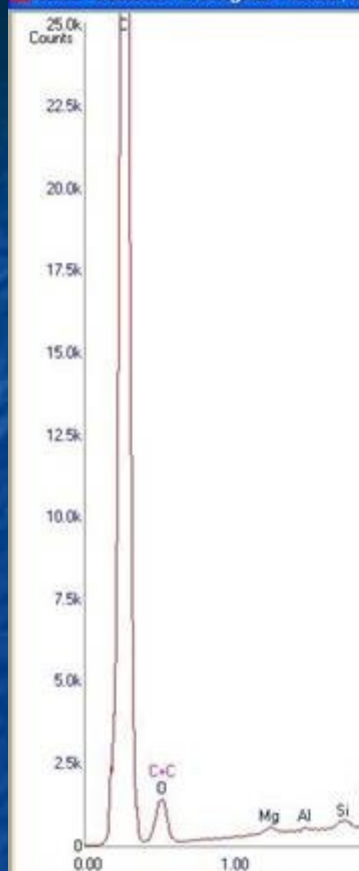


# Duct Tape Case

- Full protocol completed
- Relatively unique physical characteristics
  - Multi-layered backing
  - Textured yarns in both the warp and fill directions
- Relatively common chemical composition







Presumed Bengal C Location 1  
 Presumed Bengal C Location 2  
 Presumed Bengal C Location 3  
 Q1\_1adhesive  
 Q1\_1backing  
 Q13 adhesive  
 Q13 backing  
 Q8a  
 Q8b  
 Radio Shack 362K Location 1  
 Radio Shack 362K Location 2  
 Radio Shack 362K Location 3  
 Radio Shack 362K Location 4  
 Radio Shack Location 1

## SLICE Search

By keyword

☐ Match all  
☐ Match any

☐ Exact  
☐ Contains

Search In

☒ Name  
☐ Material  
☐ Notes  
☐ Manufacturer  
☐ Lab  
☐ Instrument

By best fit

☒ Entire range  
☐ Selected range

Low energy (keV) 0

High energy (keV) 20

By composition

Element

☐ Relative Percent  
☐ Known/Weight Pot.  
☐ Weight Percent  
☐ Oxide Percent

 50 %  
 and  
 %  
 Add  
 Delete  
 Clear

☐ less than  
☐ greater than/equal to  
☐ between

By date

☐ On  
☐ Between  
☐ Before  
☐ After  
 3/14/2005  
 and  
 3/14/2005  
 Calendar

By instrument parameters

☐ Accelerating Voltage  
☐ Detector type  
☐ Tube voltage  
☐ Window Material

By Properties

Properties Fabric

☒ Scrim (per in.) 24 ± 1 7 ± 1  
☐ Warp  
☐ Fill  
☐ Yarn  
☐ Description  
☐ Fluorescence  
☒ Weave Pattern Plain (basket)

By classification

- ☐ cases
- ☒ MANUFACTURED
  - ☐ abrasives, cutting tools
  - ☐ adhesives
  - ☐ alloys
  - ☐ art/craft products
  - ☐ automotive
  - ☐ building products
  - ☐ ceramics
  - ☐ COMPOUNDS
  - ☐ culture media
  - ☐ currency
  - ☐ dental
  - ☐ documents
  - ☐ drugs (illicit)
  - ☐ electric
  - ☐ electronic
  - ☐ explosives
  - ☐ fibers (synthetic)
  - ☐ fingerprint powder
  - ☐ firearms
  - ☐ food products
  - ☐ food supplements, vitamins
  - ☐ friction materials
  - ☐ gasketing
  - ☐ glass
  - ☐ household products
  - ☐ ink
  - ☐ lubricants
  - ☐ medical
  - ☐ military
  - ☐ miscellaneous materials
  - ☐ paints and coatings
  - ☐ personal products
  - ☐ pharmaceuticals
  - ☐ plastic
  - ☐ pyrotechnics
  - ☒ tape
    - ☐ duct tape
      - ☒ adhesive
      - ☐ backing
    - ☐ electrical tape
    - ☐ thread locking and sealing
    - ☐ welding/soldering supplies
- ☐ NATURAL
- ☐ QA/QC
- ☐ research
- ☐ TEMPORARY
- ☐ trash bin

OK

Search last results

Cancel

Search Criteria

Load search...

Save search...

Result Option

☒ Alternate colors

Search Options

☐ Intelli-Search☐ Match☐ Ports 1☐ Fax 0

Use Source

☒ SEM/EDS☐ XRF☐ TEM/EDS

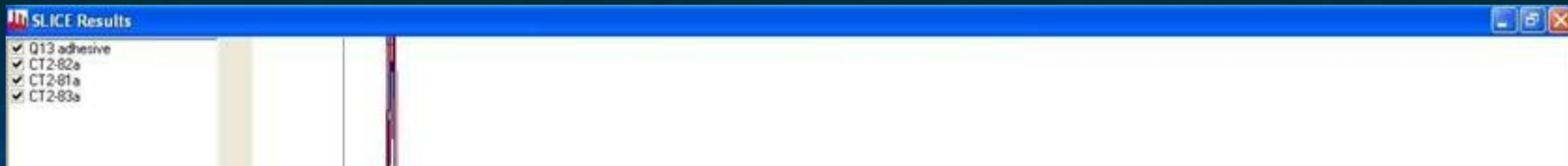
Material Category

Tape

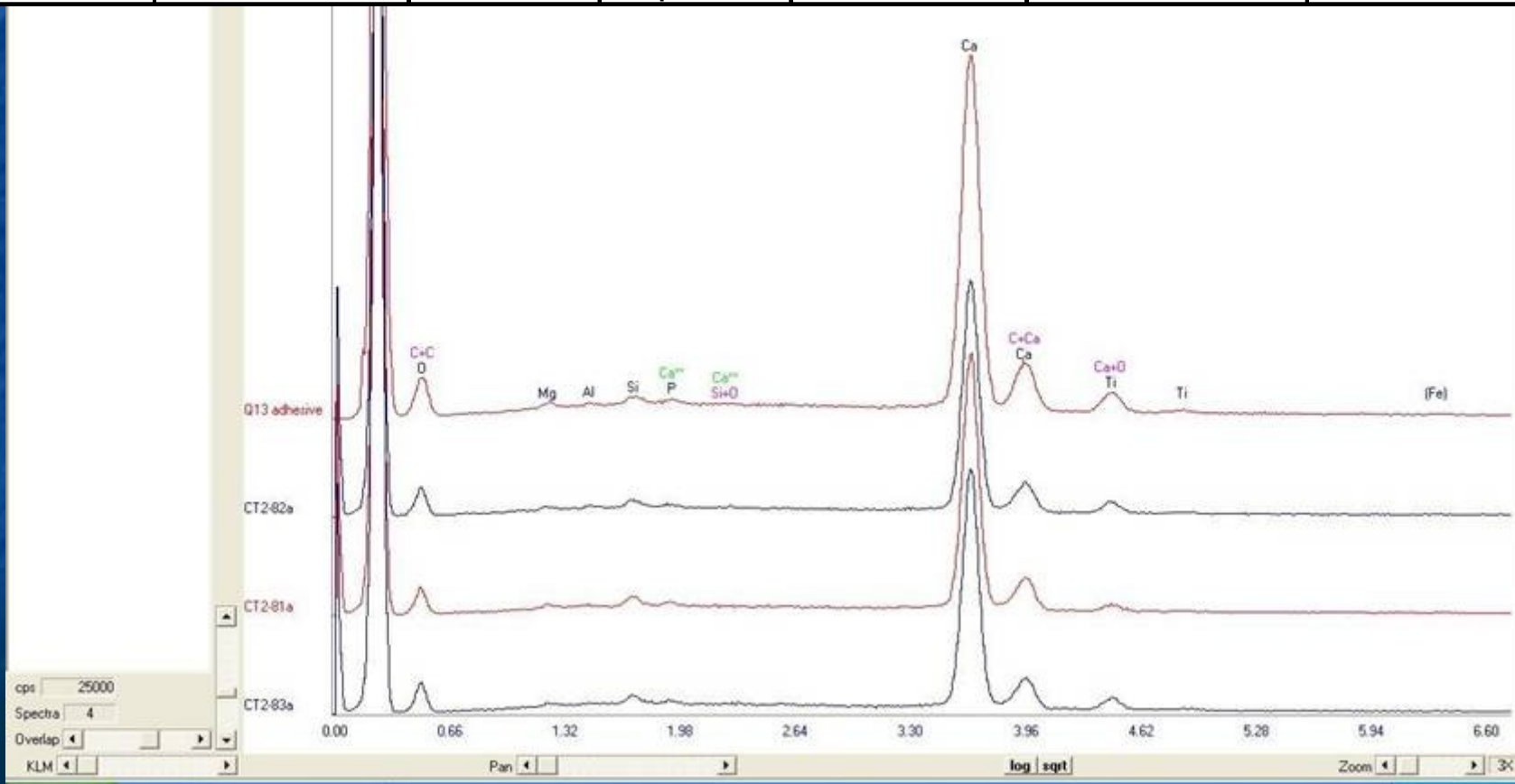
10.00 keV

Zoom Vertical Zoom

Instrument Elements  
Manufacturer Laboratory
 11  
 OL J5M-6300  
 .H  
 16/2006  
 listed

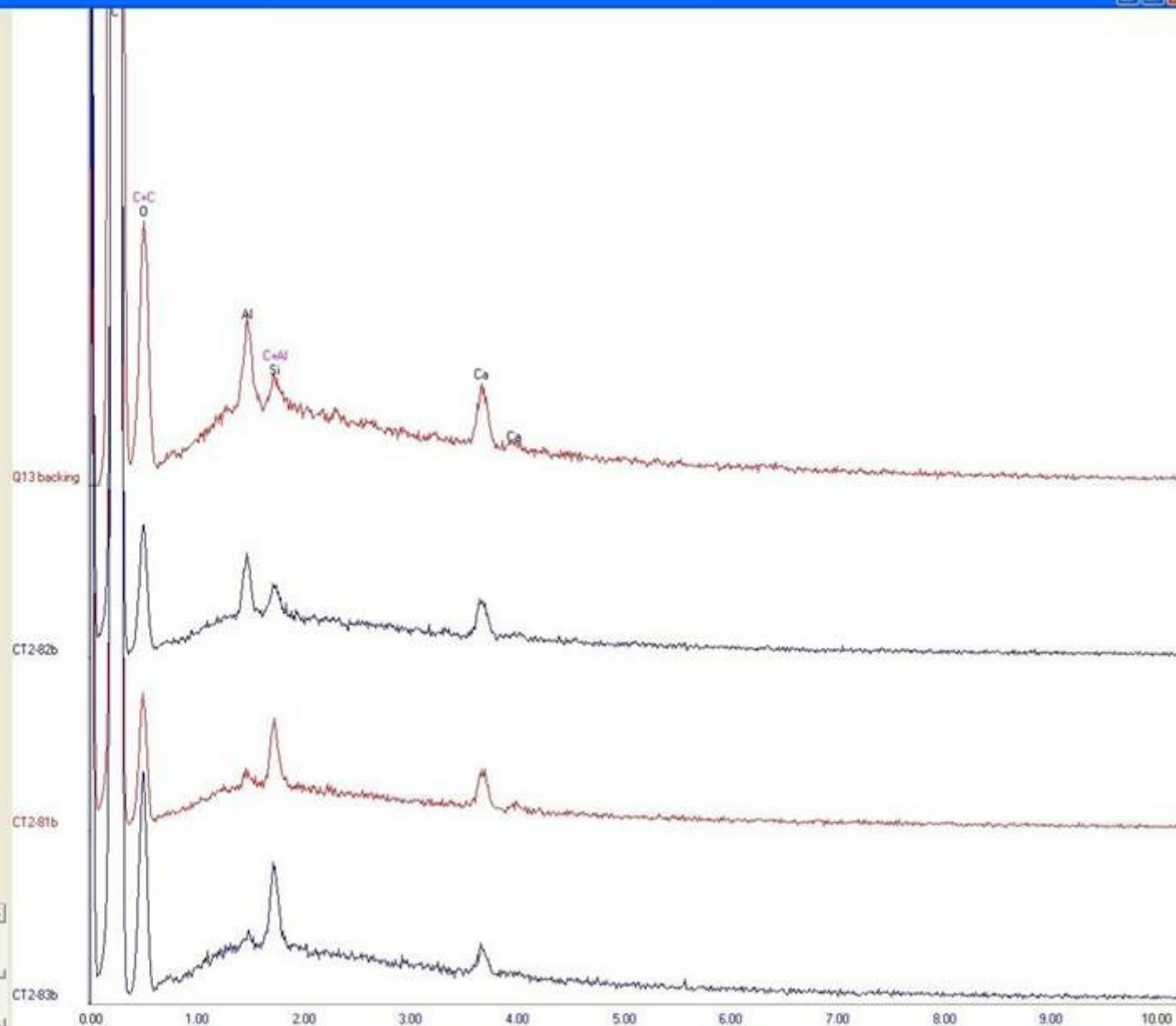


Sample	Manufacturer	Film type	Weave	Scrim Count	Fluorescence	Construction
Q13		smooth	plain	24/7	no	textured w/f
CT2-81	3M	smooth	plain	25/7	no	textured w/f
CT2-82	3M	smooth	plain	25/7	no	textured w/f
CT2-83	3M	smooth	plain	24/7	no	textured w/f



# SLICE Results

- ✓ Q13 backing
- ✓ CT2-82b
- ✓ CT2-81b
- ✓ CT2-83b



cps 2500

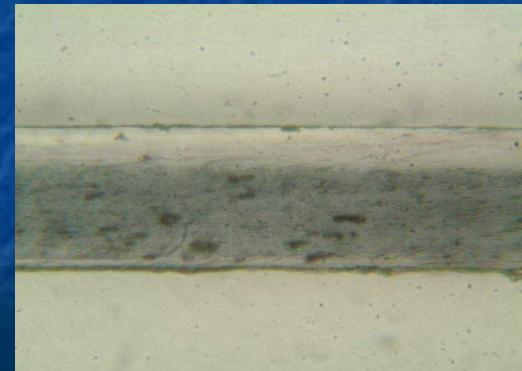
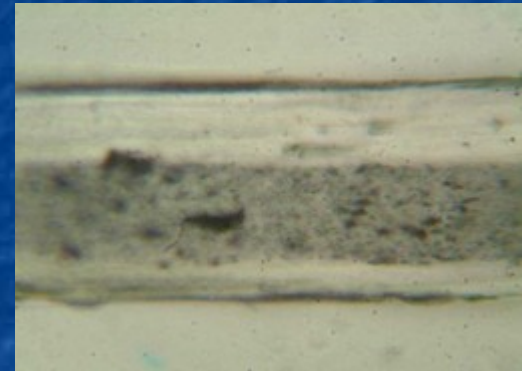
Spectra 4

Overlap



# Duct Tape Case

- Two candidates eliminated based on backing layer structure
- Final candidate could not be eliminated following comparison of data from any technique



# Duct Tape Case

- 3M Scotch® Home and Shop
- Also known as 3M™ duct tape 3900
- General purpose tape manufactured by 3M in London, Ontario, Canada
- Unable to determine the distributor of a tape specimen



# Automotive Paint Case

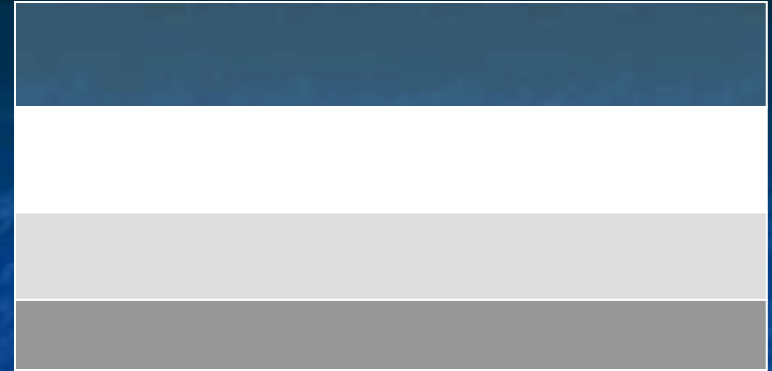
- Hit-and-run
- Victim was struck and killed by an unknown vehicle while lying on the road
- Request: Examine the victim's clothing and vehicle parts left at the scene to provide any possible vehicle information



# Automotive Paint Case

- Three paint systems encountered
  - A. White non-metallic paint chips found in victim's clothing
  - B. Light-colored metallic paint chips found in victim's clothing
  - C. Silver metallic painted plastic parts left at the scene

# Paint System A



- Following microscopic, FTIR, and SEM/EDS analyses, performed spectral searches on the OU1 and OU2 layers.
- Four candidates following comparisons of OT2, OU1, and OU2 layers. All were General Motors vehicles from the Flint, Michigan, plant from 1994-1995.

# Paint System B



- Following microscopic, FTIR, and SEM/EDS analyses, performed spectral searches on the OT2, OU1, and OU2 layers.
- Reasonable hits following comparison of all layers included four samples from GEN LRD 2000 and one each from GEN LRD 2002, GEN OSH 2001, GEN OSH 2005, and GEN WEN 2000.



# Paint System C



- Following microscopic, FTIR, and SEM/EDS analyses, performed spectral searches on the OT2 layer.
- Make/model/year searches were unsuccessful.

# Automotive Paint Case

- Since paint from at least two different vehicles was found, the contributor was contacted for more information.
  - The victim's vehicle had rolled over him prior to the hit-and-run incident.
  - The victim was driving a white 1994 GM van manufactured in Flint, Michigan.

Therefore, no subsequent exams conducted on Paint System A. However, this provides an example of a successful PDQ search.

# Paint System B



- Pulled out samples of 8 PDQ hits (5 different plant/year combinations).
- Microscopic comparisons eliminated 2 plants/years, leaving GEN OSH 2005, GEN LRD 2000, and GEN LRD 2002.
- Performed FTIR and SEM/EDS analysis on remaining candidates.



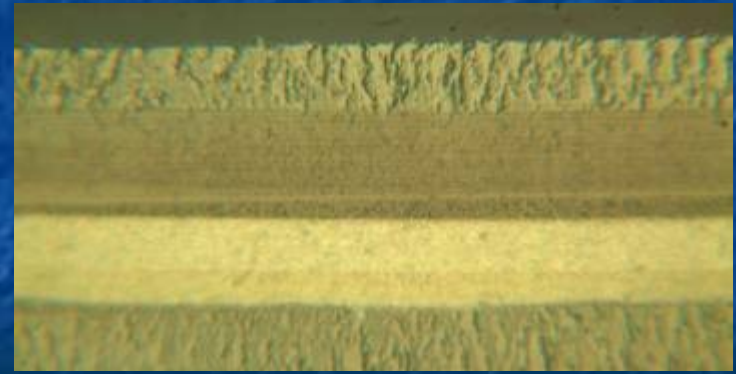
# Paint System B



- GEN OSH 2005
  - Slight color differences of primers relative to questioned sample

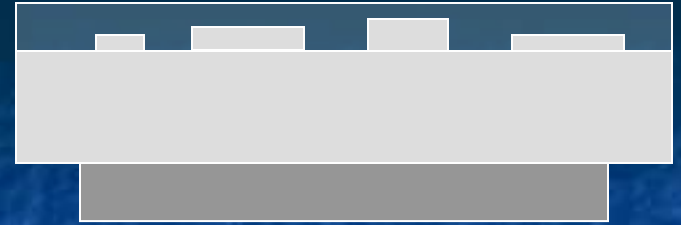


Questioned Sample

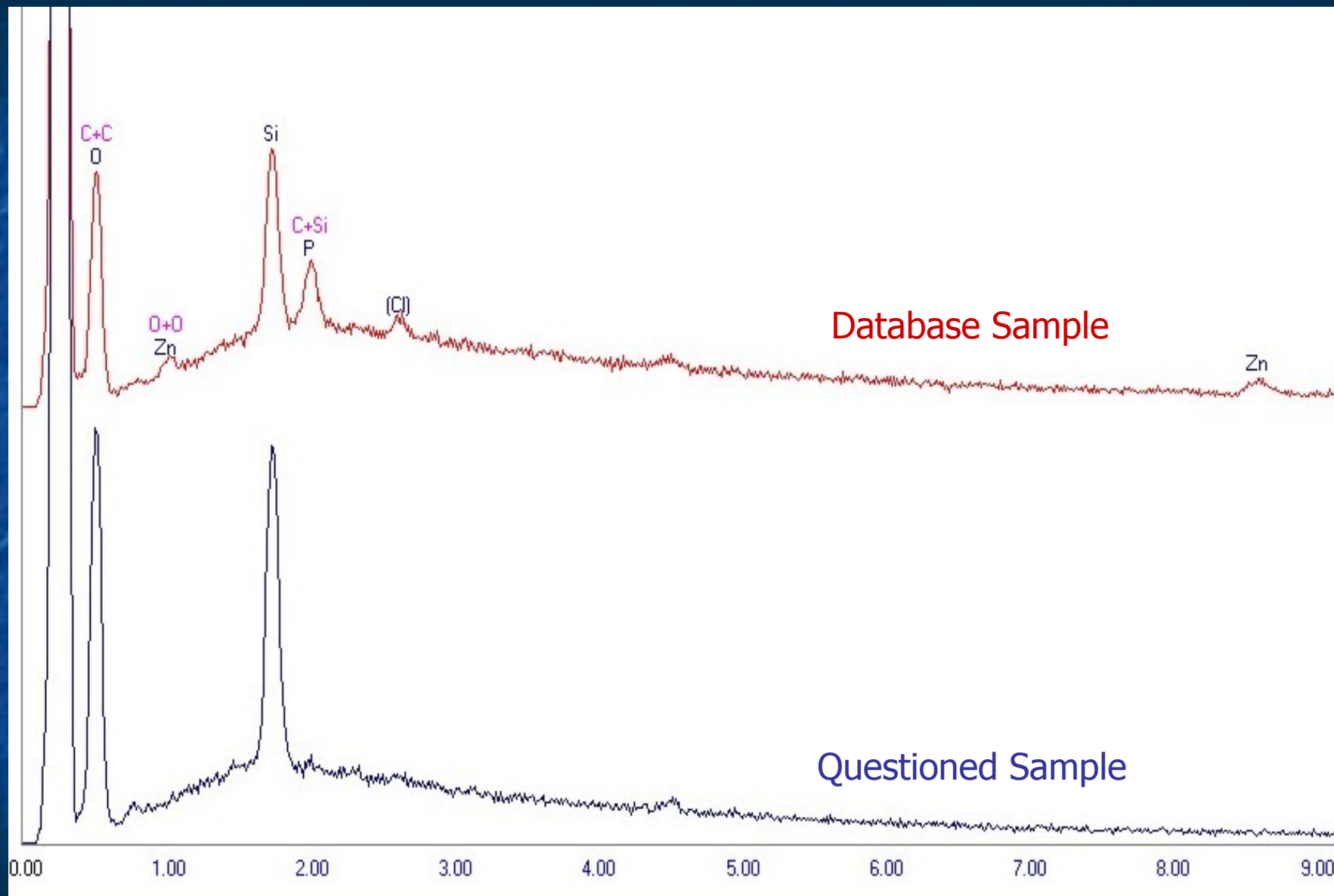


GEN OSH 2005

# Paint System B



- GEN OSH 2005
  - Slight color differences of primers relative to questioned sample
  - Slight peak width difference at  $1550\text{ cm}^{-1}$  of OT2 layers
  - Elemental differences between clearcoats



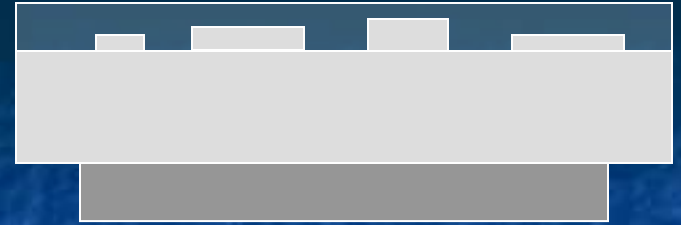


# Paint System B

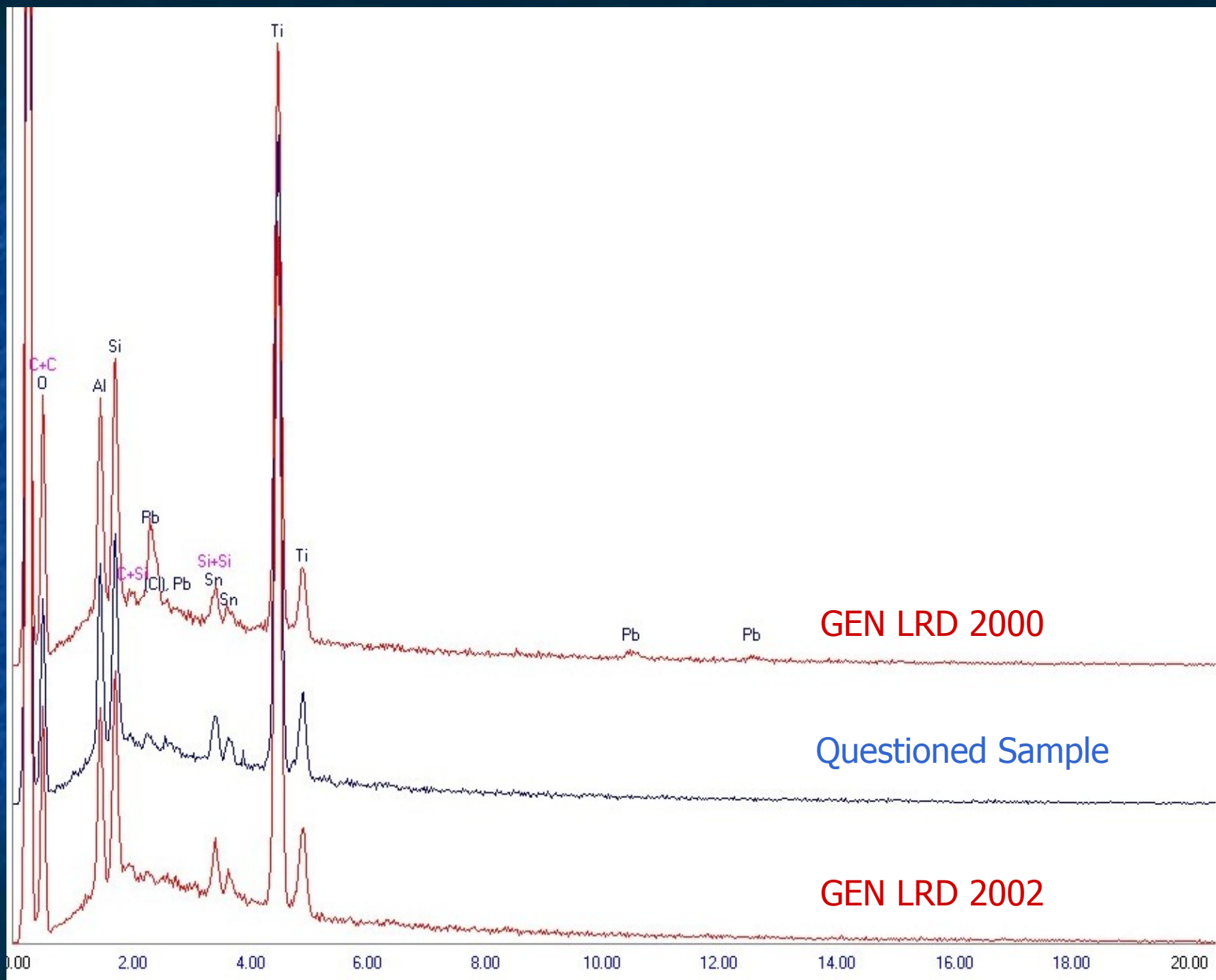


- GEN OSH 2005
  - Slight color differences of primers relative to questioned sample
  - Slight peak width difference at  $1550\text{ cm}^{-1}$  of OT2 layers
  - Elemental differences between clearcoats
  - Performed a PDQ search on other samples originating from GEN OSH but all were eliminated.

# Paint System B



- GEN LRD 2000 and GEN LRD 2002
  - These other two hits are from the same plant but from different model years
  - Relative colors of the primers consistent
  - IR spectra consistent
  - SEM analysis thus performed



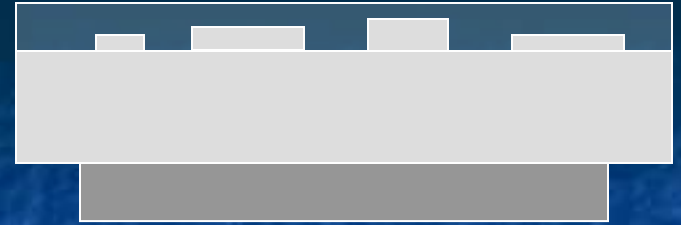


# Paint System B



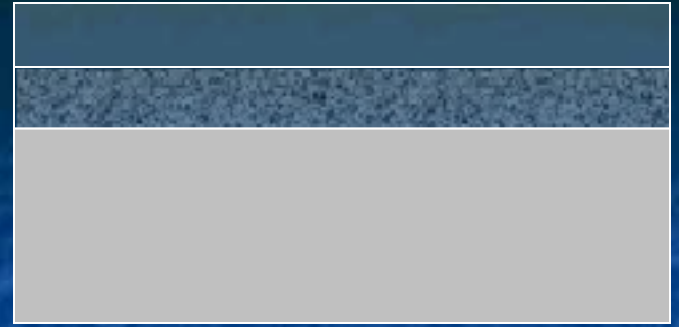
- GEN LRD 2000
  - A representative from LRD confirmed that MY 2000 was the last year this plant used Pb-based primers.
  - Next formulation change did not occur until MY 2006.

# Paint System B



- GEN LRD 2002
  - This sample could not be eliminated following all exams.
  - Based on the condition of the colorcoat, an accurate color evaluation could not be conducted.
  - The same LRD contact confirmed that no two-toned vehicles were produced at that plant during that time frame.

# Paint System C



- Using information on colors available at GEN LRD during the MY 2001-2005 time frame, color comparisons were conducted between the questioned sample and repaint pages.
- Questioned sample consistent with GM silver metallic paint color code of 8867. Color names included Ultra Silver Metallic and Silver Effect.



# Automotive Paint Case

- A partial VIN was constructed from the following information:
  - General Motors vehicle manufactured at the Lordstown, Ohio plant
  - Model year range of 2001-2005
  - During that time, LRD produced the Chevrolet Cavalier and Pontiac Sunfire.

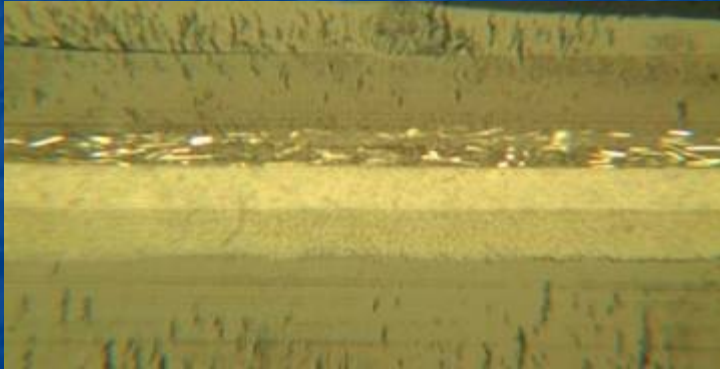


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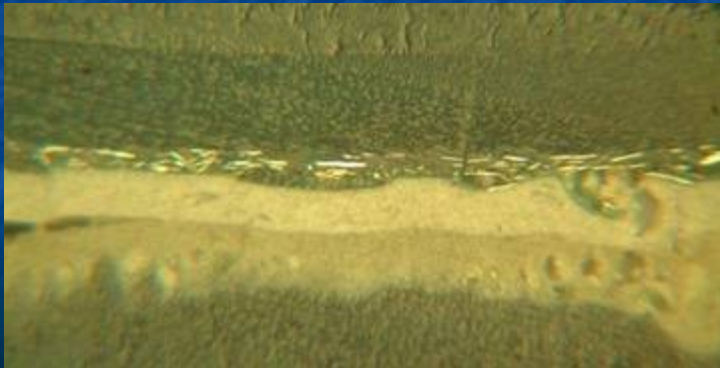




Questioned Sample



UOHL = GEN LRD 2000



UVAC = GEN LRD 2002



# Cross-sectioning Technique

