

THE ANALYSIS OF BLACK ELECTRICAL TAPE AS FORENSIC EVIDENCE

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Outline

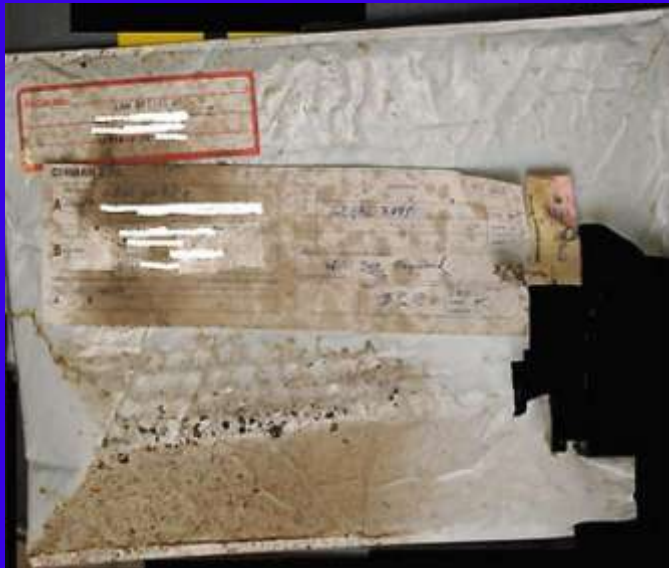
- ❖ Case Example
- ❖ Electrical Tape Analysis
- ❖ Characterization and Discriminating Power
 - ❖ Physical Properties
 - ❖ Chemical Composition
 - ❖ Fourier Transform Infrared Spectroscopy (FTIR)
 - ❖ Pyrolysis Gas Chromatography – Mass Spectrometry (PGC/MS)
 - ❖ Scanning Electron Microscopy – Energy Dispersive X-ray Analysis (SEM/EDX)
 - ❖ X-Ray Diffraction (XRD)
- ❖ Laser Ablation-Inductively Coupled Plasma-Mass Spectrometry (LA-ICP-MS) preliminary work



Case Example

Toronto “Letter Bomber” Adel Arnout, August 2007

- ❖ 3 bombs sent to roommate, handyman, lawyer
- ❖ Electrical tape comparisons provided link between bombs sent and Arnout’s residence



Can we discriminate between electrical tapes?



Recent Electrical Tape Studies

A. H. Mehlretter et. al.

- ❖ Journal of Forensic Sciences, 2011 p82-94.
- ❖ 85% discrimination based on analysis of adhesives

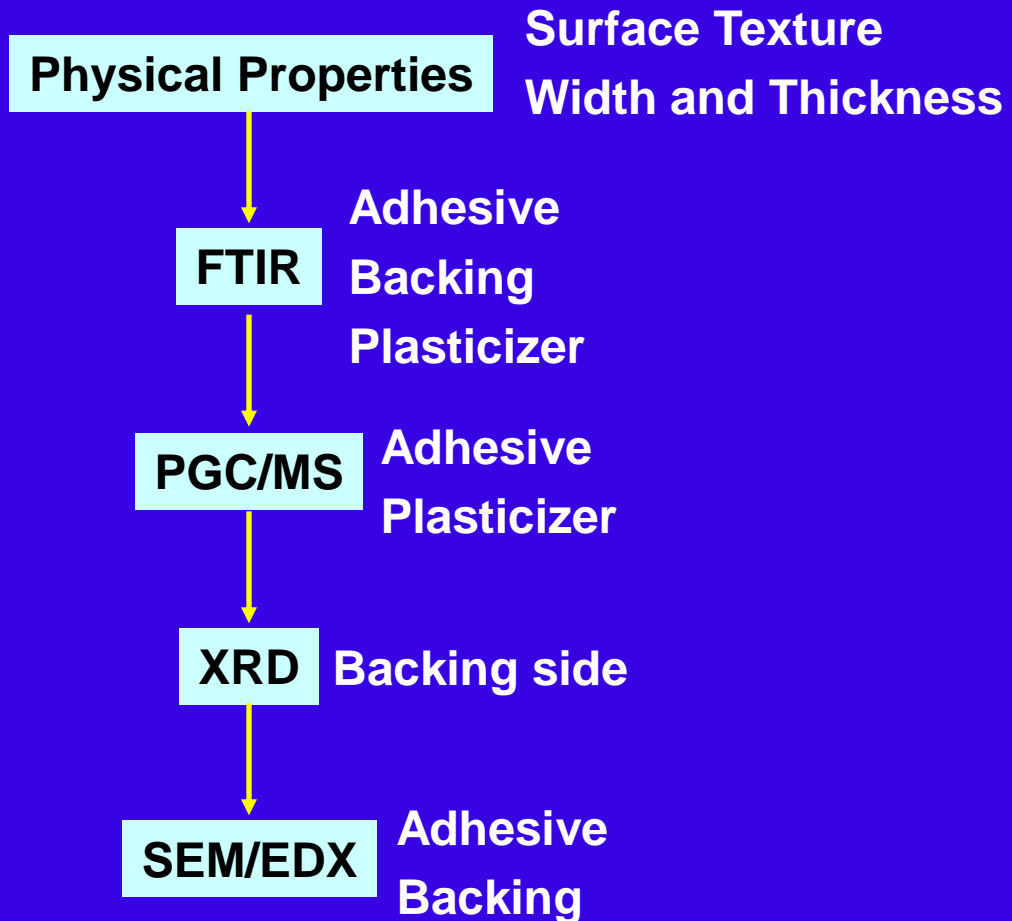
J. V. Goodpaster et. al.

- ❖ Journal of Forensic Sciences, 2007 p610-629.
- ❖ Journal of Forensic Sciences, 2009 p328-338.

Do these studies apply to electrical tapes available in Ontario?



Electrical Tape Analysis



Electrical Tape Analysis

- ❖ 78 Electrical Tapes obtained in Southern Ontario from stores and households
- ❖ Tapes were analyzed and compared
- ❖ Tapes grouped by chemical properties
- ❖ Tapes further discriminated by physical properties



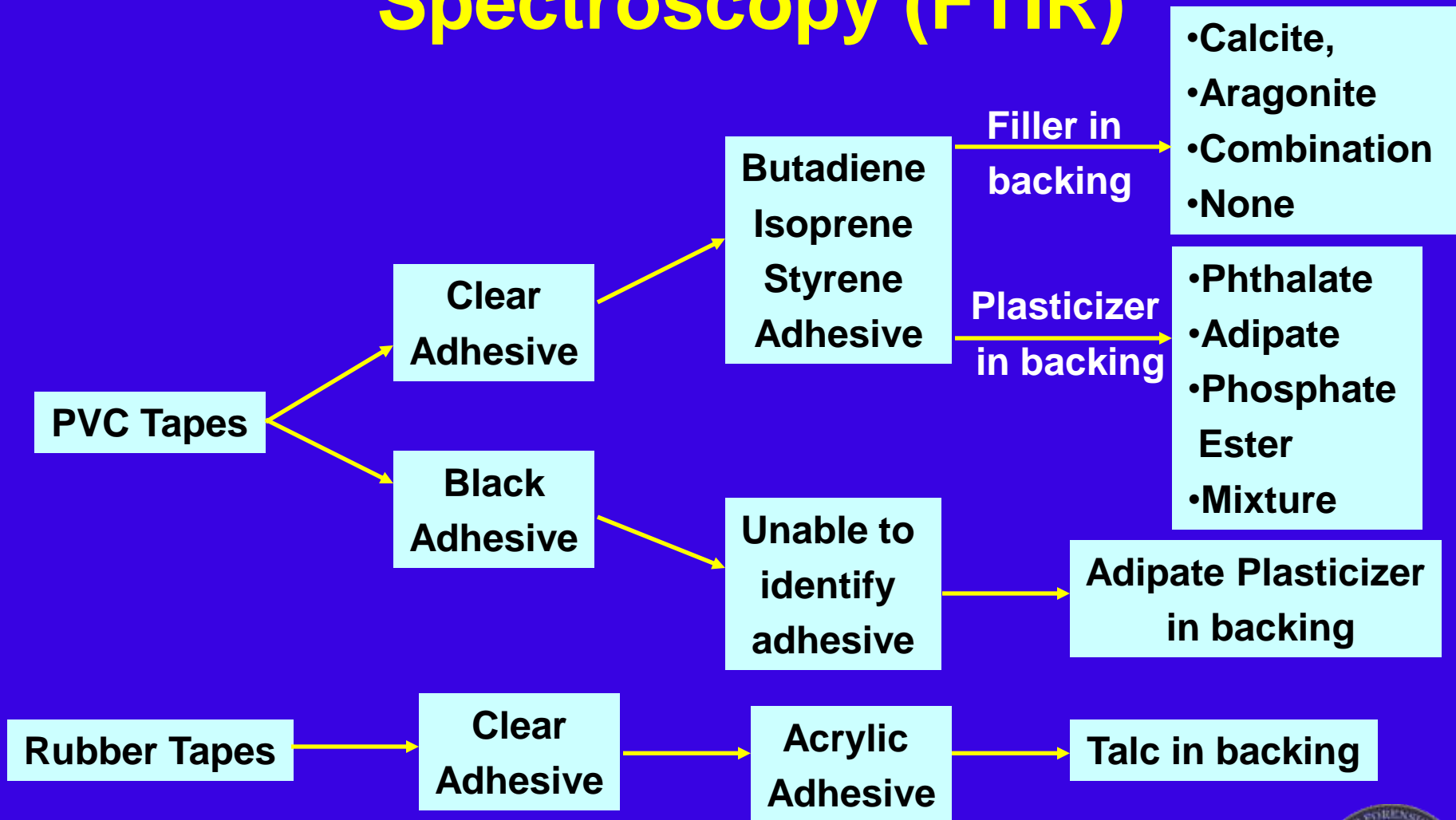
Electrical Tapes

Country	No of Tapes	No of Brands	MANUFACTURER
Taiwan	47	10	3
USA	16	4	1
China	14	9	3
Unknown	1	-	-
3 COUNTRIES	78 TAPES	23 LISTED BRANDS	7 LISTED MANUFACTURERS

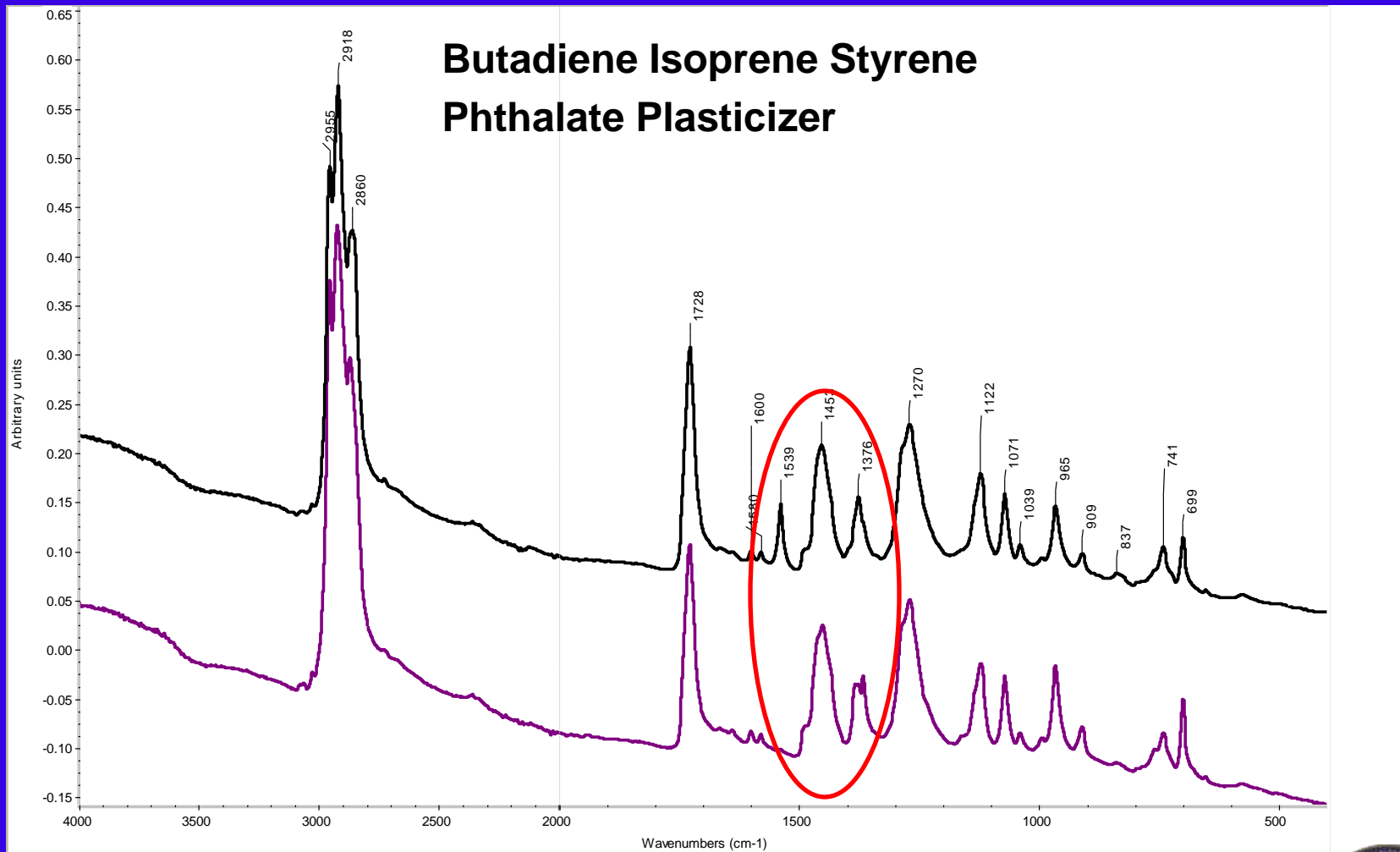
These Tapes Were Not Manufactured in Canada



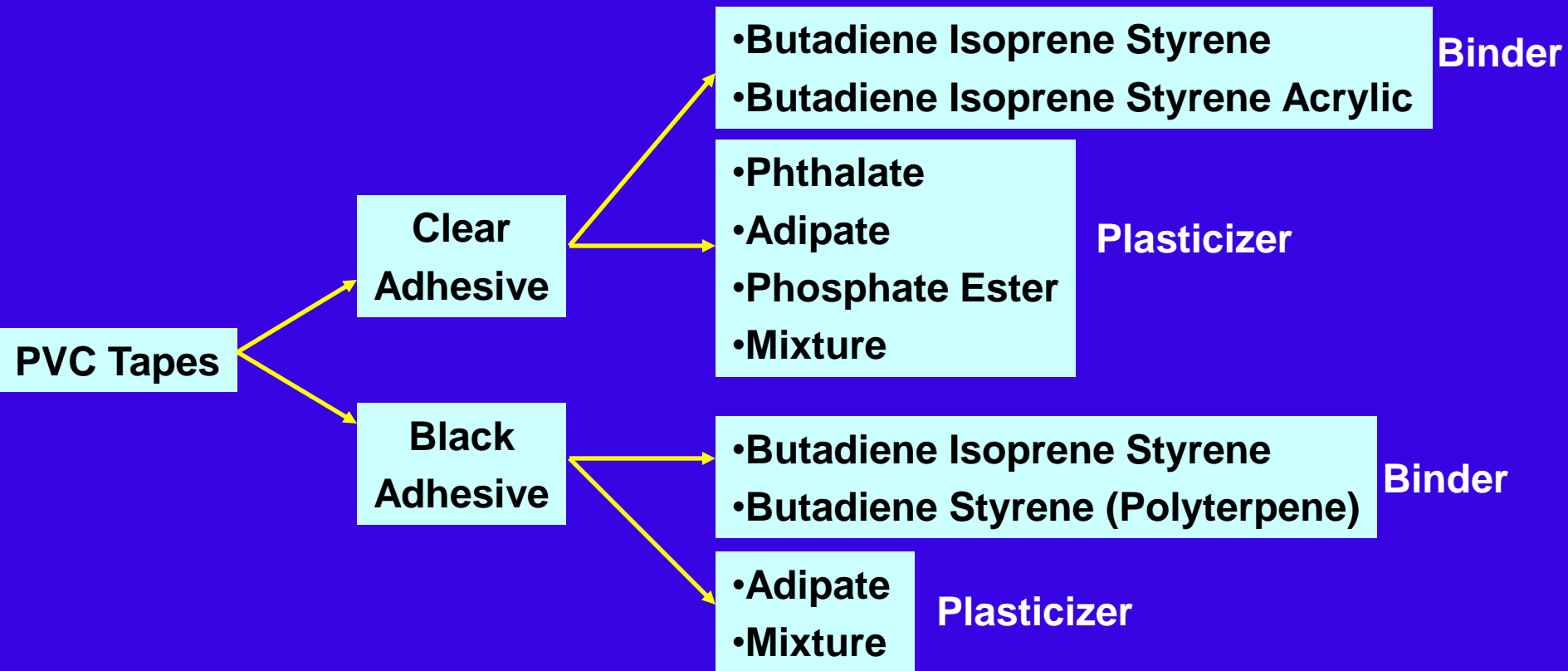
Fourier Transform Infrared Spectroscopy (FTIR)



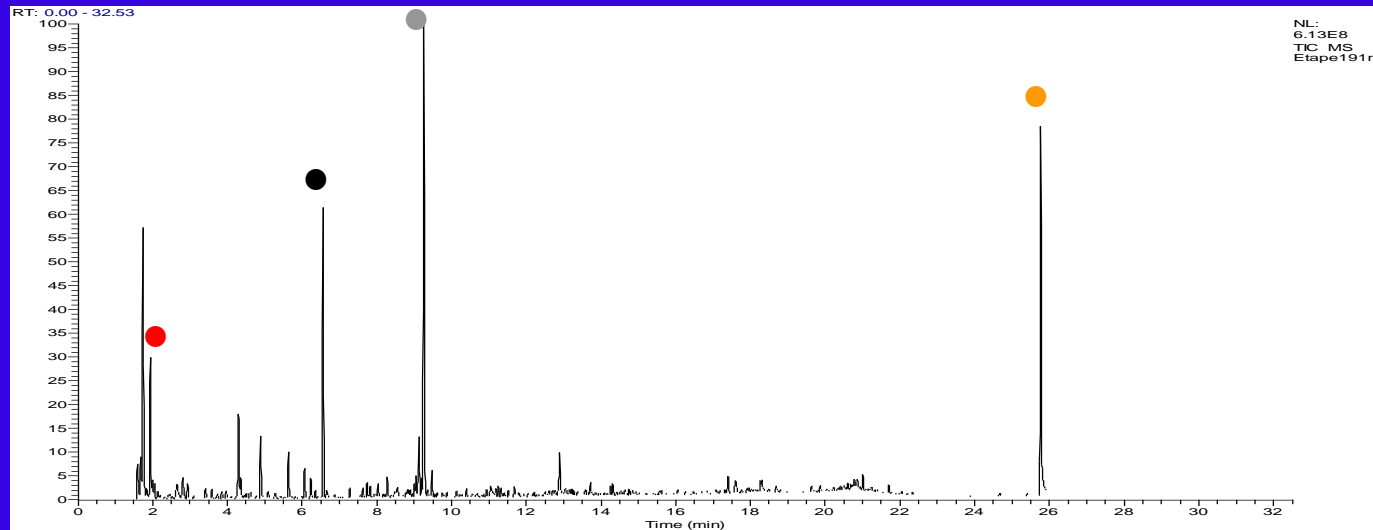
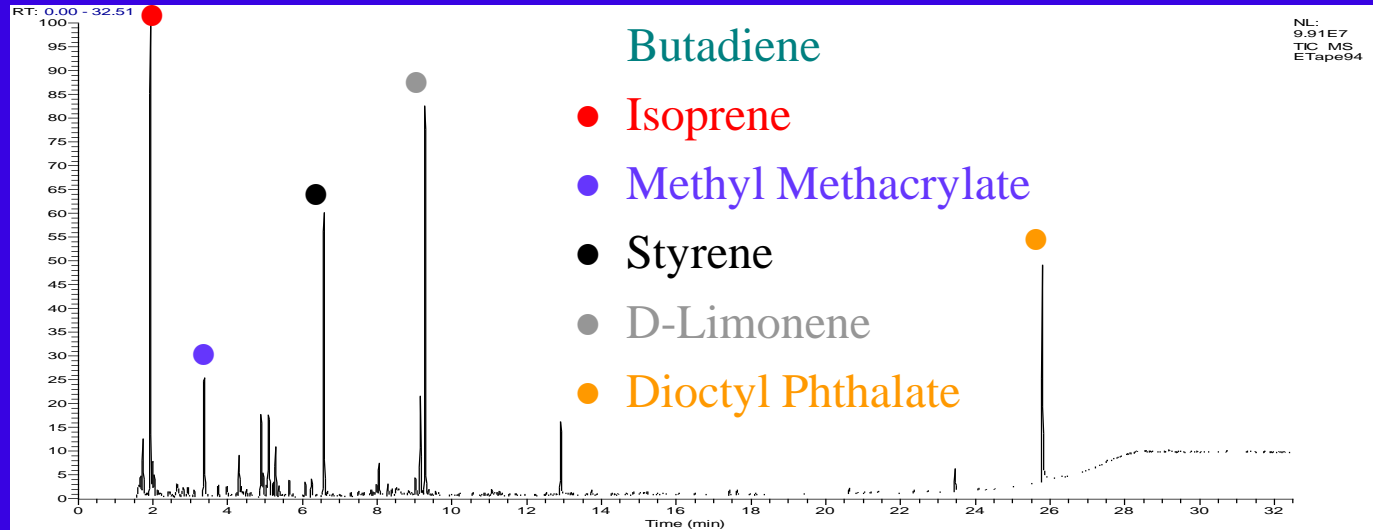
FTIR



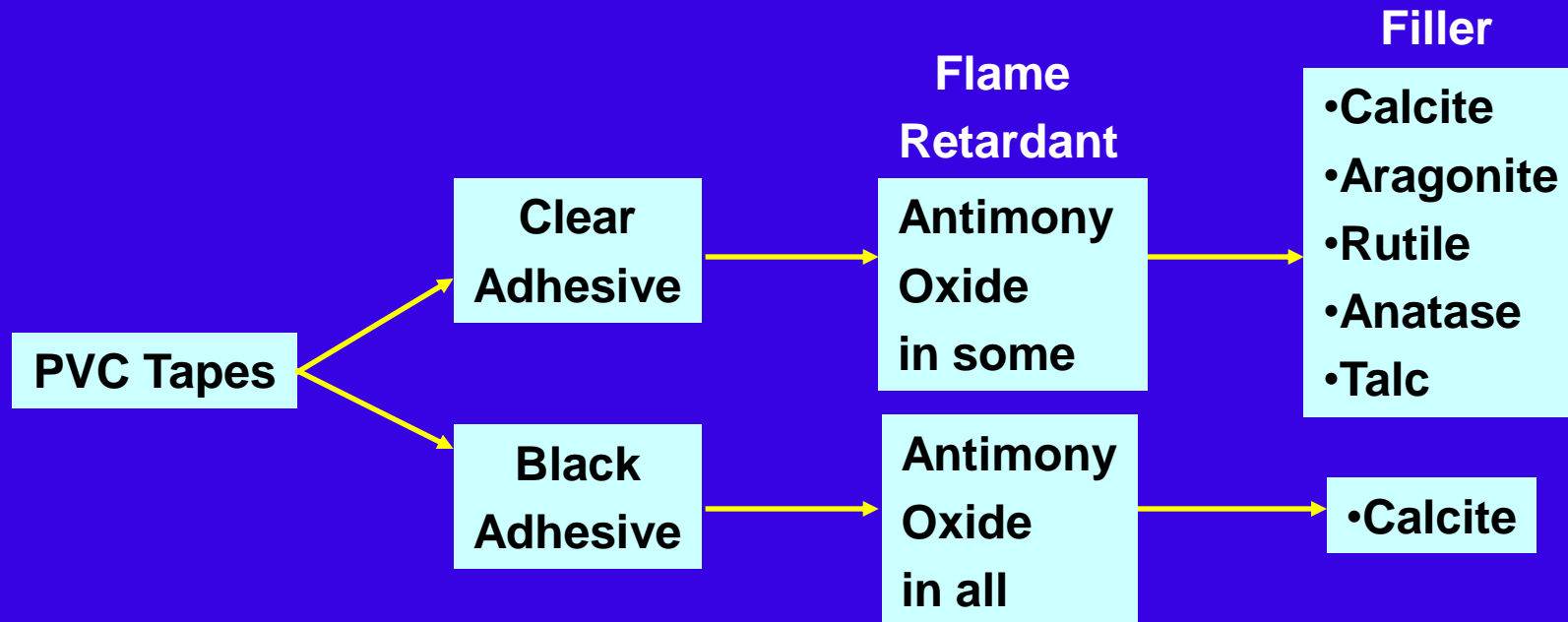
Pyrolysis Gas Chromatography – Mass Spectrometry (PGC/MS)



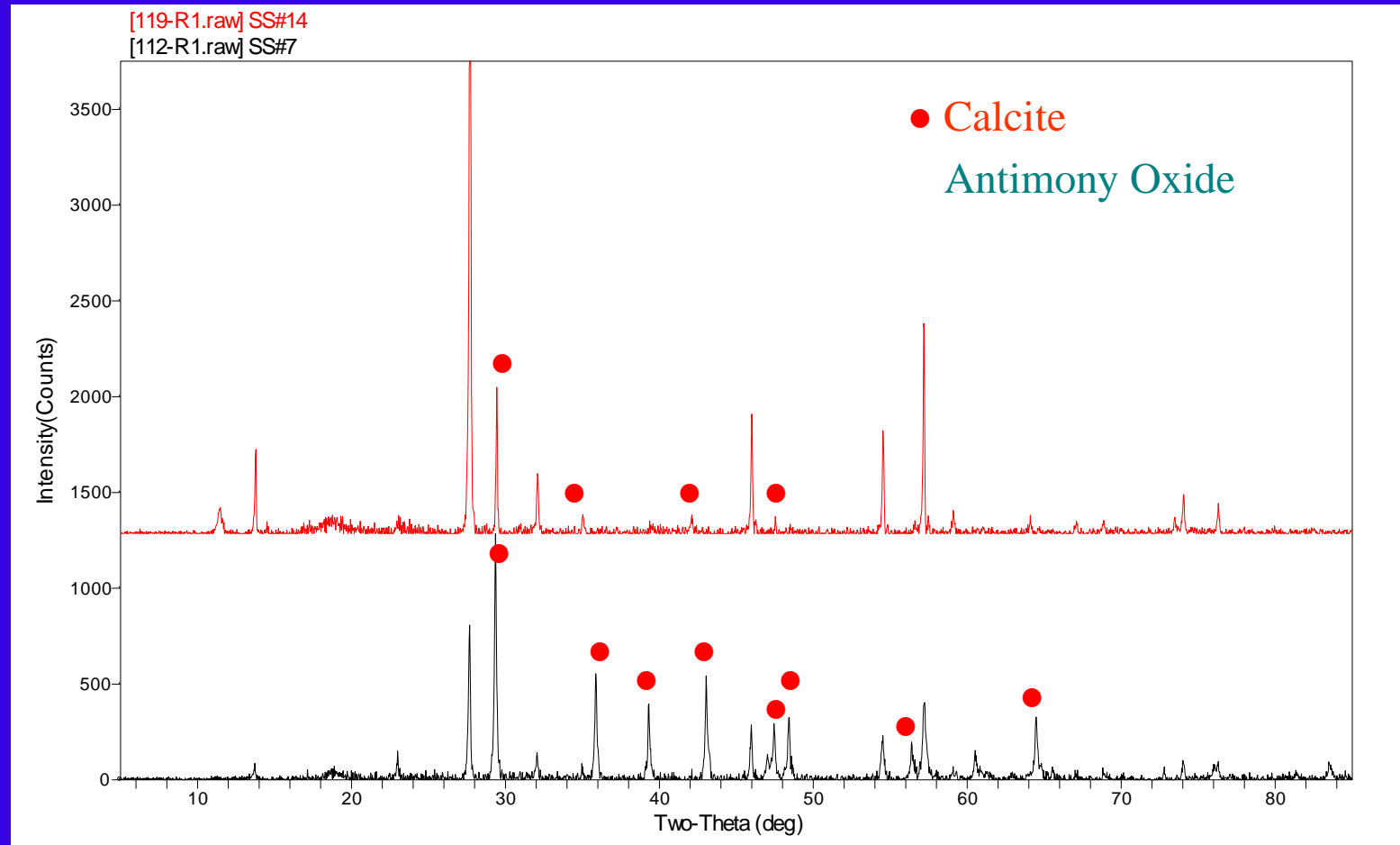
PGC/MS



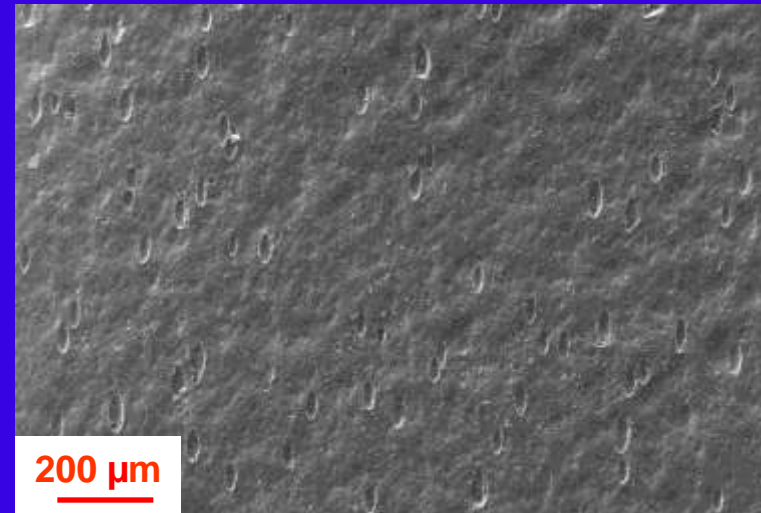
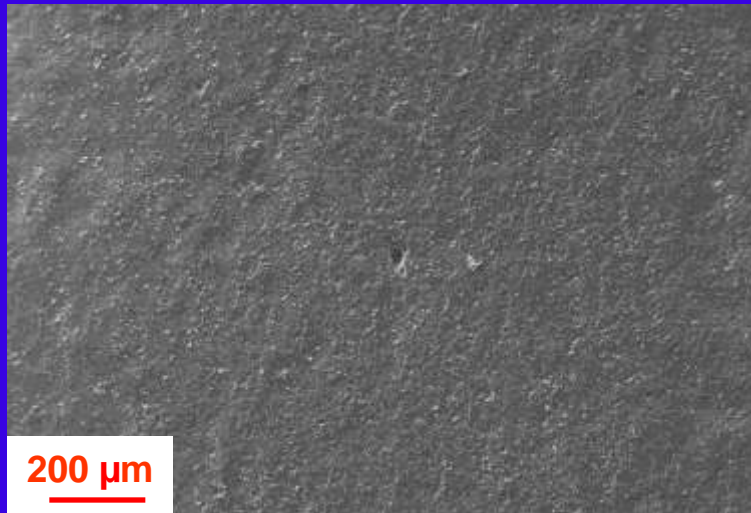
X-Ray Diffraction (XRD)



X-Ray Diffraction (XRD)

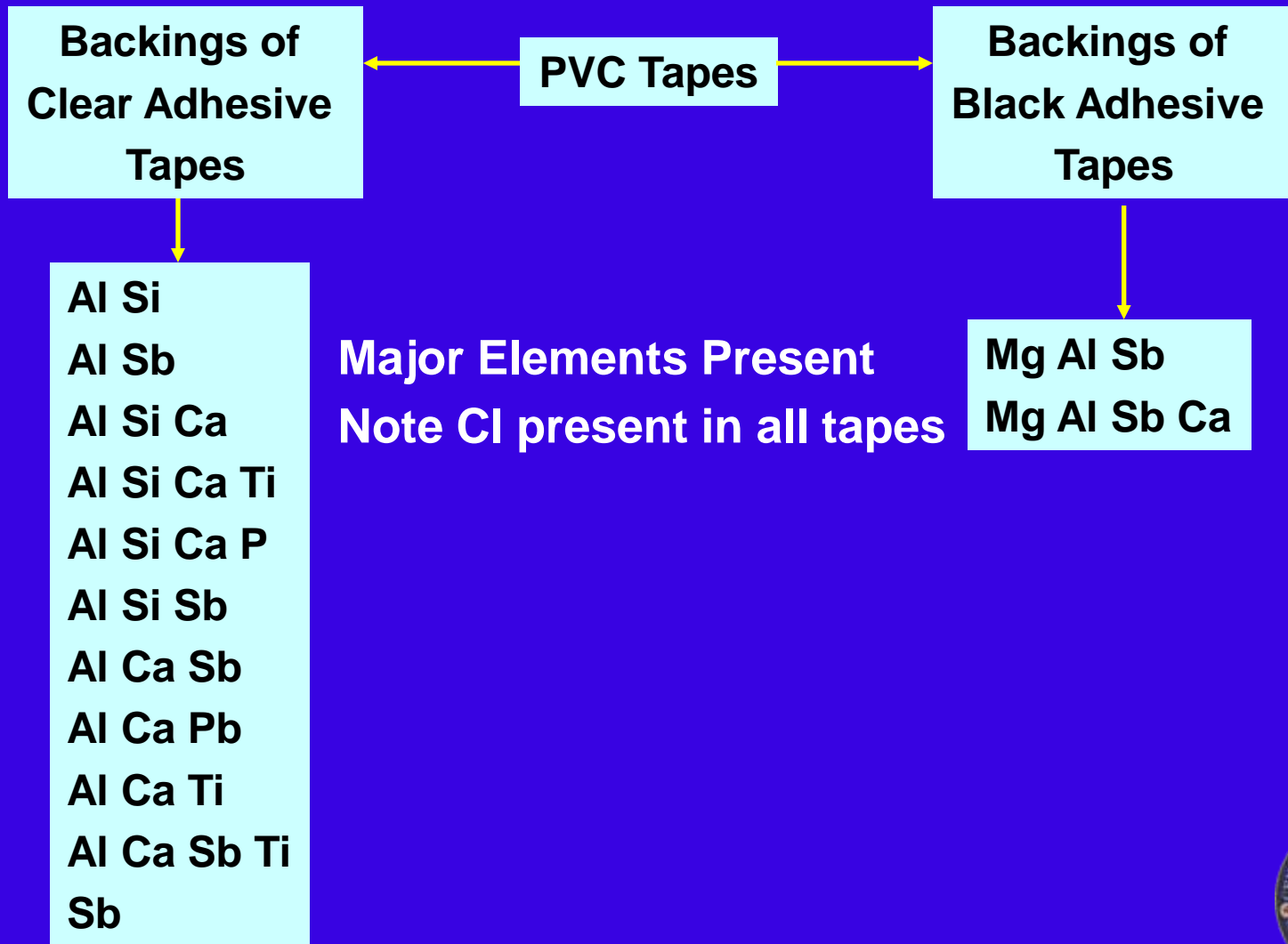


Scanning Electron Microscopy (SEM)

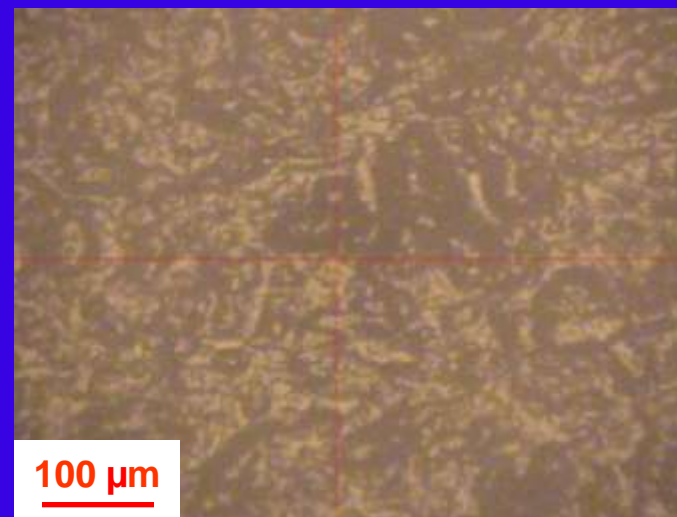
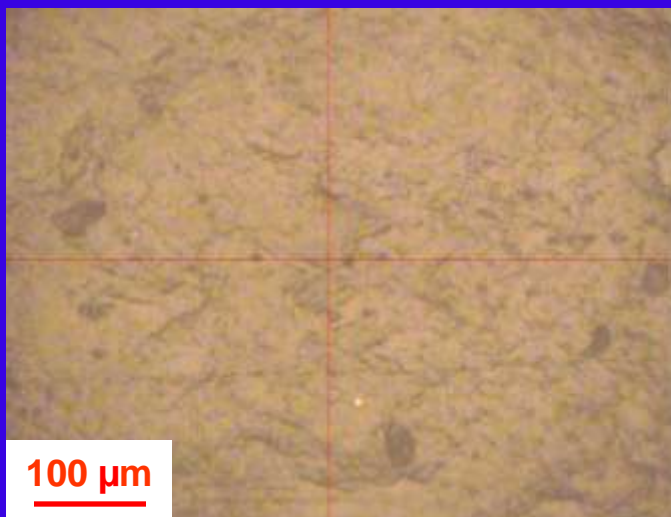
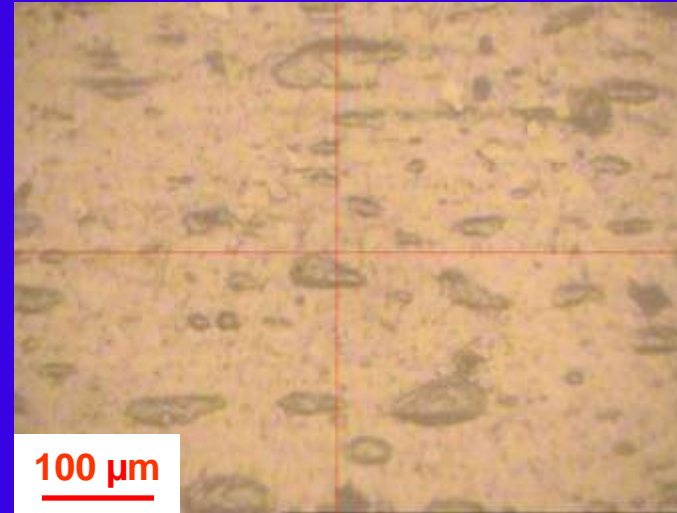
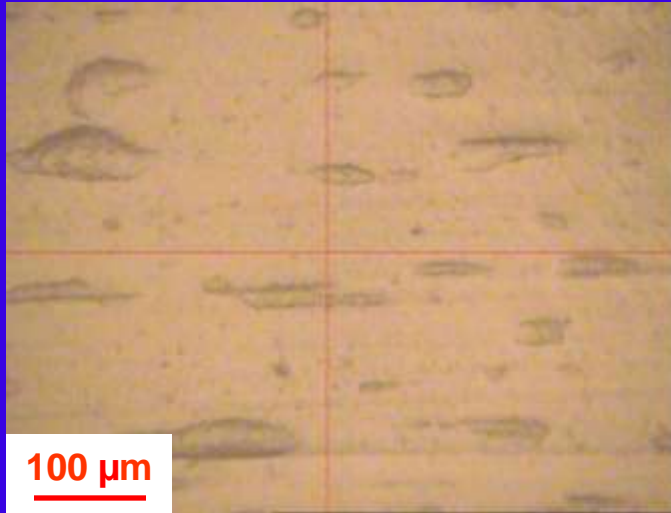


Surface features on tape backings

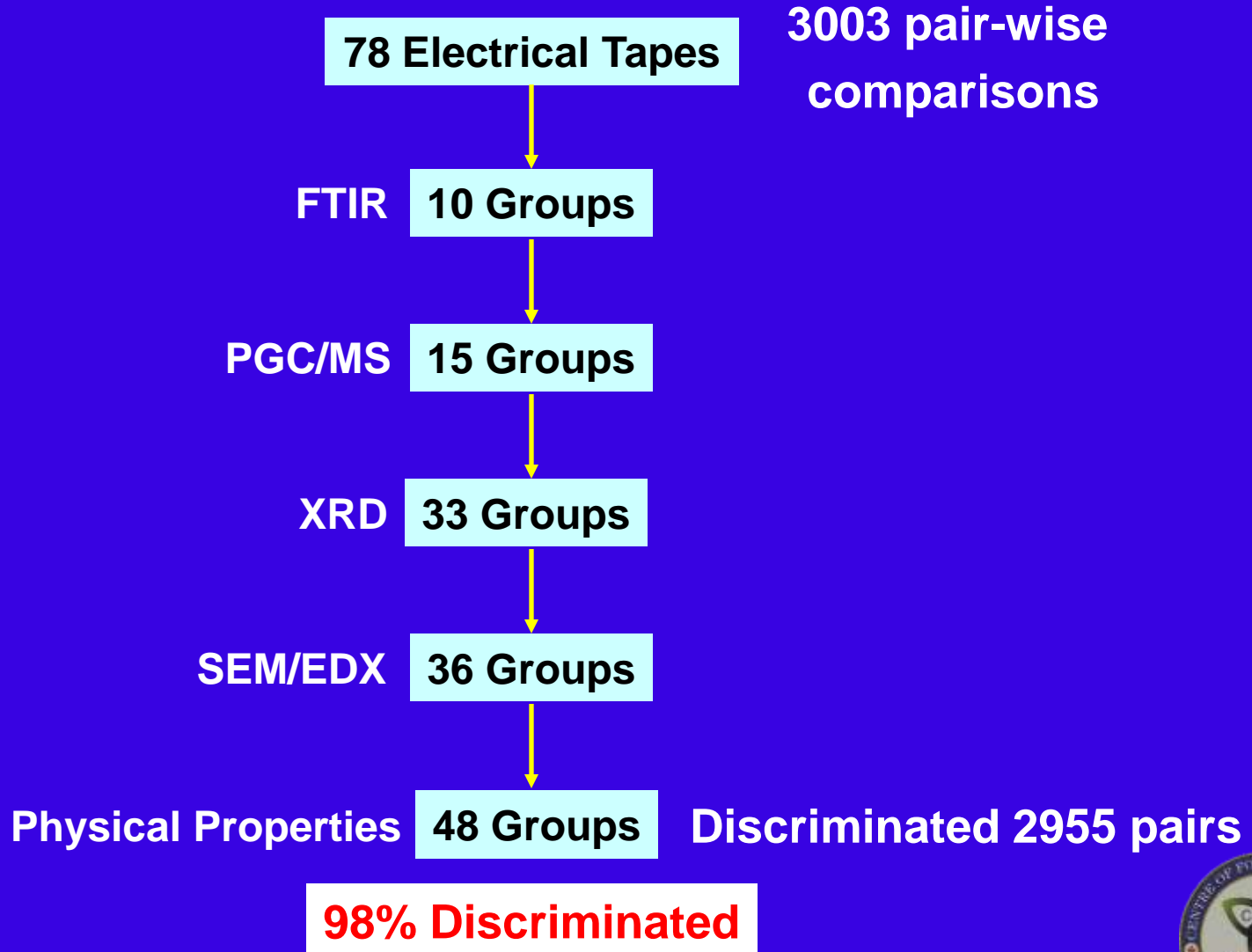
Energy Dispersive X-Ray Analysis (EDX)



Microscopy



Results



Results

- ❖ Distinguished all tapes from different manufactures
- ❖ Distinguished all but 3 pairs of tapes from different brands - indistinguishable pairs are from the same manufacturer
- ❖ Distinguished some tapes of the same brand
- ❖ Distinguished 1 out of 6 tapes in a multipack



Results - Taiwan

No of Tapes	No of Groups	BRAND	MANUFACTURER
37	22	Avatach Co. Ltd. (4, 2, 2, 2, 2, 1, 1, 1, 1, 1, 1) Tartan 3M (5, 1, 4, 1, 1, 1) Cantech/Tartan 3M (2) Temflex 3M (1, 1) Nappa Ultra Pro (1) Nexxech (1)	Avatack Co. Ltd.
8	5	Globe (3, 1, 1) Titan, Futurchem (2) Bluejay (1)	Achem Technology Corporation
2	2	Nasco (1,1)	New Age Supply Company



Results - USA

No of Tapes	No of Groups	BRAND	MANUFACTURER
12	5	Super 33+ (3, 2) Scotch 3M 700 (3, 1) Super 88 (3)	Scotch 3M, USA
4	2	Linerless Rubber Splicing Tape (3, 1)	Scotch 3M, USA



Results - China

No of Tapes	No of Groups	BRAND	MANUFACTURER
8	5	Home Electric/T4 ProFlex (3) T4 ProFlex (2) Home Electric (1, 1) Cefco (1)	Hebei Huaxia Enterprise Co.
3	3	Home-Aide (1) Nobility (1) Three Star (1)	N/A
2	2	Premium 85 (1) Revere 7 (1)	Plymouth
1	1	Duck (1)	Henkel



Results – Unknown Tape

No of Tapes	No of Groups	BRAND	MANUFACTURER
1	1	Unknown (1)	Unknown



Laser Ablation-Inductively Coupled Plasma-Mass Spectrometry (LA-ICP-MS)



LA-ICP-MS

Preliminary Analysis

- ❖ Analyzed 8 elements
- ❖ Raster scan over 1x1 mm area of PVC backing
- ❖ Preliminary data analysis
 - ❖ $\pm 40\%$
- ❖ Analyzed and compared 54 PVC tape backings
 - ❖ 1431 pair-wise comparisons
- ❖ Reproducibility studies



LA-ICP-MS

Isotopes Analyzed

Element	% of pairs discriminated for 54 PVC tapes
^{49}Ti	91
^{27}Al	90
^{25}Mg	87
^{42}Ca	87
^{207}Pb	87
^{208}Pb	87
^{68}Zn	83
^{121}Sb	77
^{123}Sb	78
^{137}Ba	64

Preliminary Results - 99.4% of Tapes Discriminated



LA-ICP-MS

Preliminary Results

12 Groups of tapes indistinguishable
by other techniques

(4, 3, 3, 3, 2, 2, 2, 2, 2, 2, 2, 2)

Multipacks

Same brand

Different brands, same
manufacturer

LA-ICP-MS

4 Groups of indistinguishable
Electrical Tapes

(2, 2, 2, 2)

Preliminary results are promising!

More work needs to be done!



Acknowledgments

National Institute of Justice (NIJ)

Federal Bureau of Investigation (FBI)

Chu Jun Wei (University of Toronto student)

Centre of Forensic Sciences

Alex Heydon, David Ruddell (LA-ICP MS)

Linda Morrison (PGC/MS)

Matthew Gibb (XRD)

Dale Randall, Elspeth Lindsay (SEM/EDX)

Cara Shepard



Questions?

