

The Significance of Class Associations in Automotive Paint Evidence



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Introduction

- Automotive paint samples, often seen in trace amounts, are commonly encountered in forensic laboratories
- Automotive paint evidence is considered class evidence. Forensic scientists are often challenged to determine the significance of an association
- Given the wide range of analyses, which may or may not be destructive to the sample, an appropriate analytical scheme is necessary for the identification and comparison of paints and coatings



Purpose and Forensic Relevance

- Consumer preferences and design trends along with costs and environmental legislation are all factors that are taken into consideration by the automobile industry and play into the selection of the composition of the automobile paint.
 - Therefore, the automobile paint industry is very diverse which enhances the significance of a paint association but also makes determining the significance challenging.
- The automobile paint industry continues to evolve, therefore it is necessary to reassess the distinctiveness of automotive paints collected in the United States in order to determine their evidential value and the significance of any class associations in automotive paint evidence.

Purpose and Forensic Relevance

Report Statement:

A six layer red paint chip recovered from the victim's shirt is similar in color, layer sequence, paint type and composition as the known red paint from the suspect's vehicle. *It is our opinion that this paint chip could have come from the suspect's vehicle.*

What does this mean?

What is the significance of this association?

What are the common colors and layer systems of vehicles?

What is the different discriminating value of the different paint types and colors?

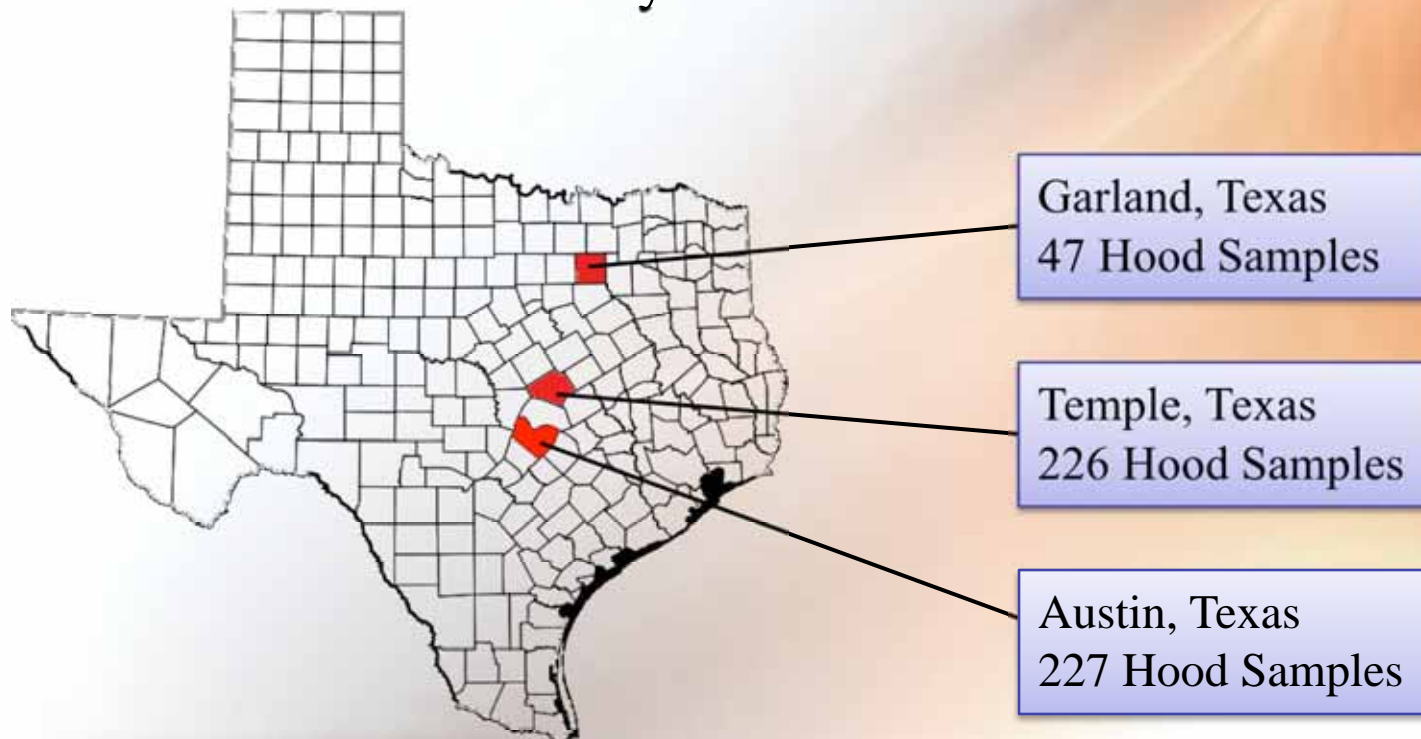
Purpose and Forensic Relevance

- Attempt to determine the degree of discrimination of automotive paint samples from a random population based on physical and microscopical examinations as well as instrumental analysis
- To address the frequency of occurrence of a paint sample based on color, effect finish and layer sequence

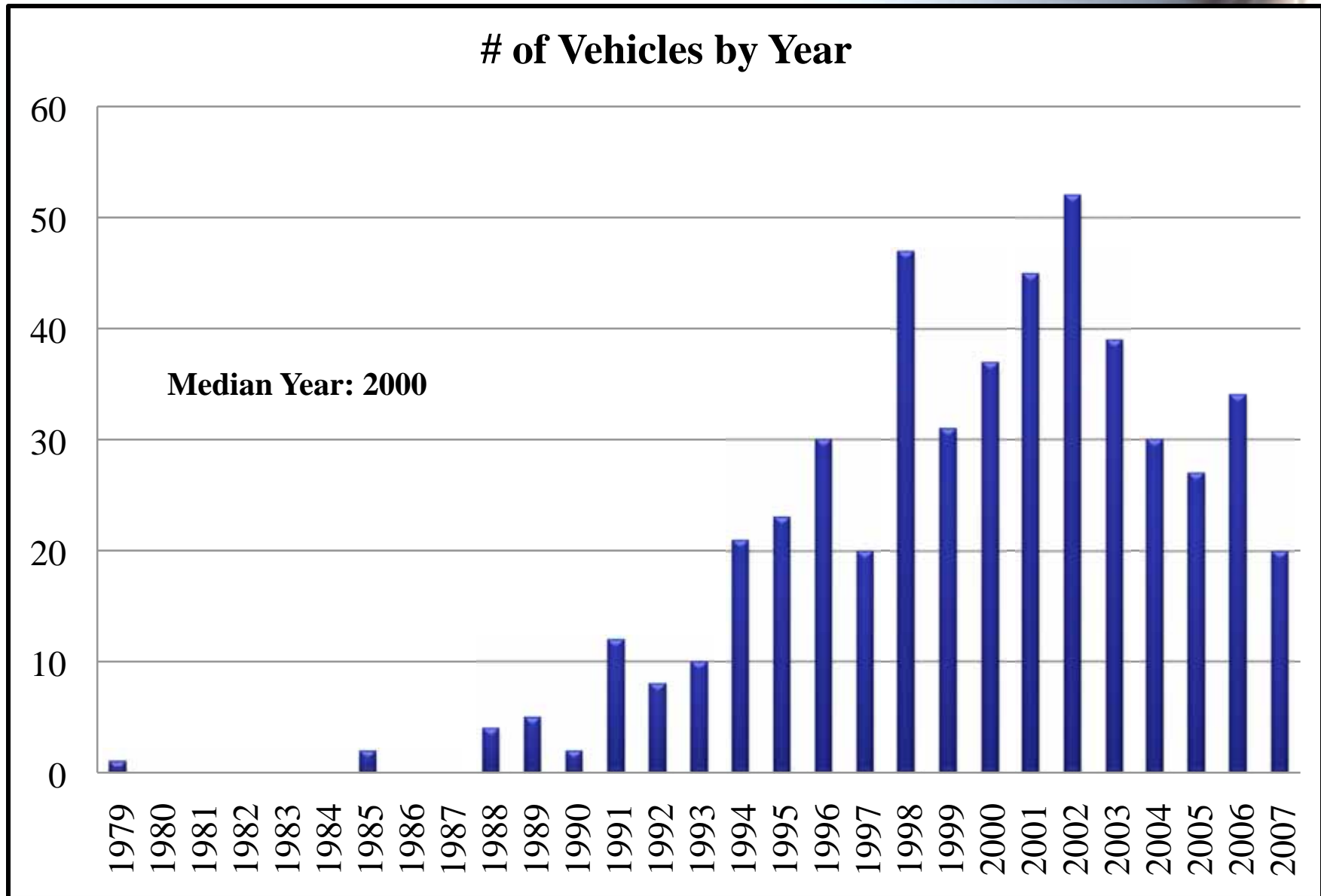
The degree of discrimination of paint evidence in combination with the frequency of occurrence of a paint sample will establish the significance of a paint association.

Method: Collection

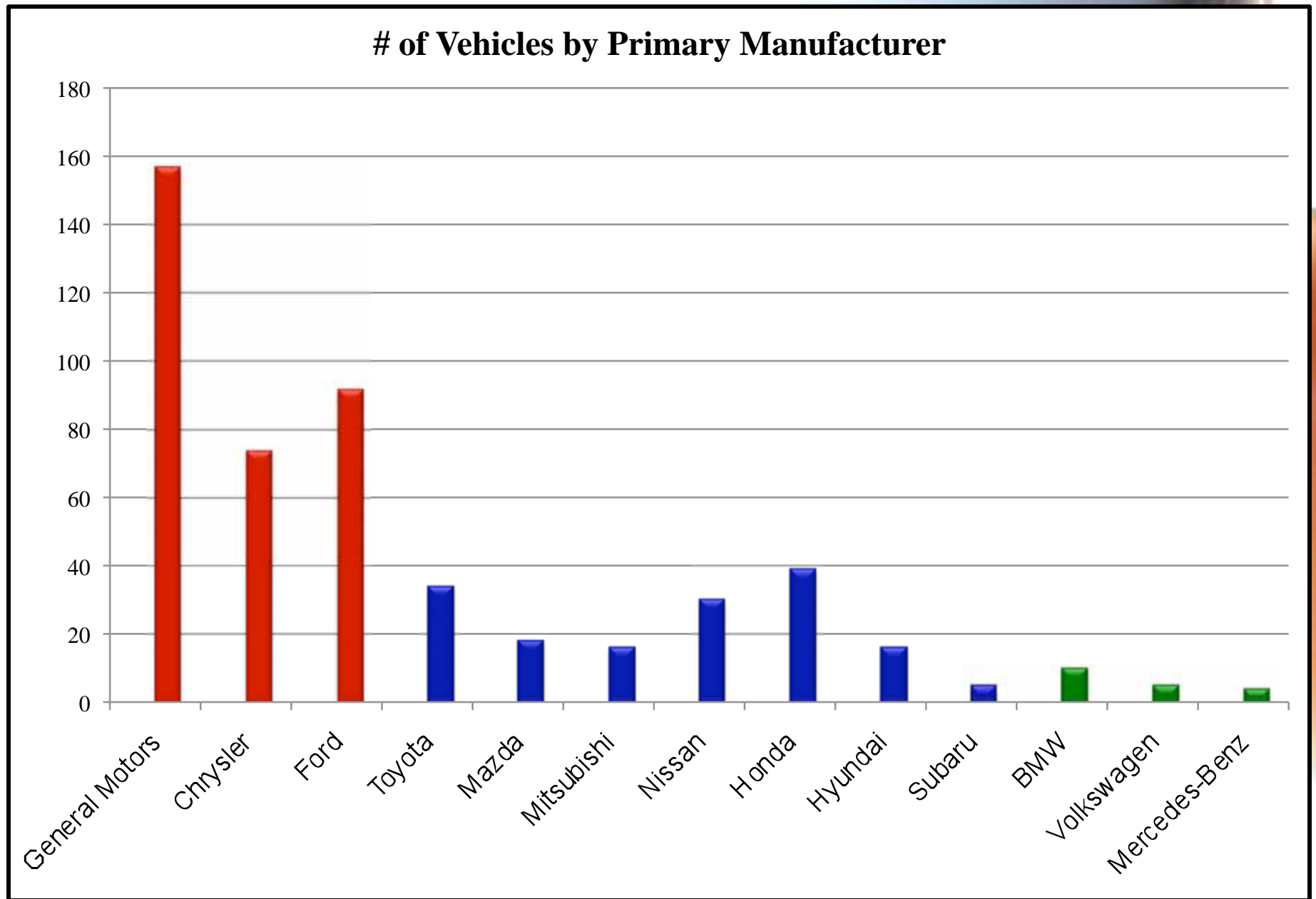
- 1168 automobile paint samples were collected from damaged areas of vehicles in the summer of 2007
 - Of the 1168 samples, 500 hood samples were analyzed (most prominent collection area)
 - Make, model, year, and VIN was recorded at time of collection and each sample was given a unique sample number
 - VINassist™ used to verify recorded information



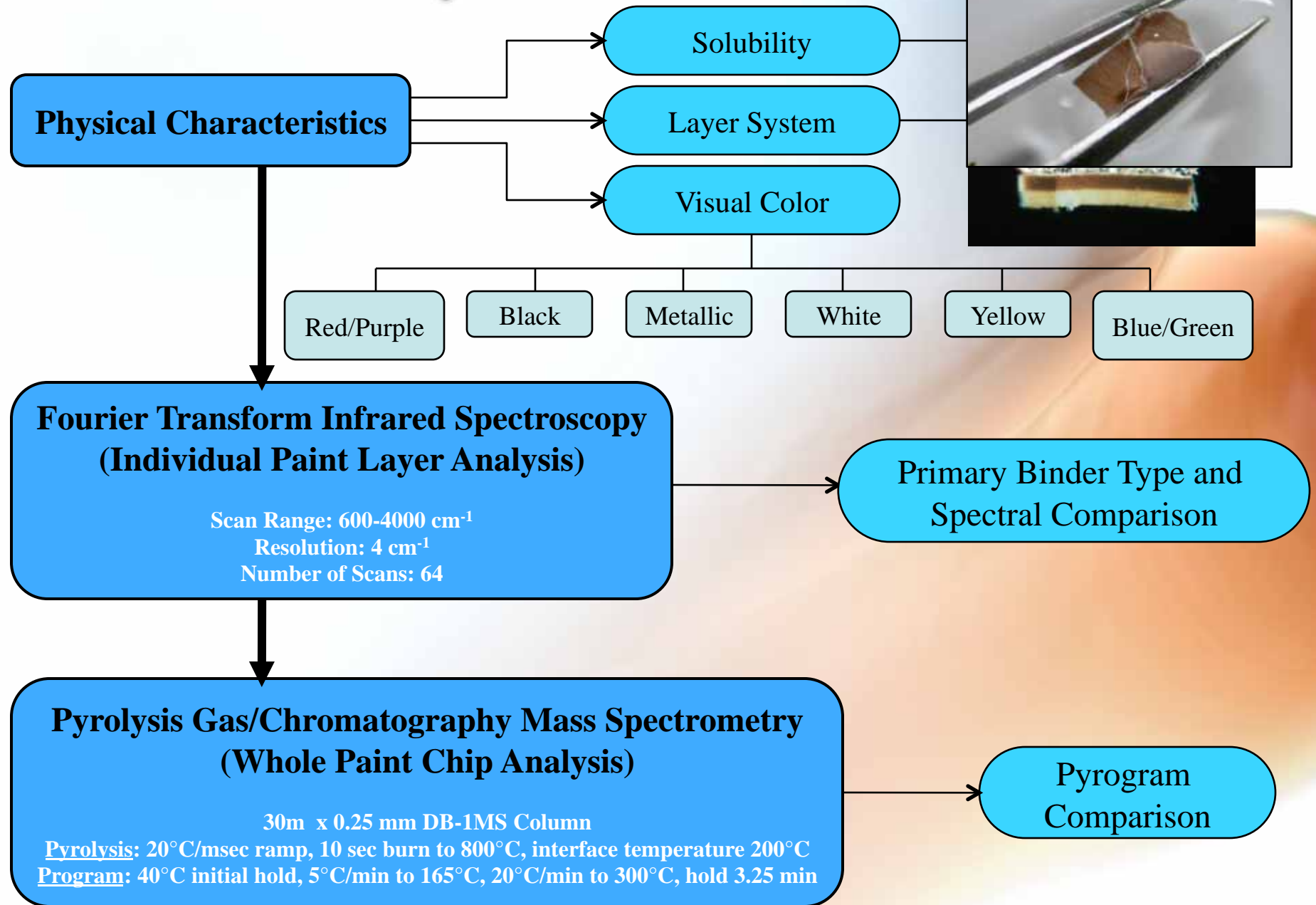
Results: Collection



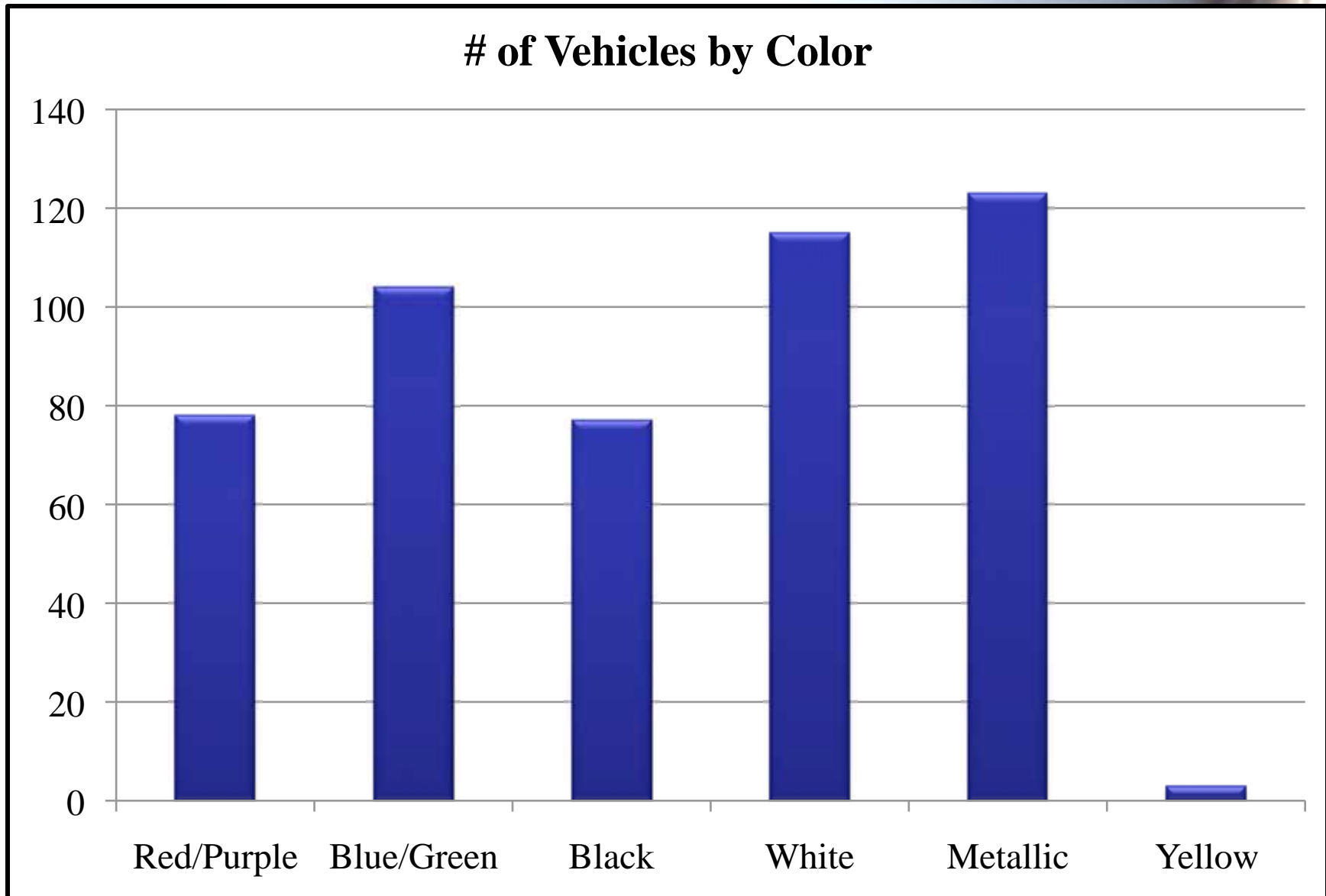
Results: Collection



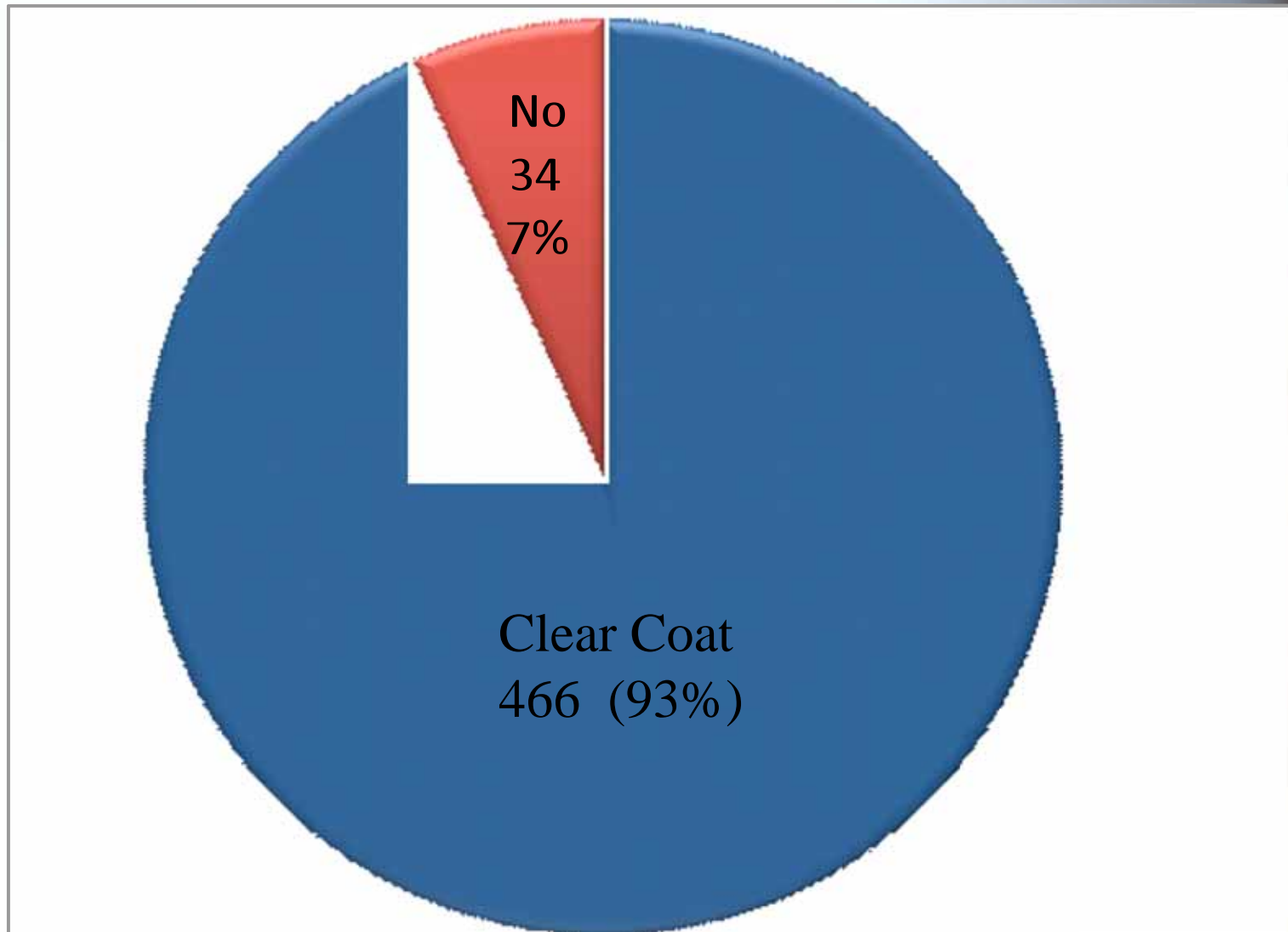
Method: Analytical Scheme



Results: Physical Characteristics



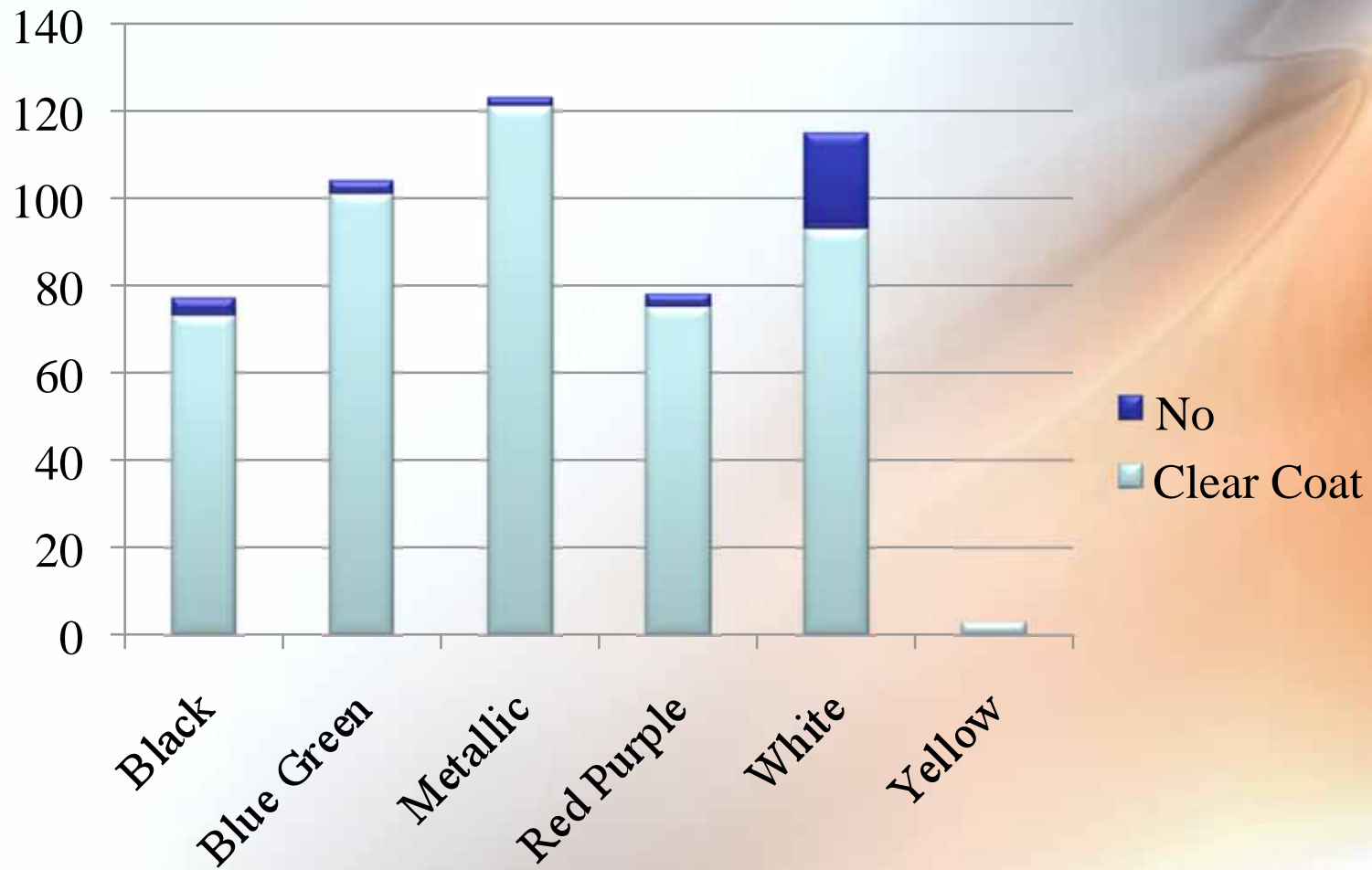
Results: Physical Characteristics



Clear Coat / Overall number of samples

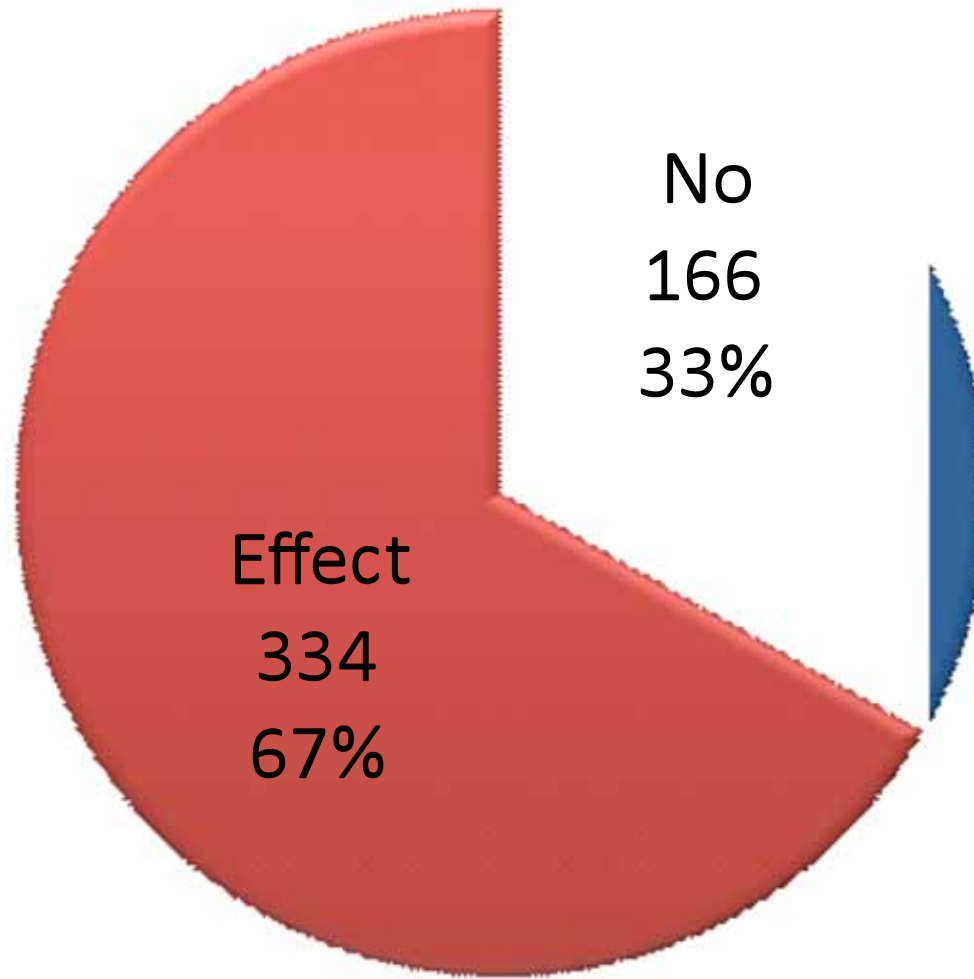
Results: Physical Characteristics

Clear Coat per Color Group

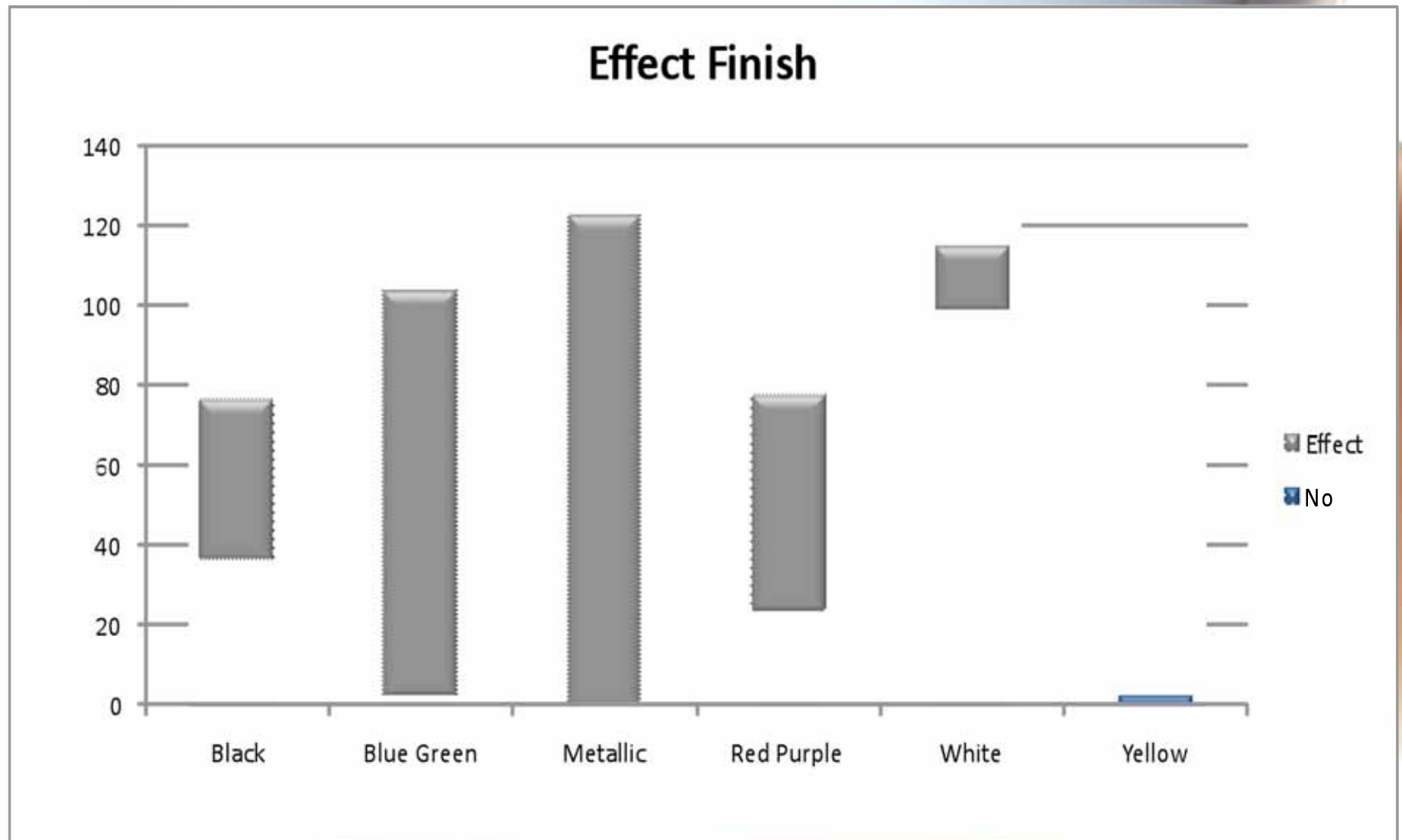


Results: Physical Characteristics

Effect Finish / Overall

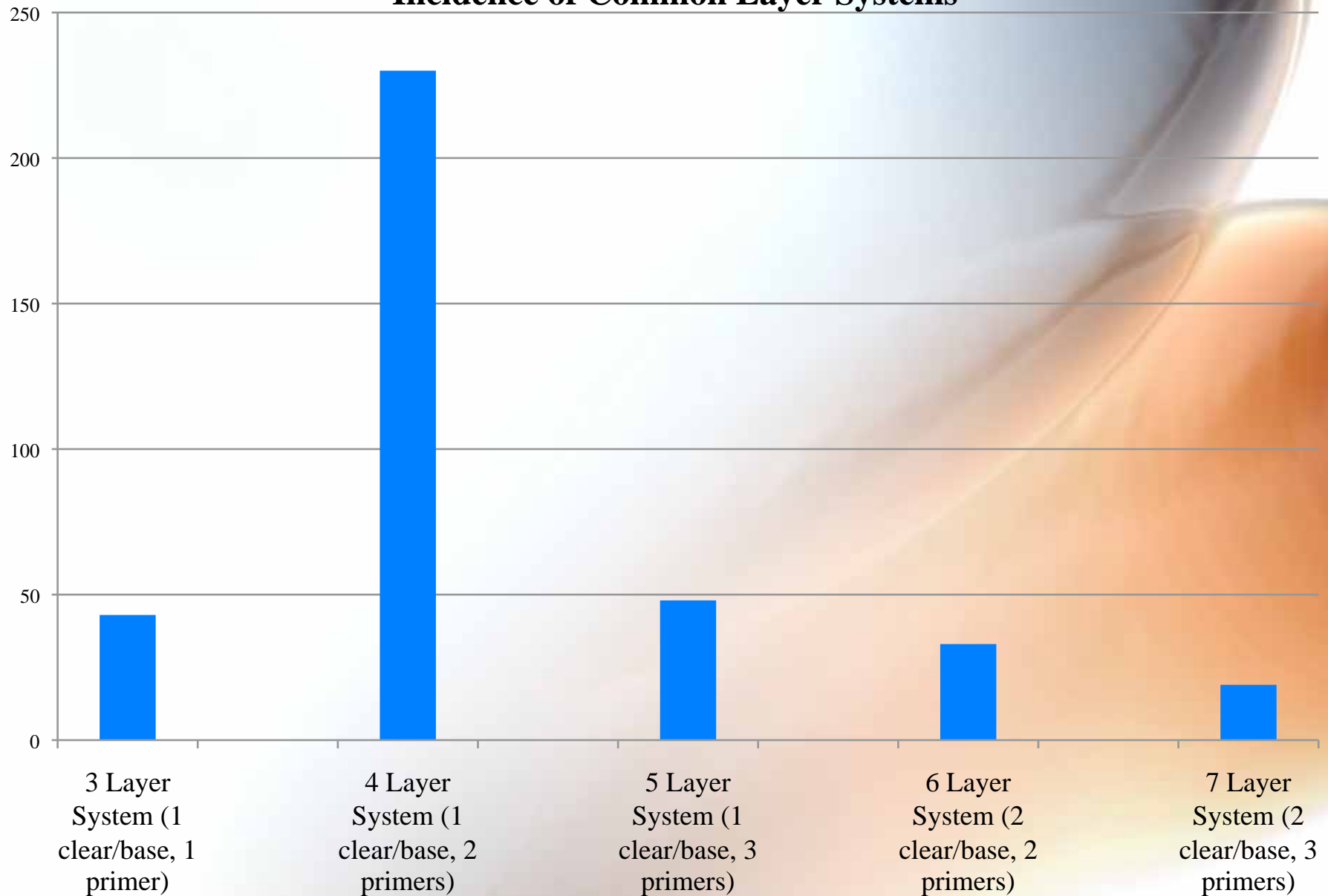


Results: Physical Characteristics



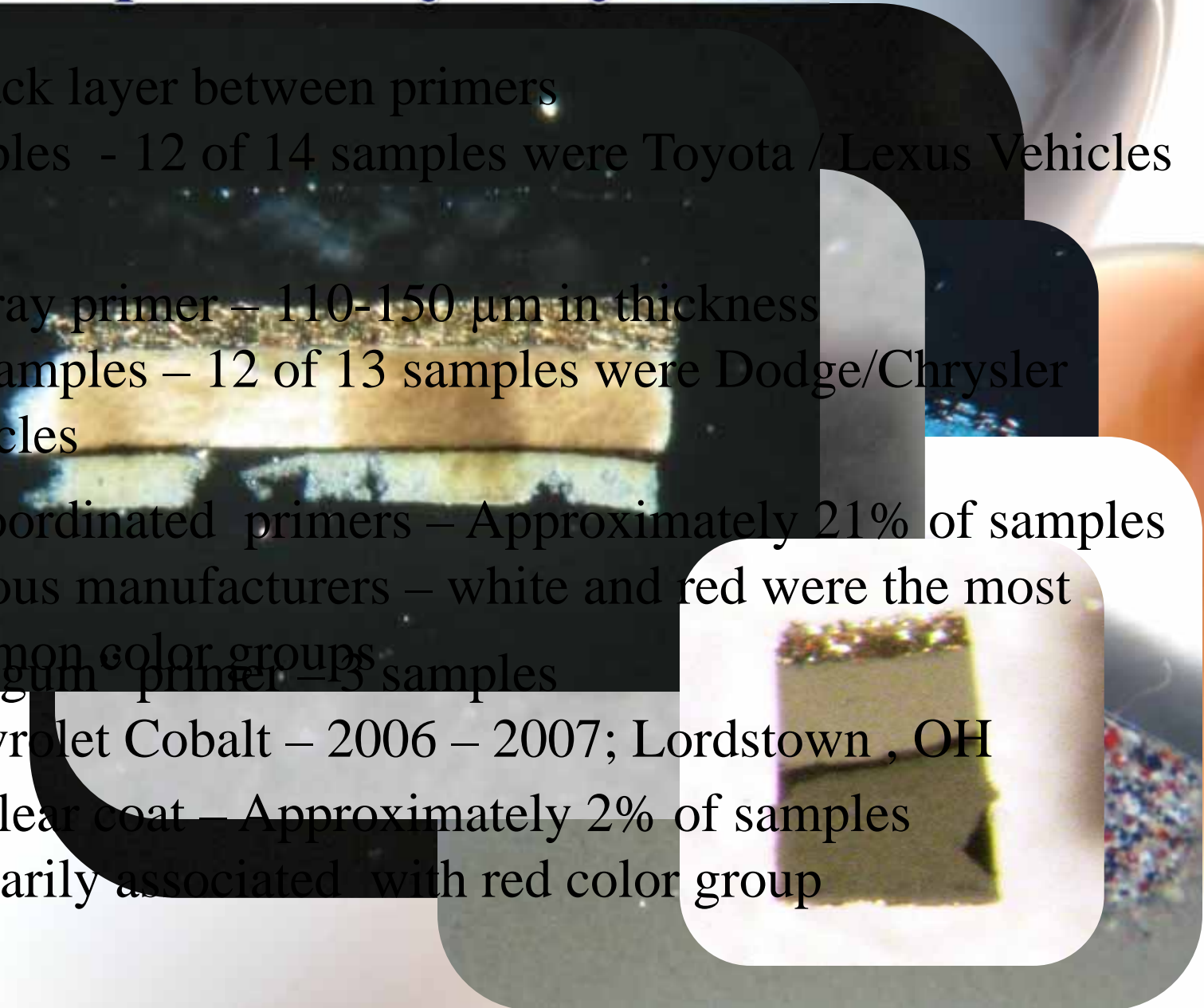
Results: Physical Characteristics

Incidence of Common Layer Systems



Results: Special Layer Systems

- Thin black layer between primers
- 14 Samples - 12 of 14 samples were Toyota / Lexus Vehicles
- Thick gray primer – 110-150 μm in thickness
 - 13 Samples – 12 of 13 samples were Dodge/Chrysler Vehicles
- Color coordinated primers – Approximately 21% of samples
 - Various manufacturers – white and red were the most common color groups
- “Bubblegum” primer – 3 samples
 - Chevrolet Cobalt – 2006 – 2007; Lordstown, OH
- Tinted clear coat – Approximately 2% of samples
 - Primarily associated with red color group



Mottled Primer Layers – 29 Samples



Results: Some Binder Types Encountered (FT-IR)

OT2 (Clear)

- ACRYLIC MELAMINE
- ACRYLIC URETHANE
- ACRYLIC MELAMINE URETHANE

OU1 (Surface Primer)

- ISOPHTHALIC ALKYD with MELAMINE
- ISOPHTHALIC AND ORTHOPHTHALIC ALKYD with MELAMINE
- EPOXY AND TERPHTHALIC ALKYD

OU2 (E-coat)

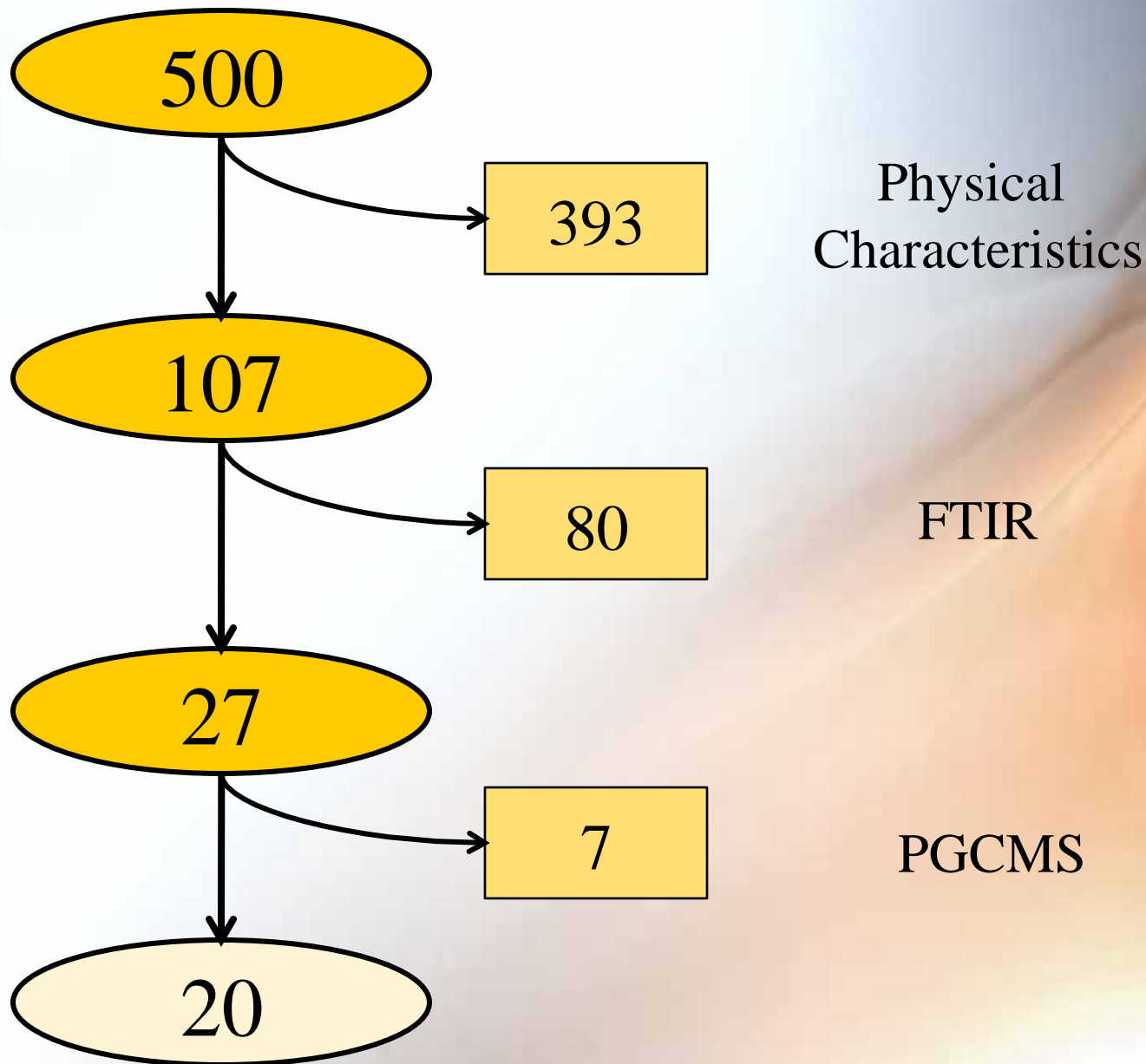
- EPOXY
- EPOXY with KAOLINITE

* Not all layers and/or samples were analyzed FT-IR

Results: Eliminations Based on Technique

(Samples)	Physical Characteristics	FTIR	PGCMS	Not Discriminated
Black	63	12	0	2
Red/Purple	61	13	2	2
Blue/Green	101	1	0	2
White	70	34	3	8
Metallic	95	20	2	6
Yellow	3	0	0	0
Total	393	80	7	20
Percentage of Total Samples	78.6	16.0	1.4	4.0

Results: Eliminations Based on Technique



Results: Non-Discriminated Pairs

Sample	Color	Year	Make	Model	Plant
408a	Black (E)	2007	Dodge	Charger	Brampton, ON (Canada)
541a	Black (E)	2007	Dodge	Charger	Brampton, ON (Canada)
208b	Red/Purple (E)	2002	GMC	Envoy	Moraine, OH
594a	Red/Purple (E)	2002	GMC	Envoy	Moraine, OH
139a	Blue/Green (E)	2006	Dodge	Caravan	Fenton, MO
G63b	Blue/Green (E)	2006	Dodge	Stratus	Sterling Heights, MI
55b	White	1994	Eagle	Vision	Bramalea, ON (Canada)
392	White	1996	Dodge	Intrepid	Bramalea, ON (Canada)
285a	White	1999	Buick	Le Sabre	Flint, MI
584a	White	1998	Buick	Le Sabre	Flint, MI
289a	White (E)	2002	Mitsubishi	Galant	Normal, IL
458a	White (E)	2004	Mitsubishi	Endeavor	Normal, IL
173a	White	2005	Chevrolet	Suburban	Silao, Mexico
412a	White	2004	Chevrolet	Avalanche	Silao, Mexico
149c	Metallic (E)	2005	Chevrolet	Venture	Doraville, GA
461a	Metallic (E)	2004	Oldsmobile	Alero	Lansing, MI
203c	Metallic (E)	2001	Chevrolet	Impala	Oshawa #1, ON (Canada)
273a	Metallic (E)	2003	Chevrolet	Monte Carlo	Oshawa #1, ON (Canada)
308a	Metallic (E)	2002	Chevrolet	Impala	Oshawa #1, ON (Canada)
350a	Metallic (E)	2004	Chevrolet	Monte Carlo	Oshawa #1, ON (Canada)

Conclusion

- 500 hood samples

$$\frac{n(n-1)}{2} = 124,750 \text{ total possible pairs (i. e. comparisons)}$$

- 20 samples (14 pairs) not discriminated

$$\frac{14}{124,750} \times 100 = 0.01 \text{ percentage of pairs not discriminated}$$

- In conclusion:

99.99% of all total pairs were discriminated

Further Analysis

- Elemental analysis of samples, particularly effect finish
 - SEM / EDS
 - X-ray diffraction
 - X-ray fluorescence
- Universal systems
 - Similarity of chemistry/layer system from one area of a vehicle to another

Acknowledgements

We would like to thank:

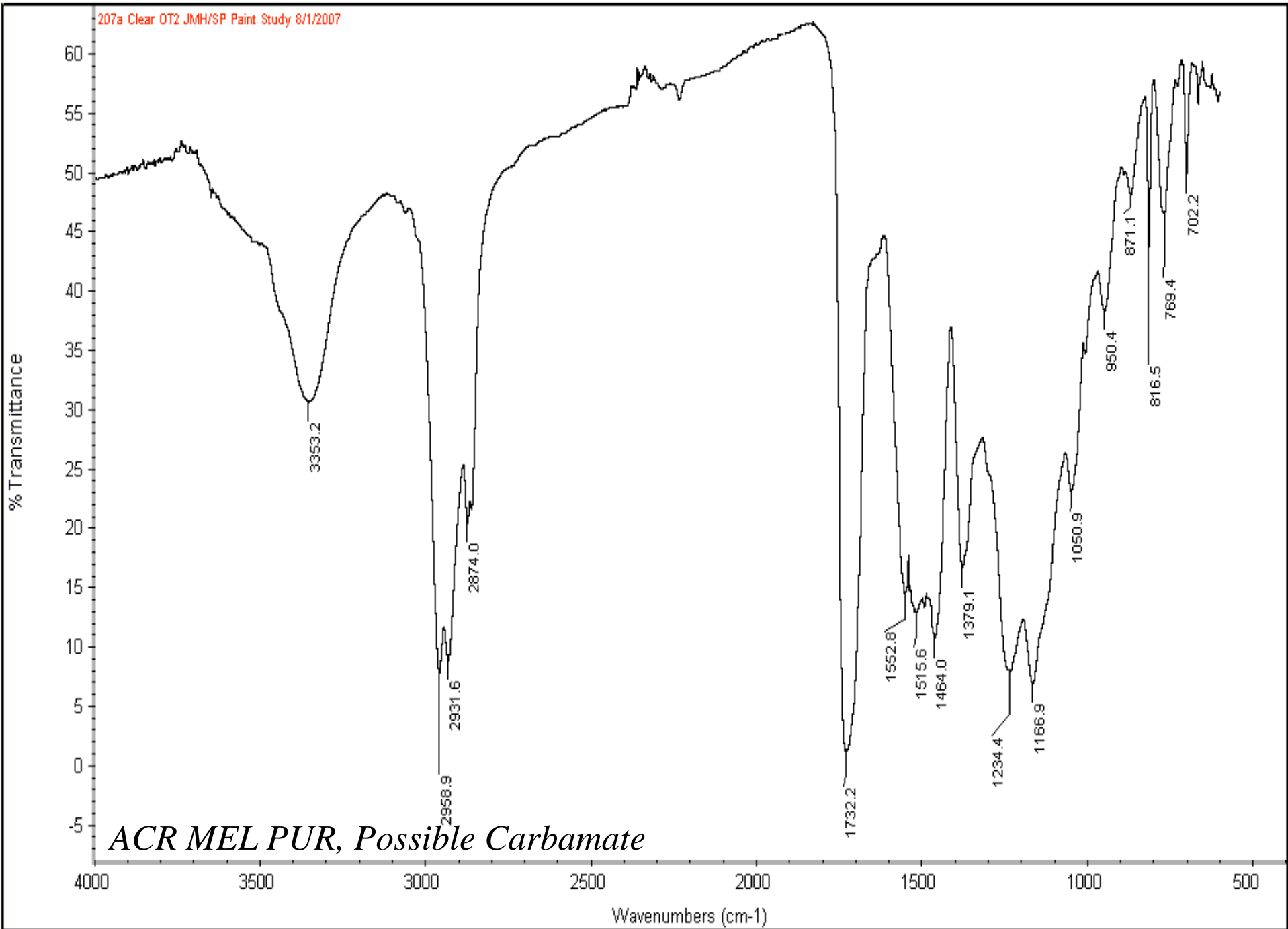
- The DPS management staff for their support and funding
- Rebecca Vasquez, Adriana Perez, Delisa Downey, and John Witkowski for help in sample collection
- Ivan Wilson and Melissa Valadez for help in sample analysis and data review



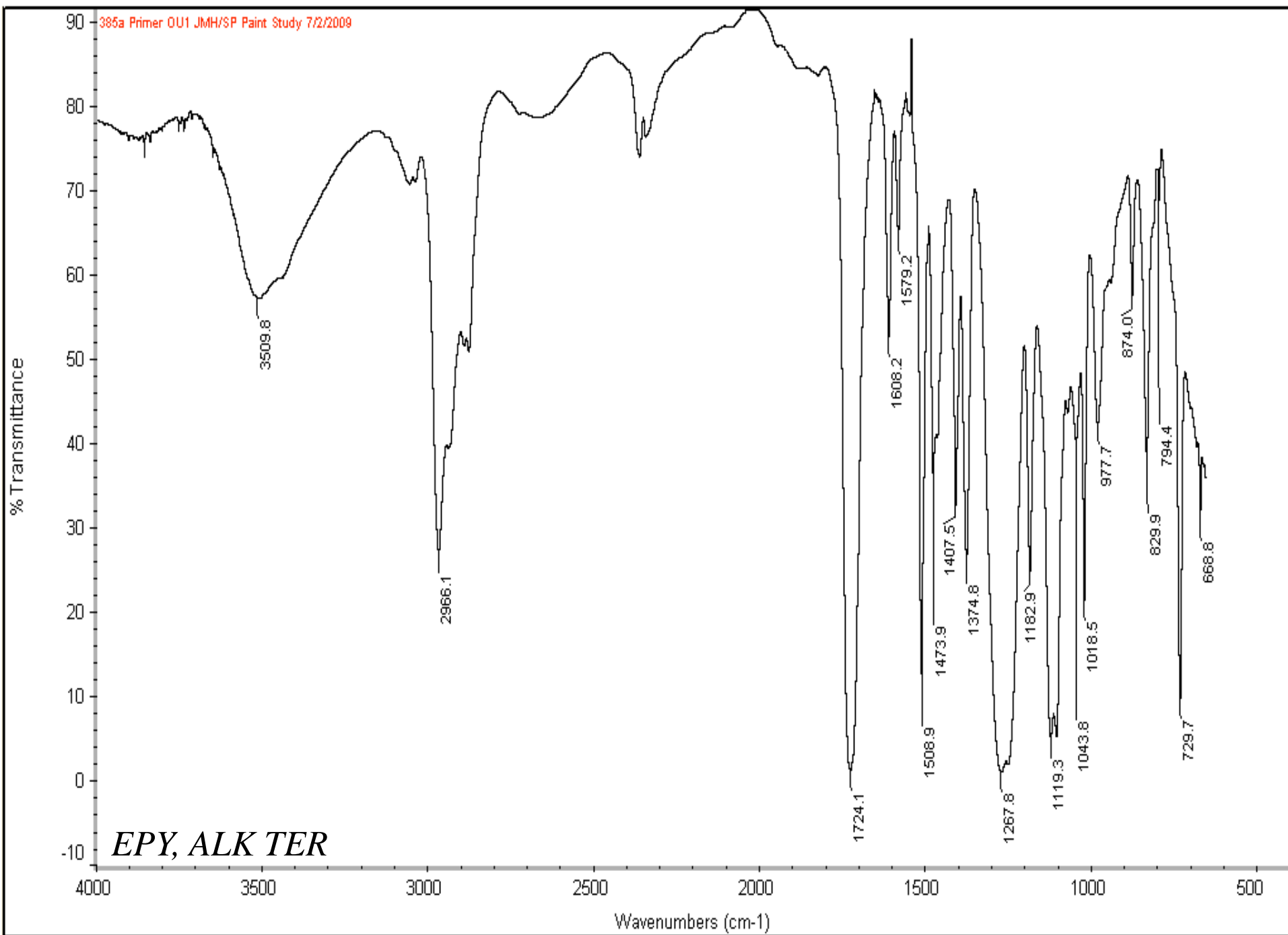
Errata

The FTIR discrimination value given in the *Eliminations Based on Technique* table on slide 19 was previously miscalculated and has since been corrected. The miscalculation did not, in any way, alter the final discrimination value for the study.

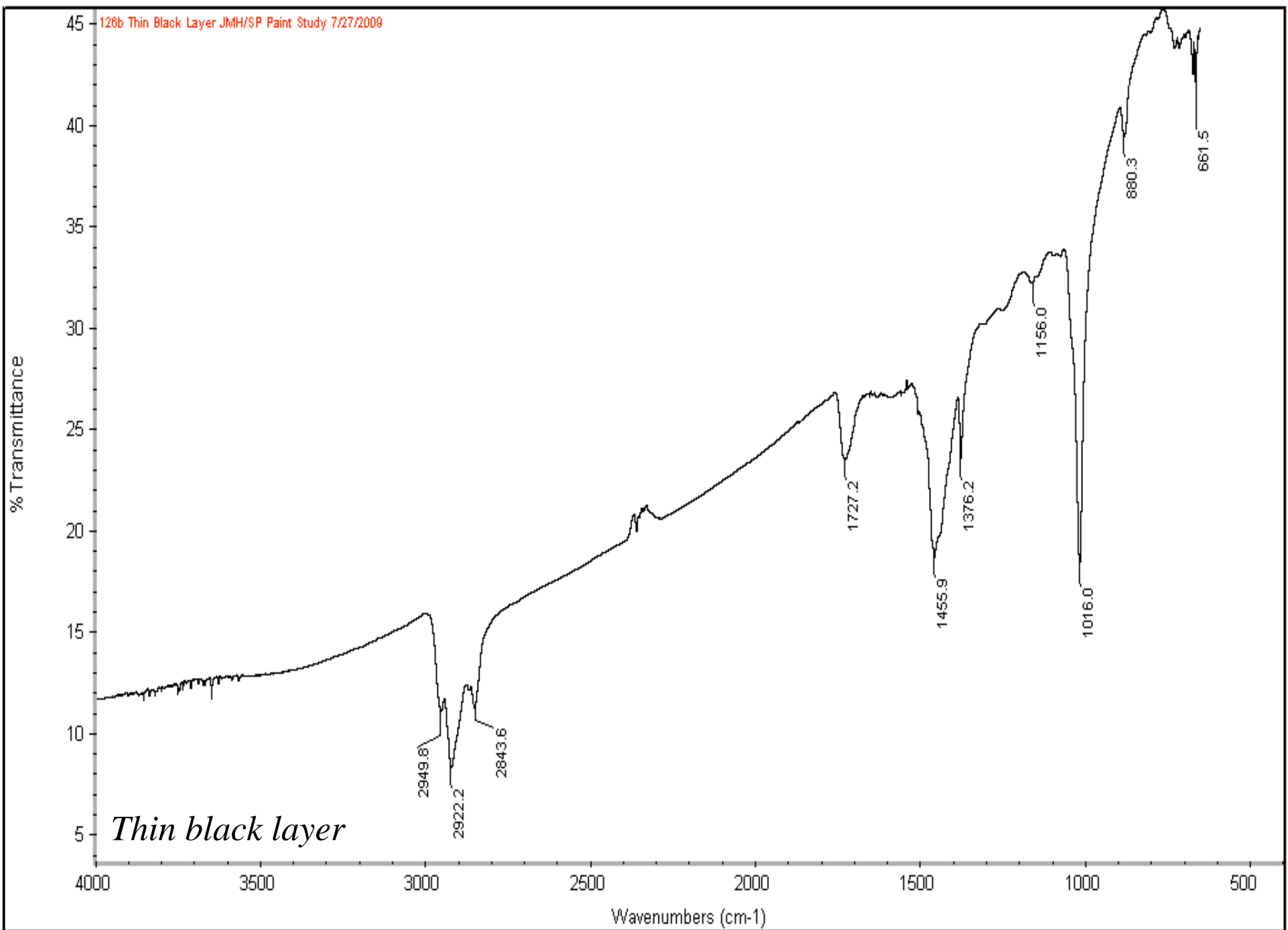




ACR MEL PUR, Possible Carbamate



EPY, ALK TER



Thin black layer