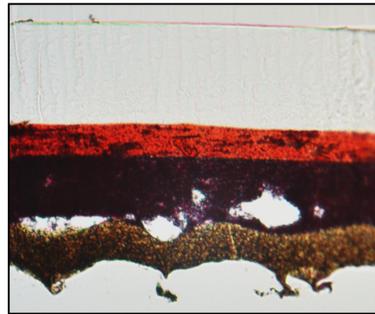# Multiblock Data Fusion of Spectroscopic Techniques for Forensic Analysis of Automotive Paint Clearcoats

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INTRODUCTION

2017 Red Metallic Hyundai Elantra Tailgate OEM

1. **Clearcoat** ←
2. Basecoat
3. Primer
4. Primer surfacer

Why clearcoats:
- Topmost, protective layer
- Prone to transfer during a collision
- Forensic interest

Composition:
- Binder and additives (UV absorbers)

Objective:
- To develop an efficient analytical sequence for the analysis of automotive paint clearcoats

Efficient analytical sequence:
- Highly discriminating
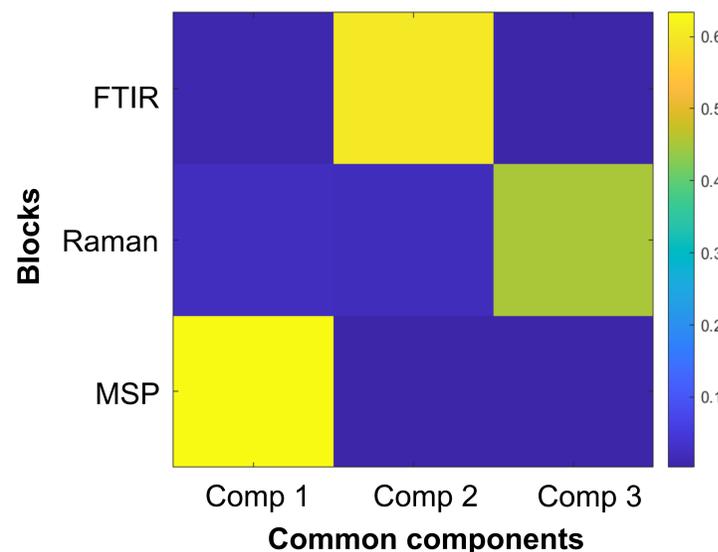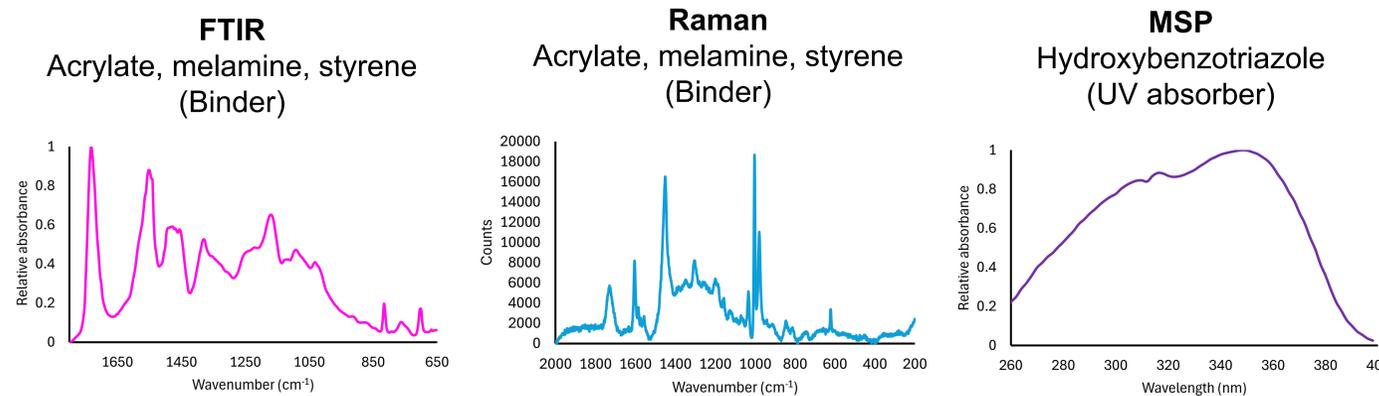- Complementary information

Validation:
- Multiblock data fusion
- Each technique treated as a 'block'

Forensic Paint Analysis
- FTIR spectroscopy
- Raman spectroscopy
- UV-Visible MSP

RESULTS & DISCUSSION

ARE ALL THREE TECHNIQUES NECESSARY?

FTIR
Acrylate, melamine, styrene
(Binder)

Raman
Acrylate, melamine, styrene
(Binder)

MSP
Hydroxybenzotriazole
(UV absorber)

Blocks (FTIR, Raman, MSP) vs **Common components** (Comp 1, Comp 2, Comp 3)

SO-PLS-DA Explained Variance
- FTIR + MSP — 94%
- FTIR + Raman — 84%
- FTIR only — 68%

High degree of complementarity between FTIR and MSP

CCSWA:
- MSP + FTIR → ~89% variability
- Raman → ~7% variability

SO-PLS-DA:
- FTIR + Raman: **23% increase** in explained variance
- FTIR + MSP: **37% increase** in explained variance

FTIR and Raman spectroscopy:
- **Similar information**
- Binder composition

UV-Vis MSP:
- **Complementary information**
- UV absorbers

ACKNOWLEDGEMENTS

MATERIALS & METHODS

Data acquisition:
- 49 automotive paint clearcoats
- FTIR spectroscopy
- Raman spectroscopy
- UV-Vis MSP

Qualitative assessment of spectral features:
- Chemical information compared across techniques

Common component and specific weight analysis (CCSWA)[1]:
- Exploratory approach
- Contribution of block to overall data structure

Sequential orthogonalized partial least squares discriminant analysis (SO-PLS-DA)[2]:
- Multiblock version of the classical PLS-DA

CONCLUSIONS

Recommendation:
- FTIR spectroscopy followed by MSP analysis

Other considerations:
- Fluorescence (Raman spectroscopy)
- Sample preparation (MSP analysis)
- Sensitivity to sample history

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