

Instrumental and Chemometric Analysis of Automotive Clear Coat Paints by Micro Laser Raman and UV Microspectrophotometry

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Instrumental and Chemometric Analysis of Automotive Clear Coat Paints by Micro Laser Raman and UV Microspectrophotometry

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Abstract:

Automotive paints have used an ultraviolet (UV) absorbing clear coat system for nearly thirty years. These clear coats have become of forensic interest when comparing paint transfers and paint samples from suspect vehicles. Clear coat samples and their ultraviolet absorbers are not typically examined or characterized using Raman spectroscopy or microspectrophotometry (MSP), however some past research has been done using MSP. Chemometric methods are also

not typically used for this characterization. In this study, Raman and MSP spectra were collected from the clear coats of 245 American and Australian automobiles. Chemometric analysis was subsequently performed on the measurements. Sample preparation was simple and involved peeling the clear coat layer and placing the peel on a foil-covered microscope slide for Raman or a quartz slide with no cover slip for MSP. Agglomerative hierarchical clustering suggested three classes of spectra, and principal component analysis confirmed this. Factor loadings for the Raman data illustrated that much of the variance between spectra came from specific regions (400 – 465 cm⁻¹, 600 – 660 cm⁻¹, 820 – 885 cm⁻¹, 950 – 1050 cm⁻¹, 1740 – 1780 cm⁻¹, and 1865 – 1900 cm⁻¹). For MSP, the regions of highest variance were between 230 – 270 nm and 290 – 370 nm. Discriminant analysis showed that the three classes were well-differentiated with a cross-validation accuracy of 92.92% for Raman and 91.98% for MSP. Analysis of variance attributed differentiability of the classes to the regions between 400 – 430 cm⁻¹, 615 – 640 cm⁻¹, 825 – 880 cm⁻¹, 1760 – 1780 cm⁻¹, and 1860 – 1900 cm⁻¹ for Raman spectroscopy. For MSP, these regions were between 240 – 285 nm and 300 – 370 nm. External validation results were poor due to excessively noisy spectra, with a prediction accuracy of 51.72% for Raman and 50.00% for MSP. No correlation was found between the make, model, and year of the vehicles using either method of analysis.

Description:

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