B57 Environmental Effects on Automotive Polyurethane Coatings: Implications for Casework

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The goal of this presentation is to present the infrared spectral variability that can occur within the same automotive polyurethane clearcoat to promote a better understanding of how this can influence casework for paint examiners.

This presentation will impact the forensic community and/or humanity by showing paint examiners why it is important to fully characterize polyurethane clearcoats when conducting a comparison analysis of this material. In particular it is important to sample at various depths from the surface or at least to sample at a consistent depth from the surface. Without proper consideration of the internal variability of these coatings incorrect exclusions could be made.

Chemical variability within automotive polyurethane clear coats has been observed in casework at the Centre of Forensic Sciences. These chemical variations were observed in the infrared spectra as differences in the relative intensity of the prominent band at 1690 cm^{-1} with respect to the 1730 cm^{-1} carbonyl band. The differences in intensity appeared to be dependent on the depth from the surface in automotive paints. A common technique of sampling clear coats for IR analysis is to manually slice thin peels, a method that does not permit the depth of sampling to be carefully controlled. This could contribute to the variation, and cause difficulties in interpreting a paint comparison.

It has been documented in the literature that polyurethane paints degrade upon prolonged exposure to UV radiation and water. The chemical changes due to the photo oxidation of these coatings have been studied using infrared and UV spectroscopy. However, in these instances the degradation process was initiated using weathering simulations. It is not known to what extent this degradation occurs under normal exposure to the environment and whether it would vary depending on the location on the vehicle. It has also been reported that the presence of water vapor during the curing process can create depth dependant variability in the polyurethane film. This may also account for the spectral variations observed.

Determining the extent of chemical variation that can occur within polyurethane automotive clear coats of real automobiles (not test panels) would be useful for interpreting these variations when they occur in casework and for developing sampling strategies. Polyurethane clear coats are used extensively as automotive repaints and to a lesser extent as OEM (Original Equipment Manufacture) clear coats, thus they are frequently encountered in cases that require analysis of automotive paint.

Differences of the relative intensities of infrared bands that appear to be reproducible could be interpreted as a differentiating feature between two paints. However, if these differences are due to internal variability of the coating that is not adequately represented then it is not a true difference. Thus, variation within the polyurethane clear coats could cause problems when interpreting infrared data especially when working with very small samples.

Polyurethane clear coats were obtained from a variety of automobiles and were analyzed using Fourier transform infrared spectroscopy to determine the chemical variations within these paints. Chemical changes in the polyurethane clear coats were assessed as a function of depth (distance from the surface) by the examination of cross-sectioned samples by infrared micospectroscopy. Differences over different locations on the automobile were examined using attenuated total reflectance spectroscopy, which is a surface sensitive technique. Distinct chemical variations were observed both as a function of depth, and of location on the vehicle in a significant minority of the samples investigated. These differences could lead to an erroneous interpretation. While demonstrating the spectral variability within a clear coat is time consuming it can be essential to achieving a correct interpretation.

The data from this analysis will be presented and the implications of these findings on data interpretation and sample preparation will be discussed.

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