## A195 Pattern Recognition Based Library Searching Techniques for IR Spectra of Clear Coat Paint Smears

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After attending this presentation, attendees will understand the principles of pattern recognition techniques, advantages of preprocessing and deconvolving vibrational spectra using the wavelet transform, and the importance of coupling search prefilters with library searching algorithms to improve the accuracy of IR spectral searches in the PDQ database.

This presentation will impact the forensic science community by being aware of modern automotive paints using thinner undercoat and color coat layers, but a thicker clear coat layer. All too often, a clear coat paint smear is the only layer of paint left at the scene of a hit and run accident where damage to vehicles or injury or death, especially of the pedestrian, has occurred. In these cases, the text-based portion of the PDQ database will not be able to identify the motor vehicle as to the manufacturer and model. However, crucial investigative lead information from infrared spectra of clear coat paint smears can be extracted from wavelet-transformed spectra using pattern recognition techniques.

Applying a wavelet packet tree to de-noise and deconvolve infrared absorbance spectra of clear coats by decomposing each spectrum into wavelet coefficients which represent the sample's constituent frequency, a genetic algorithm for pattern recognition and feature selection has been used to identify wavelet coefficients characteristic of the manufacturer and model of the automobile from which the clear coat paint sample was obtained. Wavelet coefficients characteristic of the manufacturer and model of the automobile are formulated into search prefilters. Even in challenging trials where the samples evaluated were all the same model (Chrysler or General Motors) with a limited production year range, the respective manufacturing plants could be correctly identified using a search prefilter.

Utilizing search prefilters, many of the problems encountered in library searching can be addressed. Most spectral comparisons performed during a search are of little use because the spectra in question are very dissimilar. A prefilter can quickly spot dissimilar spectra, thereby avoiding a complete spectral comparison. Prefilters allow for more sophisticated and correspondingly more time-consuming algorithms to be used for spectral matching since the size of the library is culled down for a specific match.

Searches currently performed using the PDQ database often generate a large number of hits because the chemical information in the current PDQ database is only described in terms of generic chemical formulations. The major advantage of using the pattern recognition approach to identify paint samples is an increase in search accuracy because spectra from the entire database are searched. Improving discrimination capability between spectra in the database using the wavelet packet transform for spectral preprocessing and the pattern recognition GA to identify informative coefficients permits inter-comparison of original equipment material (OEM) automotive paint layer systems using the infrared spectra alone. This allows comparison of all possible pairs in the database, reducing dependence on the text-based portion of the database, resulting in improved ease of use and fewer errors. By coupling the proposed pattern recognition searches with a library search algorithm that utilizes the cross correlation function, it will be possible to perform similarity searches (i.e. identify spectra in the library that are similar but are not identical to the unknown). If a paint sample is not contained in the PDQ library, similarity searching is crucial for a tentative identification. Currently, there are no algorithms commercially available to perform similarity searching, so this feature is expected to have significant impact in the field of spectral library searching.

**Library Matching, Search Prefilters, Spectral Pattern Recognition**

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