B67 Assessing the Capability of Combining Elemental and Phase Mapping in Automotive Paint Systems Analysis Using Scanning Electron Microscope/Energy Dispersive Spectroscopy (SEM/EDS)

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The goal of this presentation is to familiarize attendees with new methods that are potentially useful in the analysis of automotive paint systems.

This presentation will impact the forensic science community by demonstrating how the combination of elemental analysis and phase mapping using SEM/EDS can provide useful information during forensic analysis of automotive paint systems. The use of this new method may also help confirm elemental compositions among the layers of paint systems, where overlaying of the principal X-ray lines of some elements occurs.

The analysis of automotive paint systems is of utter importance in forensic investigations of hit-and-run accidents to help to identify possible involved vehicle(s) and/or accident dynamics. During the manufacturing process of automobiles, a number of layers of coatings are applied sequentially to the car body to fulfill visual and functional demands. Each layer can be composed of different ratios of organic and inorganic binders, pigments, and additives, which in combination create characteristic automotive paint systems that could be highly distinguishable. When coupled with Fourier Transform Infrared Spectroscopy (FTIR) in forensic paint analysis, SEM/EDS provides comprehensive information regarding the inorganic and organic components of each coating layer. Standard elemental mapping using SEM/EDS provides detailed elemental information, but the indication of possible chemical compounds is limited. In this work, the capability of phase mapping to identify possible constituents and provide supplementary information in addition to elemental mapping is investigated.

The analytical method was developed and tested on 13 automotive paint systems. The paint systems were embedded in epoxy and the surface was thoroughly polished to expose the cross sections of the coating layers. Elemental data were collected in replicates on the Backscatter Electron (BSE) images of the cross sections. Based on the X-ray elemental maps and the quantitative information, such as weight percentage of each element, areas of distinctive composition of elements were identified as phase maps using commercially available software. The distribution, spectra, and major contributing elements of the phases were analyzed in each sample and their corresponding chemical compounds were identified based on mole fractions calculated using weight percentages.

Results demonstrate that phase analysis can be a useful tool in identifying possible inorganic compounds present in automotive paint systems. Elemental and phase maps collected in replicates are repeatable. A slight difference was observed between the experimental and empirical mole fractions, which will lead to further investigation in the range of experimental values for accurate and precise identification of the compounds. In addition, phase mapping may also be used to determine the presence of elements in cases where overlaying of the principal X-ray lines was found. More specifically, Barium (Ba) and Titanium (Ti) were co-detected across two coating layers in three samples, and elemental maps were not sufficient in confirming whether the elements were only present in one coating or in both layers due to the overlaying of K_α line of Ti, and the L_α line of Ba. Phase maps obtained from two of the samples allowed the exclusion of Ba from the E-coats of both samples and produced more resolved spectra for analysis.

The results from this work may provide a tool to identify inorganic compounds in complex automotive paint layers that cannot be accomplished by FTIR and elemental SEM/EDS analyses alone. The application also reveals a promising potential in assisting the interpretation of X-ray lines overlay in standard SEM/EDS analysis.

Automotive Paint Analysis, Phase Mapping, SEM/EDS