J23 Invisible Migration of Luminescent Components in Inks in Crossed-Line Intersections

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Learning Overview: After attending this presentation, attendees will have a better understanding of the interactions of luminescent inks in crossed-line intersections.

Impact on the Forensic Science Community: This presentation will impact the forensic science community by helping determine the chemical identity of the luminescent compounds present in the formulation of inks to better understand the interaction of different inks in crossed-line intersections.

Characterizing the fluorescent components of inks, most commonly dyes, is very useful in document examination for association, discrimination, and intelligence purposes. Optical methods such as fluorescence, infrared luminescence, and spectroscopic methods such as Fourier Transform Infrared (FTIR) spectroscopy, and Ultraviolet/Visible (UV/VIS) spectroscopy rely on these properties. In addition, chromatographic, spectroscopic and mass spectrometric techniques such as High-Performance Liquid Chromatography (HPLC), Gas Chromatography (GC), paper chromatography, Nuclear Magnetic Resonance (NMR) spectroscopy, and Liquid Chromatography/Mass Spectrometry (LC/MS), and Gas Chromatography/Mass Spectrometry (GC/MS) have been applied to the analysis of dyes and pigments.

In recent years, laser desorption has been applied to the analysis of inks, with success in characterizing the dye, pigment, and, more limitedly, the polymeric content of the inks on paper in combination with other techniques such as Thin-Layer Chromatography (TLC) and Raman spectroscopy.

This study involved independent analyses of several inks by three laboratories in Croatia, Macedonia, and the United States. A combination of TLC, GC/MS, HPLC, Matrix-Assisted Laser Desorption Mass Spectrometry (MALDI-MS), Direct Analysis in Real-Time Mass Spectrometry (DART®-MS), and LC/MS were implemented by the three laboratories in order to characterize the luminescent components of inks present in crossed-line intersections. A combination of luminescent compounds, including crystal violet and methyl violet, were characterized and identified to be present in mixtures in the ink formulations utilizing each of the analytical techniques included in this study. When inks interact in crossed-line intersections, invisible migration may occur. This migration is a result of the intersection of the liquid inks with one another, causing a solvation effect. This causes the luminescent compounds, in this case crystal violet and derivatives. However, the temporal sequence of deposition of inks present in crossed-line intersections could not be determined. The protocol described here allows for the isolation and characterization of luminescent compounds present in the formulation of inks to varying degrees, and the information presented here can be used in the future establishment of a standard protocol for the identification of luminescent compounds in inks.

Ink, Crossing-Line Intersection, Crystal Violet