J29 Digital Walkthrough of the Validation of a Method for Measuring Magnetic Flux of Toner-Printed Documents

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Learning Overview: After attending this presentation, attendees will better understand the potential for the use of a quantitative magnetic flux measuring device to differentiate between black-and-white toner-printed documents from different sources. Attendees will gain an understanding of the magnetic characteristics exhibited by toner-printed documents and how to employ magnetic flux measurement techniques during comparative examinations between questioned and reference printed texts, including how to set up the instrument, implement a relevant test method, troubleshoot and optimize their laboratory protocol, and assess the performance of the method.

Impact on the Forensic Science Community: This presentation will impact the forensic science community by providing a method for quickly examining black-and-white toner-printed documents, reducing the need for more time-consuming or destructive methodologies.

This study presents the culmination of a body of work on the magnetic properties of toner. In the first phase of research, the stability of magnetic flux fields over time were assessed, as well as measurement repeatability and the amount of variation present in a representative toner population sample. In the second phase of research, the instrument and method parameters that affect measurement precision and accuracy were assessed. In the third phase of research, measurement signal suppression and enhancement caused by hysteresis effects and other biasing induction current spatial effects were investigated. In the fourth phase of research, measurement repeatability and reproducibility were explored via an inter-laboratory study with a defined methodology optimized based on the parameters found to be optimal in phases one through three. The fifth and final phase of research was conducted with those studies as the foundational basis, and in this phase of research the refined analytical method developed and employed in the fourth phase of this study was independently validated. During the fifth phase of research, a known reference material was developed for use with the magnetic flux measuring device to assist in assessing the precision and accuracy of measurements. This material was synthesized using a three-step process that involved resin synthesis, magnetite synthesis, and toner aggregation. The analytical method was then validated on a representative population sample consisting of 54 toner-printed document samples collected from different devices, using the known reference material as a positive reference material in addition to the previously utilized positive and negative quality control samples. During the validation study, the bias and precision, limit of detection, limit of quantitation, suppression and enhancement, and stability of measurements were assessed.

It was found that magnetic flux measurements of toners were stable over time, measurements were repeatable, and the variation between different toner samples within the population collected for this study was large enough to appreciate the relative rarity of the measured magnetic flux value, though there were some instrument and method parameters identified that could cause inaccurate or imprecise measurements. These parameters could be controlled by the implementation of a standard analytical methodology. Magnetic flux measurements of toner-printed documents conducted via a standardized analytical methodology in conjunction with a known reference sample were found to provide a promising method for deployment in forensic laboratories. The method proposed is rapid, non-destructive, requires no sample preparation, provides numeric results that can be objectively interpreted, and does not require costly consumables.

Questioned Documents, Toner, Magnetic Flux

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