

## **IMPLEMENTATION OF ION BEAM ANALYSIS FOR FORENSIC APPLICATIONS: THE WAY TO GLOBAL FORENSIC DATABASE THROUGH THE UNIFICATION OF DIFFERENT ANALYTICAL TECHNIQUES**

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Forensic sciences are often key to obtaining a conviction in a trial. However, obtaining and analyzing evidence found during the investigation is not an easy task as evidence may be tiny and found in small quantities. Of the various forensic techniques used, elemental analysis of materials has become increasingly valuable for its ability to extract forensic insights from a few tiny specimens.

IBA techniques are a subfield in elemental analysis that is recognized for its sensitive and accurate measurements of a broad range of trace elements, thus being suitable to identify chemical fingerprints. Additionally, the non-destructive character of IBA methods, which permits to repeat and multiply measurements without destroying or spoiling evidence is valuable for small amounts of evidence. Combining various IBA techniques (PIXE, PIGE, NRA, RBS, ERDA, and recently, MeV-TOF-SIMS) into a unified database is extremely powerful for determining provenance markers of the different materials, their manufacturing processes and the alteration induced by the environment.

In this talk, the results of the studies from different labs will be presented, showing the types of samples, such as food and drug provenance or glass fragments, where IBA demonstrates considerable promise. The main focus of this talk will be concentrated on how the combination of PIXE with other IBA techniques (PIGE, PGAA) can be used to provide a unified database of glass fragments that were collected from various vehicles covering different manufacturers and years of production and received from Israeli Division of Identification and Forensic Sciences (DIFS). Moreover, we will demonstrate that the combination of elemental analysis using IBA and Machine Learning tools provided a reliable classification model with high (>87%) accuracy in identifying glass fragments origins, that can be potentially used by different laboratories around the world. We believe that using this methodology of combining various sources of measurements will both improve model performances and make the models accessible to law enforcement agencies that do not have access to IBA. Finally, the workflow presented in this talk can be extended to many other domains of forensics (e.g., gunshot residues, flammable liquids, substances of abuse, etc).