Reducing Sample Amount for the Forensic Analysis of Float Glass Fragments

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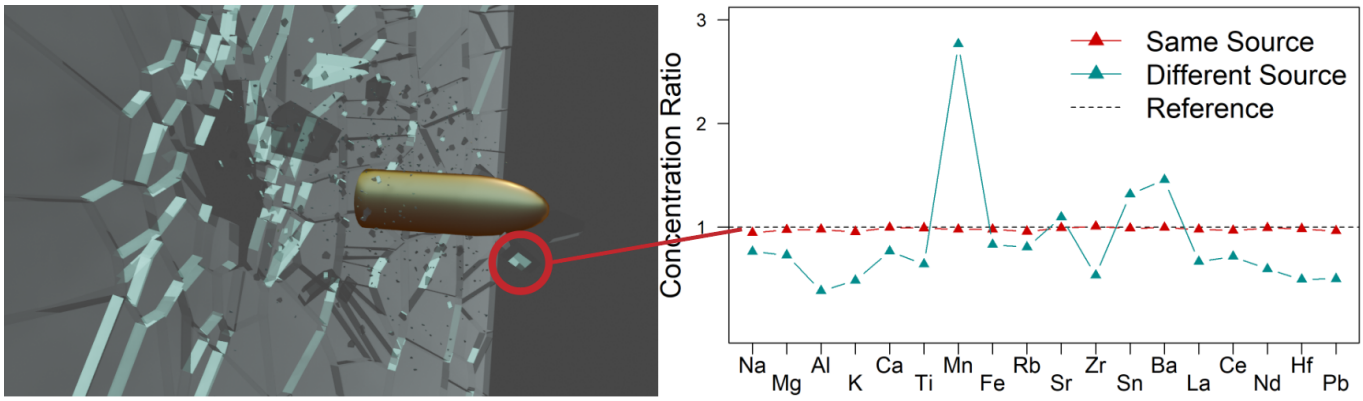
Float glass is a common piece of evidence in burglaries, car crashes and violent crime. The matching of a fragment found in a suspect's clothes or skin to broken glass at the crime scene can be a strong link between the two.[1] Currently, refractive index measurements and elemental fingerprint matching are used to determine the source of a glass fragment. While refractive index measurements suffer from a high rate of errors, elemental fingerprint determination requires a sample volume that is often larger than the common pieces of evidence. Laser ablation inductively coupled plasma mass spectrometry (LA-ICP-MS) for the determination of elemental fingerprints has proven to be the most efficient analytical method for glass fragments, requiring fragments that are approx. 400 x 200 x 100 µm in size.[2] However, half of the recovered samples are smaller than that, limiting the application of the method.[3]



In this work, a new LA-ICP-MS method was developed using a low dispersion ablation cell allowing for a resolved laser pulse analysis of fragments. Due to the fast aerosol washout, multi-elemental analysis with sequential mass analysers was no longer possible. As such, a time of flight mass spectrometer was used for quasi-simultaneous detection of multiple elements. This layer-by-layer approach provides more information from small samples and decreases the required sample volume significantly (approx. 20 µg to 0.8 µg). Furthermore, the increased amount of data points allows the use of new statistical treatments such as multivariate statistical tests. This work investigated different matching procedures, achieving comparable error rates to the established method, while requiring 25x less sample material. Additionally, the effect of aerosol transport on the matching of glass fragments was investigated, with a focus on the effect of uneven samples in low dispersion laser ablation. As a result, the low dispersion ablation cell was modified to allow better aerosol transport for large spot sizes and uneven samples.

[1] R. J. Watling, B. F. Lynch and D. Herring, *J. Anal. At. Spectrom.*, **1997**, *12*, 195–203.
[2] P. Weis, M. Dücking, P. Watzke, S. Menges and S. Becker, *J. Anal. At. Spectrom.*, **2011**, *26*, 1273–1284.
[3] P. Becker, C. Neff, S. Hess, P. Weis and D. Günther, *J. Anal. At. Spectrom.*, **2020**, *35*, 2248–2254.