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ToF-SIMS Imaging of Heritage Materials: Tackling Analytical Challenges to Widen the Interdisciplinary Impact

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Preserving art objects requires understanding their structure and composition. They are made of both organic and inorganic materials that have aged and interacted within uncontrolled environments over long periods. The multiple links between the microstructure and the macroscopic properties are increasingly being investigated in heritage science through interdisciplinary collaboration, fostered by the improved sensitivity and spatial resolution in analytical techniques used to investigate heritage samples.[1] Time-of-flight secondary ion mass spectrometry (ToF-SIMS) imaging has grown in relevance in the context of heritage science over the last decades. Its main asset is the simultaneous localization and identification of both organic and mineral components with sub-micrometer resolution at the surface of a sample. It has already shown its suitability for samples such as historical painting cross-sections.[2]

A first challenge is the identification of reliable marker ions in the mass spectra for a given historical compound detected in a specific location in the aged painting. This requires a deep understanding of the sample itself at the micrometre scale, of the changes happening at its interfaces, and of any contaminants. Access to state-of-the-art instruments with tandem MS capabilities, and an optimized approach for analysing heterogonous insulating samples is critical. Additionally, the methodology developed to perform Tof-SIMS imaging on art objects can be extended to other types of oddly shaped heterogeneous insulating surfaces. Another stimulating goal is identifying and mapping proteinaceous materials simultaneously with other ingredients, which will be extremely valuable to conservation experts as they are ubiquitous in paintings.

ToF-SIMS imaging of heritage objects yields datasets where some information is yet to be understood. To facilitate information sharing in this interdisciplinary context, communication ways need to be adapted to the end users, such as conservators and art historians, i.e. to allow them to browse and annotate the data from their own viewpoint. The SCIMITAR project is tackling all these exciting challenges, and the latest results will be presented.[3]

References

[1] C. Bouvier, A. Brunelle, and S. Van Nuffel, in *Applications of Mass Spectrometry for the Provision of Forensic Intelligence*, ed. S. Francese and S. Bleay, Royal Society of Chemistry, 2023, vol. 14, ch. 10, pp.236-264

[2] C. Bouvier, S. Van Nuffel, P. Walter, A. Brunelle, *J. Mass Spectrom*., 2022, **57(1)**, e4803

[3] SCIMITAR Project Description, https://doi.org/10.3030/101108506