MeV SIMS as an emerging nuclear analytical technique for surface analysis of paint materials in cultural heritage

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The preservation of works of art as cultural heritage requires sensitive analytical techniques that can help identify the materials that were originally used by the artist. Accurate determination of major constituents of paints as well as understanding their chemical stability provides invaluable information to restorers and curators, and usually requires a multi-analytical approach for chemical characterization.

Secondary ion mass spectrometry with MeV primary ions (MeV SIMS) is an accelerator-based nuclear analytical technique that has great potential for studying organic materials in cultural heritage objects due to its high surface sensitivity, higher secondary molecular ion yields, lower fragmentation, and higher mass range than conventional (keV) SIMS, as well as chemical imaging capability [1–3]. This technique allows investigating the chemical composition and degradation phenomena that occur in the uppermost layers of materials without the need for sample preparation [4]. This is an added value as surface layers cannot be analyzed by e.g., standard chromatographic methods coupled to MS. In addition, MeV SIMS can also be considered as non-destructive since primary ion doses are well below the so-called static limit, so the sample may be preserved for subsequent characterization by other techniques.

The use of MeV SIMS to study the works of art is only beginning to be recognized as currently only a few accelerator laboratories around the world develop and utilize this method. In this work we will present current research on artists' paints performed at the Ruđer Bošković Institute accelerator facility, where two MeV SIMS setups have been developed for the analysis and molecular imaging of organic materials [2,3]. The focus is on the analysis of a wide selection of pigments, binders, mock-up paint mixtures and commercial products that fall into categories of both traditional and modern materials. The aim is to investigate the ability of detecting and identifying individual components in complex paint mixtures by building an MeV SIMS mass spectra database that would facilitate material characterization in surface analysis and chemical imaging of real art samples, aged paints, or paint cross-sections. To this end, several examples of real samples analysis are also presented and discussed.

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