The nuclear microprobe in cultural heritage studies: state of the art and challenges

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At the crossing of physical sciences and humanities, the characterization of cultural heritage materials addresses central issues of art history, archaeology and conservation science, such as ancient manufacture technologies, raw materials procurement and artefact preservation. Among the wide panel of analytical techniques employed, ion beam analysis plays a prominent role due to an almost unique combination of excellent analytical features in terms of sensitivity and accuracy, joint with a non-destructive and even non-invasive character. The advantage of the nuclear microprobe, with respect to broad beam IBA, stems from its ability to take into account the frequent multi-scaled heterogeneity of materials constituting artworks and archaeological objects. The combination of multiple IBA techniques with a micron-sized beam provides a unique 3-D imaging tool for a large range of elements including light ones. If the full potential of the microprobe can only be realised under vacuum, thus on small items or on samples, external micro-beam setups featuring a degraded lateral resolution (20-50 µm) appear satisfactory for many applications, and fulfil the non-invasive character required for the study of precious artefacts. In addition to the ease of target handling and positioning in front of external micro-beam end-stations, the combination of a fast beam deflection with a mechanical translation of the target enables large scale high resolution mapping up to centimetres.

This communication will present the state of the art of nuclear microprobe applied to Cultural Heritage. The variety of activities in the field conducted at facilities throughout the world will be surveyed, with special focus on the shared transnational access to NMP to study cultural heritage offered in Europe (CHARISMA FP7 program). New developments targeted at such applications, both from instrumental and data processing viewpoints, will be depicted through recent examples conducted with the AGLAE external microprobe. The place of the NMP among other microprobes, ranging from laboratory instruments (Raman and electron probes) to the most advanced ones at large scale facilities (Synchrotron) will be reassessed. The pending challenges of the application to Heritage will be stressed, such as the development of high speed data acquisition system for the fast mapping of areas, and of software tools for mining the massive dataset generated. The study of delicate items such as paintworks constitutes another major defy. In this specific case, the reduction of the damage induced on sensitive constituent materials (lead white, varnish, bindings, etc) by the high fluences required by NMP calls for new damage monitoring and mitigation strategies.

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