Contribution ID: **75** Type: **ORAL**

Accelerators, X-rays and cultural heritage: combining micro and macro level investigations with different purposes in mind

Thursday, 16 June 2022 08:30 (30 minutes)

Cultural heritage artefacts such as paintings, stained glass windows and (illuminated) manuscripts are examples of complex macroscopic objects consisting of a multitude of different materials, in close proximity to or in intimate contact with one another. Given sufficient time and a number of external stimuli (such as impinging UV and visual light, variable relative levels of humidity or of reactive volatile species from the ambient atmosphere) these react with one another and form secondary products. When such spontaneous chemical reactions negatively influence the mechanical properties of the artefact at the macro-level or significantly change one of its relevant properties (color, surface texture, ⋯), they become noticeable. Understanding the mechanisms and principal factors that trigger or determine the speed of these alteration reactions is very relevant for both preventive and corrective art conservation.

To gain such insights, employing a combination of analytical methods that allow to extract information on the chemical constituents of the degraded surface of CH artefacts at different length scales, has been proved to be very effective. Preferably (but not all) such methods are non-invasive, i.e. do not cause damage to the CH artefacts being studied.

At the macro-scale, various forms of hyperspectral imaging can be used. Macroscopic X-ray fluorescence (MA-XRF) and diffraction (MA-XRPD) are non-invasive imaging methods with intermediate to high chemical specificity that are very suitable for examining the surface of CH artefacts, either to obtain information on the original materials used to construct the artefacts or on any surface alteration that took place during the artefact's history. MA-XRF and MA-XRPD scanners can be constructed using X-ray tube sources.

Large scale particle accelerators such as synchrotron facilities are able to generate X-ray beams of sub-micrometer dimensions. It is thus possible to study heritage materials at the nanometer to micrometer level. Methods such as (sub)microscopic X-ray fluorescence, X-ray absorption spectroscopy and X-ray diffraction, either used sequentially or simultaneously, allow to study minute samples of CH artefacts, complementing the information obtained by macro-level investigations and allowing to formulate hypotheses on the manufacturing technology the artefacts and/or degradation mechanisms that have modified their surface.

As a first example of the combined use of micro- and macro-level chemical imaging methods, the study of metal-based inks used to write Egyptian papyri will be discussed. Red and black inks inscribed on 12 ancient Egyptian papyrus fragments belonging to the Papyrus Carlsberg Collection (Copenhagen), deriving from the Tebtunis temple library"in Fayum, Egypt were analyzed using synchrotron-based 2D elemental and phase mapping.

Another example of a macro/micro combination that will be discussed involves the examination by MA-XRF and scanning electron microscopy coupled to energy-dispersive X-ray analysis of a medieval stained-glass panel formerly from Notre Dame, Paris revealing its material history, including the degradation of the substrate glass and some of the glass paints employed to create it.

Last example involves the use of micro- and macro-level XRF and XRPD for the study of the pigments and their degradation behavior in Rembrandt's masterpiece 'The Nightwatch', a large oil on canvas from the 17th C.

Primary author: Mr JANSSENS, Koen (AXIS Research group, NANOlab Centre of Excellence, University of Antwerp, Belgium)

Co-author: COLLABORATORS (AXIS Research group, NANOlab Centre of Excellence, University of Antwerp)

Presenter: Mr JANSSENS, Koen (AXIS Research group, NANOlab Centre of Excellence, University of Antwerp, Belgium)

Session Classification: Application of accelerator science and technology for characterization and treatment of heritage objects

Track Classification: Track 1: Application of accelerator science and technology