

Understanding the spontaneous degradation of painted works of art: multimodal and multi length scale characterization using X-ray beams

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The AXIS research group of the University of Antwerp (BE) makes use of different synchrotron X-ray microprobe beamlines in Europe: ID21 at ESRF for low energy micro-XRF and -XANES, P06 at PETRA-III for high energy micro-XRF, -XANES and -XRD, the PUMA beamline at SOLEIL for micro-XRD and the micro-XAS beamline at SLS for 2D and 3D micro-XRF. The application area mainly targeted is the cultural heritage/fine art sector, where our focus is on pigment use and pigment degradation in artworks by 15-20th c. artists. These studies usually are done in collaboration with major European or American museums such as the Rijksmuseum (Amsterdam, NL) and the National Gallery of Art in Washington DC (US). Next to that, we regularly participate in synchrotron measurement sessions aimed towards studying the behavior of radionuclides in/their effects on the environment, in particular the transfer of radionuclides from the aqueous medium towards biota. Here we collaborate with the CERAD Centre of Excellence of the University of Aas (near Oslo, NO).

Our studies on the spontaneous degradation of works of art usually comprises two stages/length scales in which we first employ self-built mobile macro-level scanners (doing XRF and XRD measurements) that operate in a non-invasive manner. The elemental and crystal phase maps that result usually provide a wealth of information on the materials used by the artists to create the artworks and on their state of preservation. However, to obtain more complete insights into the chemical transformations that have occurred at and below the surface of painted artworks, sampling of the paint and (sub)microscopic mapping XRF, XANES and/or XRD of the components of the resulting paint stratigraphies is highly relevant in many cases.

Relevant examples of studies involving 13th -20th c. wall, panel and canvas paintings will be presented. These will be used to underline that, next to the elemental maps provided by macro- and micro-level XRF, in the majority of cases, more compound- or oxidation state-specific information is required to answer questions related to artwork degradation. This makes it almost in all cases necessary to employ one or more companion techniques together with macro/micro XRF. Preferably these measurements are all done simultaneously in the same multimodal synchrotron beamline.

Primary author: JANSSENS, Koen (University of Antwerp)

Presenter: JANSSENS, Koen (University of Antwerp)