Multiple scale length studies of cultural heritage materials and objects by synchrotron radiation X-ray methods and non-invasive spectroscopic techniques

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Cultural heritage objects are complex and heterogeneous systems made up of organic and inorganic compounds, with either amorphous or different crystalline structure, that can undergo chemical changes over time. Original constitution materials and degradation compounds can be distributed as layers and aggregates within the object, by reaching sizes down to the order of few hundred nanometres. To get the highest level of information from the object under investigation, it is therefore necessary to combine a set of complementary analytical methods that are capable to provide elemental speciation, molecular and structural information at multiple scale lengths.

Synchrotron radiation-based (SR) X-ray techniques (i.e., XRF, XAS and XRD) have been increasingly used within the last decades for their capabilities to provide spatially resolved elemental speciation and structural information down to the (sub)micrometre scale length. [1-4] Additional insights into the molecular nature, optical and electronic properties of original components and related degradation compounds have been gathered instead by UV-Vis-NIR and vibrational (micro)spectroscopies (IR and Raman). Moreover, macro-scale non-invasive investigations by portable devices (operating from the IR to X-rays range), carried out *in situ* directly at the surfaces of artworks, have been exploited to identify original materials and map areas where alterations are currently in development. [5]

This lecture will provide an overview of our research activities aimed at understanding the degradation mechanisms of selected artists'pigments in paintings (i.e., chrome yellows, arsenic sufildes, Prussian blues, cadmium yellows and reds) and the carbonatation of calcium-based consolidants into limestone matrixes. [6-11] SR-based X-ray data acquired at beamlines ESRF-ID21/-ID26/-BM08 (Grenoble, FR) and PETRA III/DESY-P06 (Hamburg, DE), in combination with molecular spectroscopy results obtained from the analysis of artificially aged mock-ups, historical artworks and related micro-samples will be presented. Issues related to SR X-ray induced damages of painted surfaces and strategies for mitigating them will be also discussed. [12]

References

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