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Synchrotron radiation-based X-ray methods and vibrational spectroscopy techniques for the study of cultural heritage materials: a multi-method and multi-scale approach

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Cultural heritage objects are heterogeneous systems composed of organic and inorganic compounds, with a different extent of crystallinity, that may be subjected to complex chemical and physical transformations over time. Analytical investigations are further complicated by the fact that original constitutive materials and corresponding secondary products of artifacts and works of art can be present as layers and aggregates with sizes down to a few hundred nanometres. Thus, the use of complementary analytical tools that are capable to provide spatially resolved elemental speciation and molecular/structural information at multiple scale lengths is highly desirable to get the maximum level of information from the object/samples under investigation.
In such context, the use of synchrotron radiation-based (SR) X-ray techniques, including XRF, XAS and XRD (in point analysis and 2-D/3-D mapping/imaging mode), has grown up within the two last decades for their capabilities to provide spatially resolved elemental speciation and structural information down to the nanometric scale length. In general, the integration of these methods with a wide range of laboratory techniques (e.g., electron microscopy, UV-Vis spectroscopy, vibrational spectroscopy…) is highly desirable in order to acquire complementary insights into the chemical nature and spatial distribution of the constitutive materials and newly formed compounds in the analysed object.
This lecture will focus on the description and discussion of a series of case studies published in the literature during the last 10-15 years, in which X-ray beams (employing SR and traditional sources) of nanometer to millimeter dimensions and molecular spectroscopic methods have been used for non-destructive/non-invasive studies of different types of cultural heritage materials (i.e., ceramics, glasses, paintings, stones.