

## **X-ray based imaging and spectroscopy of cultural heritage materials**

K. Janssens,

*Department of Chemistry, University of Antwerp, Universiteitsplein 1, B-2610 Antwerp, B*

The mission of cultural heritage institutions is to preserve and protect artifacts from the distant or more recent past. In order to fulfill this mission in a professional manner, detailed knowledge on alteration phenomena of various kinds that gradually and unobtrusively are taking place at or below the surface of these objects is required. In order to be able to investigate the nature of these chemical transformations that sometimes lead to the formation of microscopically thin alteration layers, the use of state-of-the-art micro analytical methods is required. Next to being able to provide information on the composition of various materials at or just below the surface, these methods also must be able to deliver highly specific information on the nature of the chemical compounds that are locally encountered. In this respect, our recent experience shows that the use of a combination of synchrotron X-ray based spectroscopic and imaging methods such as X-ray fluorescence analysis, X-ray absorption spectroscopy and X-ray diffraction can reveal significantly new information of certain alteration processes that have remained enigmatic for a long time. Concrete examples to be discussed is the darkening of originally yellow lead chromate paint layers, as encountered in paintings of V. Van Gogh and the blackening of red cinnabar-based paint layers in works of Rubens.

Since many decades, X-ray radiography (XRR) is a standard method employed in many cultural heritage institutions and musea to non-destructively inspect paintings. XRR can reveal hidden/overpainted layers in such artifacts, provided the absorption contrast is sufficiently large. By employing element-specific X-ray fluorescence and/or crystal-phase specific X-ray diffraction contrast instead of the X-ray absorption contrast, the information that can be recorded about hidden layers in a painting can be significantly enhanced. The possibilities and limitations of using macroscopic XRF and XRF/XRD scanning for investigation of paintings by artists such as Vincent van Gogh and Rembrandt van Rijn will be discussed.