

X-RAYS IN ART AND ARCHAEOLOGY – HISTORY, PRESENT STATE AND PERSPECTIVES

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The application of x-rays to objects of art and archaeology and the attempt to gain valuable insights into the construction as well as the chemical composition in a non-destructive manner is more or less as old as the knowledge of the radiation itself. Wilhelm Conrad Roentgen and his coworkers have already investigated paintings, metallic artifacts and polychromed sculptures. Nowadays, x-ray radiography or computer tomography are standard techniques widely used and accepted by art historians, archaeologists, curators and conservators as these methods enable information about the manufacturing process and the condition of an object without “touching” the artifact or even taking original sample material.

Among the instrumental techniques, which have been applied to studying the material composition of objects of art and archaeology, both x-ray fluorescence (XRF) and x-ray diffraction analyses using x-, γ - or synchrotron radiation as well as particles such as protons (particle induced x-ray emission: PIXE) have gained growing interest in the last decades. XRF and PIXE are in principle applicable to all elements except the first two (H, He) of the periodic system. However, it is quite difficult to measure many light elements and these require advanced instrumentation, which often limits practical work to atomic numbers above 11 (Na). Even in that case, the detection of the characteristic radiation of the elements with an atomic number between 11 and 16 (Na – S) is difficult due to the fact that most of the instruments used for non-destructive analysis of artifacts are air-path systems and the characteristic radiation of the elements Na – S is absorbed by the ambient atmosphere. Additionally, traditional instruments use an x-ray beam of several mm in diameter, which limits the application of XRF to specific problems such as the identification of pigments in miniature paintings or tiny decorations of objects made of glass, ceramics or metals.

In this presentation a short historic overview of the techniques used in art and archaeology will be presented and the applicability of XRF and XRD as a tool for non-destructive investigations of objects of art and archaeology will be discussed. A word about the concept of “non-destructive” might be necessary, as for the scientist this term is identical with preserving the sample, whereas for a curator or conservator it has the connotation that no original sample material must be taken and the object is not changed or altered at all. Newly developed micro x-ray tubes used in combination with polycapillary lenses for focussing the primary beam to less than 100 μm as well as highly sensitive detectors for the secondary x-ray radiation are an additional step forward to fulfill the requirements for non-destructive analysis of such objects, which are in cases unique.