Trace Element Analyses with Synchrotron Radiation Induced X-ray Fluorescence

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Synchrotron radiation x-ray fluorescence (SRXRF) analysis has become an advanced and essential analytical technique in many fields of research: e.g. life and environmental sciences, medical applications, energy related and new (nano) functional material developments, forensic chemistry, industrial or cultural heritable applications, and earth or planetary sciences.

There is not one, but various types of x-ray fluorescence analyses, which relate to the different excitation/detection possible geometries. The efficient use of each of these techniques requires instrumental developments including source, detector and challenging sample environments for in situ analysis, set-up characterization, accurate sample preparation, software developments, theoretical considerations, and combination with other tools of characterization, including laboratory based-methods.

Nano and fast (on-the-fly) synchrotron radiation x-ray fluorescence, current state of the art, offering elemental imaging with high lateral spatial resolution, is the most attractive and important SRXRF. Along with however, confocal XRF microscopy for depth analysis, fluorescence tomography for three-dimensional analysis, and projection-type imaging for rapid analysis are in constant expansion. Total reflection x-ray fluorescence has been developed for ultra-trace elemental quantification, chemical state, and surface analyses. Grazing incidence and grazing exit have found a regain of interest with their ability to provide precise elemental depth analysis of complex nano-stratified materials, with high sensitivity and at the nanometre scale. All these methods can be combined with a tunable monochromatic beam to give access to elemental speciation determination via x-ray absorption spectroscopy, and other techniques can be associated, such as x-ray reflectometry, x-ray diffraction, x-ray excited optical luminescence, Raman, etc.

The development of synchrotron radiation x-ray sources has extended greatly the capabilities of x-ray fluorescence analysis for the determination of trace element concentrations. A brief description of synchrotron radiation properties will be given in order to discuss the improved analytical capabilities, and in particular the improved detection limits compared to existing laboratory x-ray fluorescence techniques.