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Application of X-ray spectroscopy instrumentation in Forensic Sciences

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Most forensic studies deal with the identification and characterization of a sample, which is the evidence of some crime activity, comparison of samples coming from different sources, and interpretation of the results obtained in the context of the events. X-ray instrumentation has been commonly used in forensic science and also in some related fields such as Cultural Heritage objects authentication. Main strengths are its non-destructive nature, thus preserving crime evidences and materials integrity, its ability to identify chemical compounds, to determine elemental chemistry and, in some cases, elemental speciation. Moreover, the versatility of the X-ray techniques permits the analysis of very diverse materials, -inorganic, organic, metals-, in powder, solid or liquid forms.

Different X-ray spectroscopy based tools, just as many other analytical techniques, have been applied for the analysis of crime evidences. Classical X-ray based techniques used in forensic work are X-ray powder diffraction (XRD), X-ray fluorescence (XRF), X-ray imaging and energy dispersion X-ray emission linked to an electron microscope (SEM-EDX). These complementary techniques are mainly used for micro- and macro- trace analysis. Conventional macro-XRF, whilst attractive for the forensic analyst, sometimes cannot be applied because in the majority of cases crime scene specimens are microscopic in nature. The common bench-top XRF systems have analysis spot of perhaps 2–4 cm, and are unsuited to perform, for instance, analysis of a 100 μm pieces or even less size.

During the last decades, noticeable development was made in the instrumental aspects of X-ray spectrometry, especially in the improvement of X-ray optics and detection systems. All this resulted in a wide variety of instrumentation becoming available nowadays. Significant advances in focusing optics (development of collimators and polycapillary lenses) have promoted the design of micro beam sources for the analysis of small regions by conventional X-ray instrumentation. The use of automatized XYZ stages allows the possibility to choosing point, line profile or mapping analyses. A microscopic particle from a crime scene can be directly analysed without any sample preparation, simply located using optical cameras, and subsequently characterized for elemental content.

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