C8 Two-Dimensional X-Ray Diffraction for Forensics and Archaeology

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After attending this presentation, attendees will gain an understanding about the basic concept and recent advances of two-dimensional X-ray diffraction, including the key technology, configurations, and applications relevant to forensics and archaeology.

This presentation will impact the forensic science community by introducing the two-dimensional X-ray diffraction as a powerful material characterization tool as well as the advantages for forensics and archaeology. This presentation will provide experimental examples both in general material research and forensic studies.

Compared to the conventional X-ray diffraction, the two-dimensional diffraction pattern contains not only the diffraction intensity distribution in two-theta direction based on the Bragg law, but also the diffraction intensity distribution along the gamma direction (along the diffraction ring).[1] The intensity distribution and two-theta variation along the gamma direction can reveal the strain, crystallite orientation distribution, and size. The diffraction patterns, appearing identical with the conventional X-ray diffraction, can be significantly different if observed with two-dimensional diffraction. Therefore, two-dimensional X-ray diffraction can distinguish two samples with identical chemistry content and phase as long as they were formed at different conditions. Two-dimensional diffraction patterns are also easy to compare, evaluate, and present to the courtroom.[2]

The recent advances in two-dimensional X-ray diffraction have significantly benefited forensics and archaeology. The brilliant X-ray sources can deliver highest X-ray flux for fast data collection and deal with small sample volume, weak diffraction, and low concentration. The point focus preferred with the area detector is very suitable to point the X-ray beam to the interested area of evidence and controlled substance. The photon-counting area detector with a large detection area, high sensitivity, high resolution, and near-zero background noise can reveal the phase, crystal structure, crystal particle size, and crystal orientation from a very small amount of the sample. Typical analysis for forensics and archaeology involves identification of materials and structures from a small amount or a small area of samples, also referred to as microdiffraction. In order to preserve the original evidence and art, the analysis must be done non-destructively and without sample treatment. Two-dimensional X-ray diffraction is an ideal, non-destructive, and highly sensitive analytical method for examining samples of all kinds, such as metals, polymers, ceramics, soils, coatings, paints, biomaterials, and fibers for forensic science and archaeology. Sample alteration or treatment is typically not necessary and the data collection can be repeated many times without any damage to the sample. Two-dimensional diffraction patterns contain abundant information and are easy to observe and explain in the courtroom. This presentation will cover various applications used for forensics and archaeology analysis. Experimental examples for general materials characterization, including phase identification, texture and microstructure analysis, and case study examples in forensics and archaeology are also given.

References:

1. Bob He, *Two-dimensional X-ray Diffraction*, John Wiley & Sons, 2009.
2. W. Kugler, X-ray diffraction analysis in the forensic science: the last resort in many criminal cases, *Advances in X-ray Analysis*, 2003, 46, 1-16.

XRD, Microdiffraction, Area Detector

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