

TISSUE ELEMENTAL MAPPING USING HDXRF WITH DOUBLY CURVED CRYSTALS

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The bio-essential elements Fe, Cu, and Zn are thought to be major contributors to the pathogenesis of cardiovascular and neurological disorders, and perhaps other diseases. High-definition x-ray fluorescence (HDXRF) is a convenient method for mapping of elemental distributions in tissues collected by biopsy or autopsy. Monochromatic beams give a low signal-to-noise ratio and, therefore, higher sensitivity than other methods. The micro-focusing beam also provides mapping with high spatial resolution.

The excitation x-ray beam is constructed from a conventional laboratory x-ray tube. It is focused by doubly curved crystal (DCC) optics based on Bragg diffraction. The monochromatic focusing beam strikes a tissue sample and produces x-ray fluorescence of metals in the specimen. An energy dispersive detector (ED) is used to detect the fluorescence spectrum. The tissue sample is scanned in the x-y plane that lies perpendicularly to the focused x-ray beam, allowing observation of highly localized metal concentrations. Metal composition at each location can be determined through ED spectra.

This work demonstrates the use of DCC optics in obtaining a monochromatic focusing beam. The experimental system was constructed using a 50 W x-ray tube, DCC optics, and a silicon drift detector. A beam spot of 70 μm was obtained. X-ray fluorescence lines were detected for Fe, Zn, and Cu in human brain tissues while the sample was scanned in an x-y plane. Trace elemental tissue mappings for both normal and abnormal tissues were performed.