Beyond the characteristic lines: recognizing composition in biological tissues using X-ray Fluorescence

S. Pessanha[1,2], S. Pandolfi[1], J. Silva[1], R. Inocêncio[1], F. Silva[2], J.P. Santos[1], A. Félix[2,3], J. Machado[1]

[1]LIBPhys, NOVA School of Science and Technology, Campus Caparica, 2829-516, Caparica, Portugal
[2]NOVA Medical School, Campo Mártires da Pátria, 1169-056, Lisboa
[3]Instituto Português de Oncologia de Lisboa Francisco Gentil
e-mail: sofia.pessanha@fct.unl.pt

Energy Dispersive X-ray fluorescence is an analytical technique that takes advantages of the characteristic radiation emitted by atoms, after ionization of the inner shells using X-rays. However, other processes of interaction of X-rays with matter can be used to gauge information on sample's composition.

The suitability of comparing the Compton-to-Rayleigh ratio of the characteristic lines X-ray tube in an EDXRF spectrum to obtain the mean Z was already established [1-3]. For a given experimental configuration (scattering photon energy and geometry) a curve based on model samples of varying atomic number can be built, in order to gauge the dependence of the Compton-to-Rayleigh ratio with the sample's mean Z. In this work, such curve was built using model samples consisting of different proportions of reference materials of hydroxyapatite [Ca10(PO4)6(OH)2], and boric acid [H3BO3], a 20 mm thick block of PMMA (polymethyl methacrylate) and a 10 mm thick block of paraffin (CnH2n+2, used for sample embedding). This way, a mean atomic number range of 5.2 <Z< 14.2 was obtained.

This calibration curve was developed for a portable X-ray fluorescence setup with triaxial geometry (3pXRF) and applied to animal hard tissues such as ivory, bone and teeth, in order to evaluate the collagen content, otherwise invisible to XRF. Also, Formalin-fixed Paraffin Embedded tissues, collected during biopsies and surgeries, were evaluated using this approach and two different incoming energies, in order to compare different probing volumes, assess the thickness of the samples and evaluate dark matrix composition.

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