Quantitative AES IX and Quantitative XPS II: Auger and X-Ray Photoelectron Intensities and Sensitivity Factors from Spectral Digital Databases Re-Analysed using a REELS Database

National Physical Laboratory, Teddington, Middlesex, UK
email: martin.seah@npl.co.uk

An extension has been made of previous analyses of peak area intensities for elemental spectra in digital AES and XPS databases [1,2]. The intensities, instead of being analysed after removal of a background using the Tougaard Universal cross section [3], are now analysed after removal of the extrinsic characteristic loss background by deconvolving the relevant angle-averaged reflected electron energy loss spectrum (REELS) [4]. These latter spectra are calculated from a digital REELS database using a recently defined scaling of the characteristic losses. The new background removal procedure leads to an improvement in the correlation between experiment and theory for intensities in both AES and XPS. The spectra now have typically 29% intrinsic loss intensity, compared with 115% using the Tougaard Universal cross section.

Analysis of the correlations shows that a systematic divergence remains for each element, which is the same for XPS as for AES, attributed to an inadequacy either of the angle-averaged REELS method or of the material-to-material dependence of the TPP-2M equation used in the calculation of the IMFPs. Correction for this is possible in a new matrix-less quantification formulation [2] using average matrix sensitivity factors (AMRSFs). This leads to correlations between experiment and theory with scatter factors of $\sqrt{\langle x^2 \rangle / \langle x \rangle^2} = 1.08$ and $\sqrt{\langle x^2 \rangle / \langle x \rangle^2} = 1.11$ for AES and XPS, respectively, for a wide range of elements and peaks. These excellent correlations underpin the choice of formulae to calculate AMRSFs for quantification in spectrometers giving true spectra, or those spectrometers that may be calibrated to provide such spectra, as shown in Fig 1 (a) and (b).

![Fig 1](image1.png)

Fig 1 Calculated average matrix sensitivity factors: (a) AES - for K shell (•), L shell (◆), M shell (○) and N shell (x) for a 10 keV electron beam at 30° to the surface normal, (b) XPS - for the 1s (●), 2p (◆), 3p (◇), 3d (○), 4p (◆), 4d (□), 4f (x), 5p (○) and 5d (☆) electrons for Mg X-rays at the magic angle.