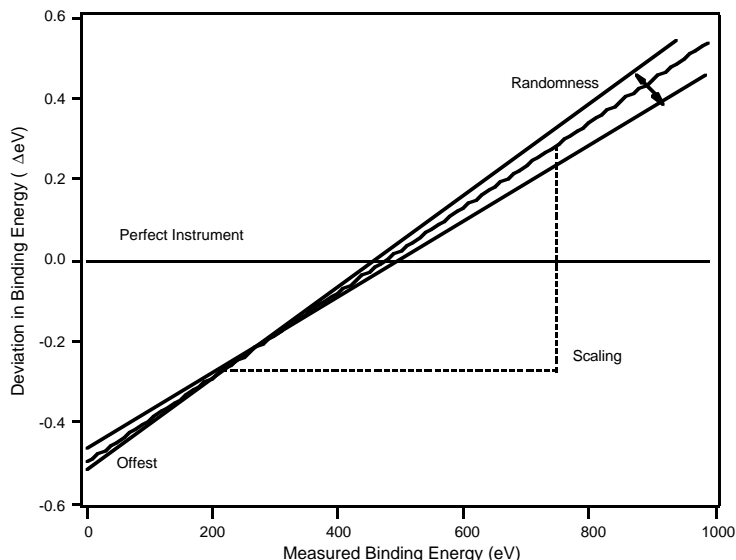


Homework 2

1. Three factors determine the accuracy of binding energy (BE) in an XPS spectrum*. They are offset, scaling, and randomness of the calibration curve for the spectrometer. The calibration curve is a plot of deviation in BE ($BE_{\text{measured}} - BE_{\text{theoretical}}$) versus measured BE for a series of peaks. In linear graphic analysis terminology (assuming the data follows a straight line), offset is the intercept, scaling is the slope, and randomness is the standard deviation of the slope. The figure to the right shows a hypothetical plot for a perfect instrument and one that is not well calibrated.



Calibration measurements on an XPS system give the following values of BE (in eV). Determine the offset, scaling, and randomness of the spectrometer. What is the true value of BE for a C 1s peak that is measured at 287.50 eV on this system? Give the answer for the true BE with the appropriate error based on the offset, scaling, and random errors in the calibration curve for the spectrometer. You may assume theoretical values are infinitely accurate.

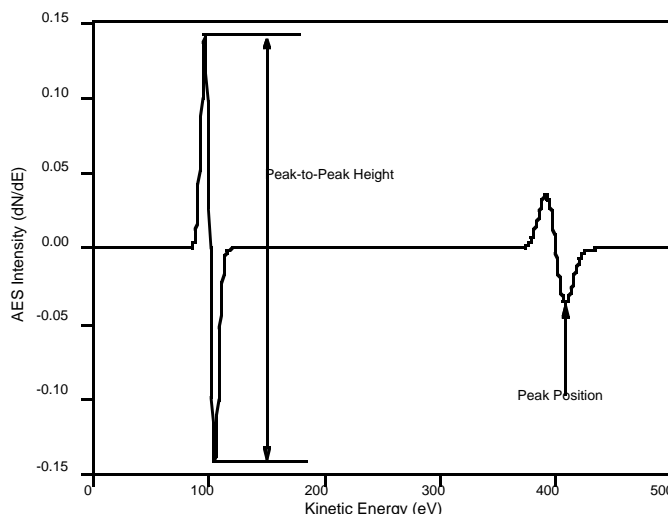
	measured	theoretical
Cu 3p	75.00	75.14
Au 4f _{7/2}	83.80	83.98
Cu L3MM	567.70	567.97
Cu 2p _{3/2}	932.30	932.67

* M. T. Anthony and M. P. Seah, XPS: Energy Calibration of Electron Spectrometers, *Surf. Interface Anal.* **6(3)** (1984) 95.

2. One cause of offset errors in XPS is a mistake in setting the spectrometer work function, ϕ . An XPS (and AES) spectrometer measures electron kinetic energy (KE). The textbook gives the conversion equation between KE and BE based on ϕ . Consider the following situation: the work function of an XPS spectrometer has been calibrated using a spectrum of a Au 4f_{7/2} peak taken with a step size between channels of 0.05 eV. What error would be associated with the BE of a peak that has been measured in a spectrum with a step size between channels of 0.05 eV? Assume that scaling and random errors are zero for the spectrometer.

3. Many AES systems provide spectra as the first derivative of signal (intensity) as a function of electron kinetic energy (KE). Peak positions are set by the bottom-most extension of the curve. Atomic concentration, x_i , is proportional to peak-to-peak height, I_i . Refer to the figure on the right.

The attached figure shows five simulated AES spectra (in derivative mode). They are to represent spectra from five experiments under the same conditions. We want to find the concentration ratio, x_B/x_A . Determine



from the spectra in any way you deem appropriate the expected ratio of I_B/I_A , where I_i is the peak-to-peak height (intensity) for peak i. Account for measurement and random errors in the result that you report. Show your error calculations. The raw data will be posted on the Web.

