MTS 723 F97 December 2, 1997

Homework 5

1. Describe a measurement protocol that you would use to determine the atomic composition of a homogeneous binary metal alloy composed of A and B using AES. Assume that you have the Auger matrix factor, F_{AB}, for the alloy, NOT relative sensitivity factors.

2. Determine whether the O/Al ratio of the catalyst changes due to treatment using the two spectra in Fig. 5.8 of the text by Watts. Use both the Al LMM and KLL transitions in your analysis.

3. Consider the AES spectrum of SiN in Fig. 6.11 of Briggs and Seah.
a. Define all the peaks in SXY terminology.
b. Compute Auger matrix factors F_{SiN} and relative sensitivity factors S_{Si}/S_N for Si and N using both Si transitions for comparison.
c. Using appropriate information about escape depths for electrons in materials, estimate the ratio $(1 + r_{LKE})/(1 + r_{HKE})$ where r is the backscatter coefficient and LKE and HKE are the low and high kinetic energy AES peaks for Si respectively.

4. Consider the spectra in Fig. 6.14 - 6.16 of Briggs and Seah.
a. Compute Auger matrix factors F_{AB} and relative sensitivity factors S_A/S_B for i. A = Al, B = O and ii. A = Al, B = C using Fig. 6.16.
b. Determine the relative O/Al and C/Al concentration ratios for the spectra in Figs. 6.14 and 6.15.

5. You are given a binary A-B metal alloy with a composition A that varies as $n_A = n_A^o \exp(-z/d)$, where n_A^o is the surface concentration (number/m^3), z is the depth into the material (m), and d is a diffusion length parameter (m).
a. Show that, when taken under similar experimental conditions, the expected ratio of AES peak to peak intensities for the alloy to pure A can be expressed as

$$\frac{I_A}{I_A^\infty} = x_A^o \frac{\overline{V_A}}{\overline{V_A^\infty}} \frac{(1 + r_{BS})}{(1 + r_{BS}^\infty)} \frac{\lambda_A}{\lambda_A^\infty} \left[\frac{d}{\lambda_A \cos\theta + d}\right]$$

where x_A^o is the surface mole fraction of A in the alloy and the infinity superscripts designate values from pure A.

b. Based on the above fomulation, discuss the physical meaning of the results when $\lambda \cos\theta >> d$ and when $d >> \lambda \cos\theta$. Which case is indicative of a surface segregation phenomena and which is similar to expectations from diffusion profiles in materials?
c. For the KLL transition of carbon measured using a CMA with the sample surface perpendicular to the axes of the CMA, what value of d is such that $d \sim \lambda \cos\theta$ (give your answer in nm)? Provide references for the numerical values you use to answer this question.