Homework MME 4501 – MASE 6402

Problem 6. What is the approximate sampling depth of AES in Al for electron energies of 2 keV?

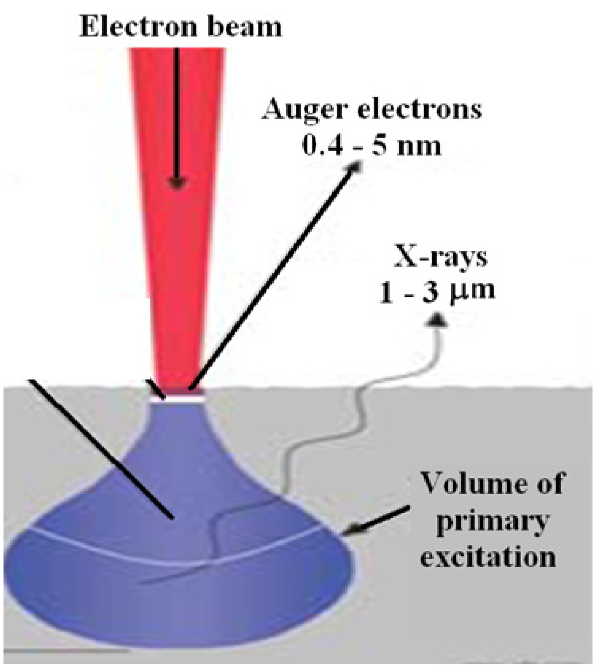
A) Read the notes and find an approximate value of the depth in Å.

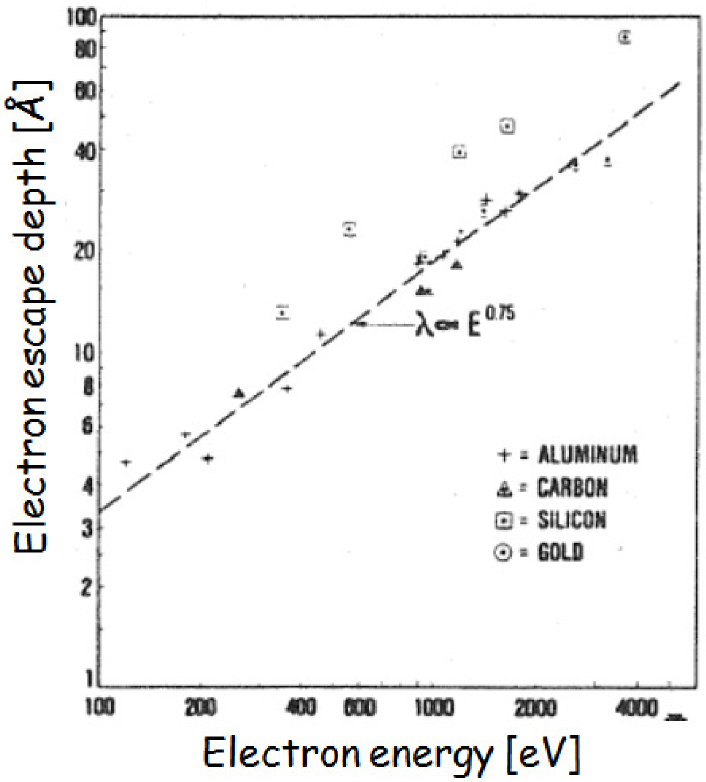
B) Express your answer in monolayers (ML) assuming 1 ML = 3 Å.

C) Calculate your answer in "electron wavelengths"; an electron wavelength is the rough size of the electron given by $\lambda = h/[2mK]^{1/2}$, where h is Planck's constant, m is the mass of the electron (in kg) and K is the electron's kinetic energy (in joules).

Answer.

A) From the graph in notes (see below) at electron energies of 2 keV the Auger electrons escape from about 30 Å.





B) Taking 1 ML = 3 Å, the escape depth is about 10 ML.

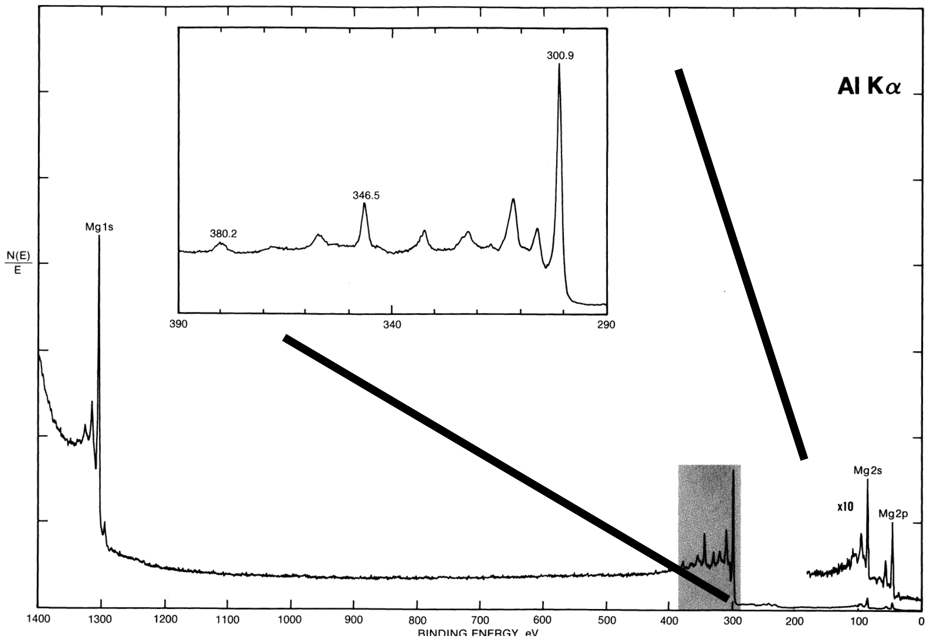
C) $\lambda = h/[2mK]^{1/2} = (6.63\times10^{-34}\ m^2kg/s)/[2 \times 9.1\times10^{-31}\ kg \times 2000\ eV \times 1.6\times10^{-19}\ J/eV]^{1/2}$

$= 2.74\times10^{-11}\ m = 0.274\ Å = 0.091\ ML \approx 1/10\ ML.$

Thus, the escape depth in wavelengths is 30 Å /0.274 Å ≈ 104.5 λ,

Problem 7. Transforming XPS data to AES.

A student bombarded Mg with Al Kα x-rays of photon energy 1486.6 eV and captured the emitted electrons, the computer analysis package for XPS produced the spectra shown below corresponding to the proportional number of electrons captured versus their binding energies.



A) Looking at the enlargement of the gray region shown as an inset, determine the kinetic energy of the electrons emitted.

B) Later it turned out that the electrons were not photoelectrons but Auger electrons, use your answer to part A) to determine the Auger transitions that produced those electrons. The binding energy information for Mg is:

Subshell	1s (K)	2s (L_1)	2p1/2 (L_{23})
BE (eV)	1305	90	51

Solution.

A) KE = hν - BE = 1486.6 – 300.9 = 1185.7 eV,

KE = hν - BE = 1486.6 – 346.5 = 1140.1 eV, and

KE = hν - BE = 1486.6 – 380.2 = 1106.4 eV.

B) by trial and error, test all possible transitions: $KL_{23}L_{23}$, KL_1L_{23}, KL_1L_1 ...

KE = (K - L_1) – L_1 = 1305 - 90 - 90 = 1125 eV ~ 1106.4 eV.

KE = (K - L_1) – L_{23} = 1305 - 90 - 51 = 1164 eV ~ 1140.1 eV.

KE = (K - L_{23}) – L_{23} = 1305 - 51 - 510 = 1203 eV ~ 1185.7 eV.

Thus, the 300.9 eV peak that has a KE of 1185.7 eV, probably corresponds to $KL_{23}L_{23}$ transition that has a KE of 1203 eV.

Likewise, the 346.5 eV peak that has a KE of 1140.1 eV, probably corresponds to KL_1L_{23} transition that has a KE of 1164 eV. And the 380.2 eV peak that has a KE of 1106.4 eV, probably corresponds to KL_1L_1 transition that has a KE of 1125 eV.