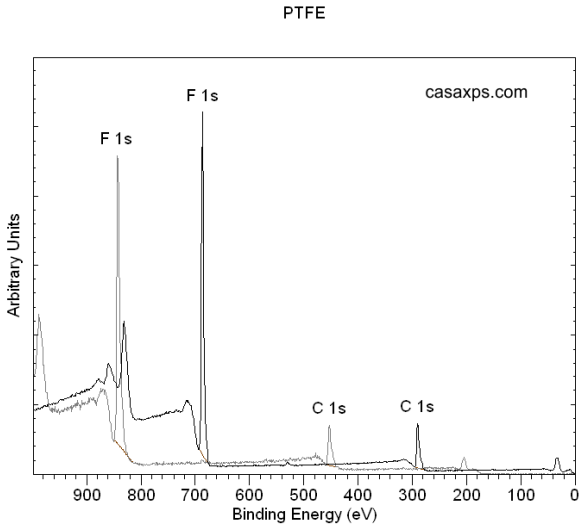
Exercise 1: XPS

a) A MgK_α X-ray source is used to record the XPS spectrum of palladium. At which kinetic energies would one expect peaks? Tipp: The most prominent peaks will originate from the 3s, 3p and 3d shells.

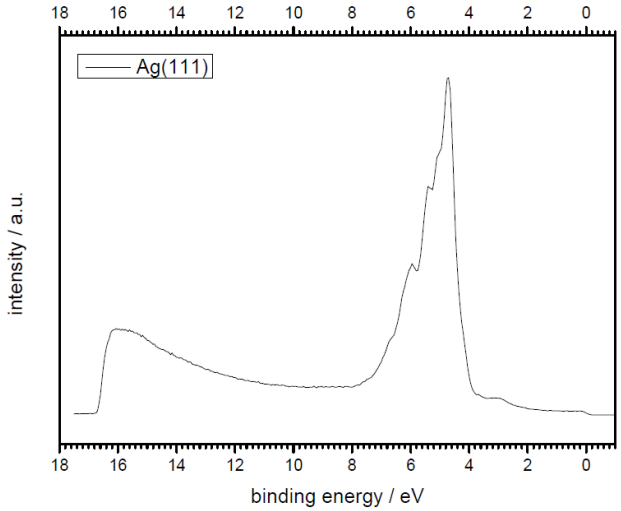
b) Look at the two spectra of Teflon on the left. What might cause the difference, given that it is the same sample? How could one prevent it?



Exercise 2: Ultraviolet photoelectron spectroscopy

a) UPS is very similar to XPS. What are the main differences?

b) The following spectrum was measured on a clean Ag(111) surface using UV-light from a He-I source.



i) Evaluate the work function of Ag(111).

ii) What is the origin of the peaks at ~5 eV?

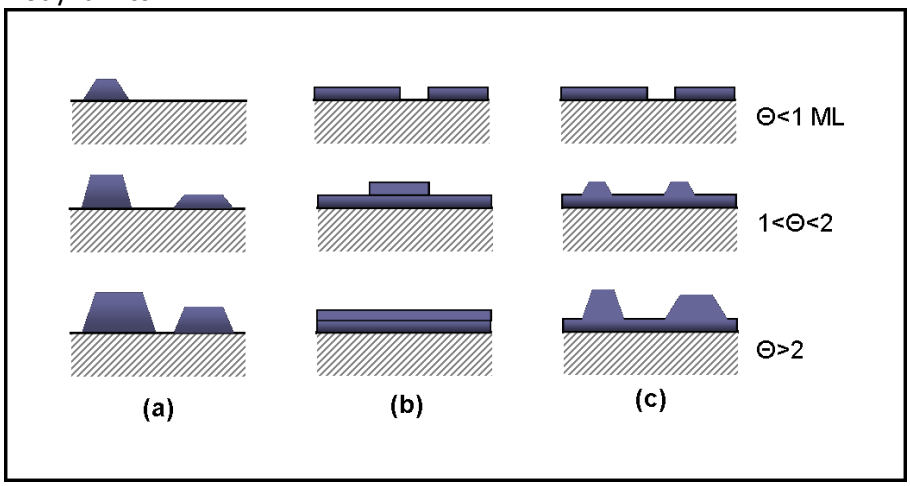
Exercise 3: Surface diffusion

a) The hopping rate of a nitrogen atom on the Fe(100) surface is 10^{-3} s^{-1} at 300 K and $3x10^{-2}$ s^{-1} at 330 K. Estimate the diffusion coefficient and calculate the activation energy. Take into account that Fe is a bcc crystal with lattice parameter 2.87 Å. Assume the vibration frequency n_0 is $4.3x10^{12}$ Hz.

b) Random-walk diffusion of Ag atoms occurs over the Si(111) √3x√3-Ag surface. Estimate the mean displacement of the atom in a time of 1 s and 1 h at 450 °C. D_0 = 10^{-3} cm^2s^{-1}, E_{diff}=0.33 eV.

Exercise 4: Thin film growth

a) Thermodynamics



i) Name the three growth modes shown above.
ii) Explain why a film grows on a substrate in each of the growth modes using the surface tensions.
iii) How can you experimentally distinguish the three growth modes using XPS?
iv) How can you distinguish them with RHEED?

b) Kinetics: For the case of homoepitaxy, considering the parameters “substrate temperature” and “deposition rate”: how should one choose those parameters in order to obtain 2D or 3D growth? Explain.