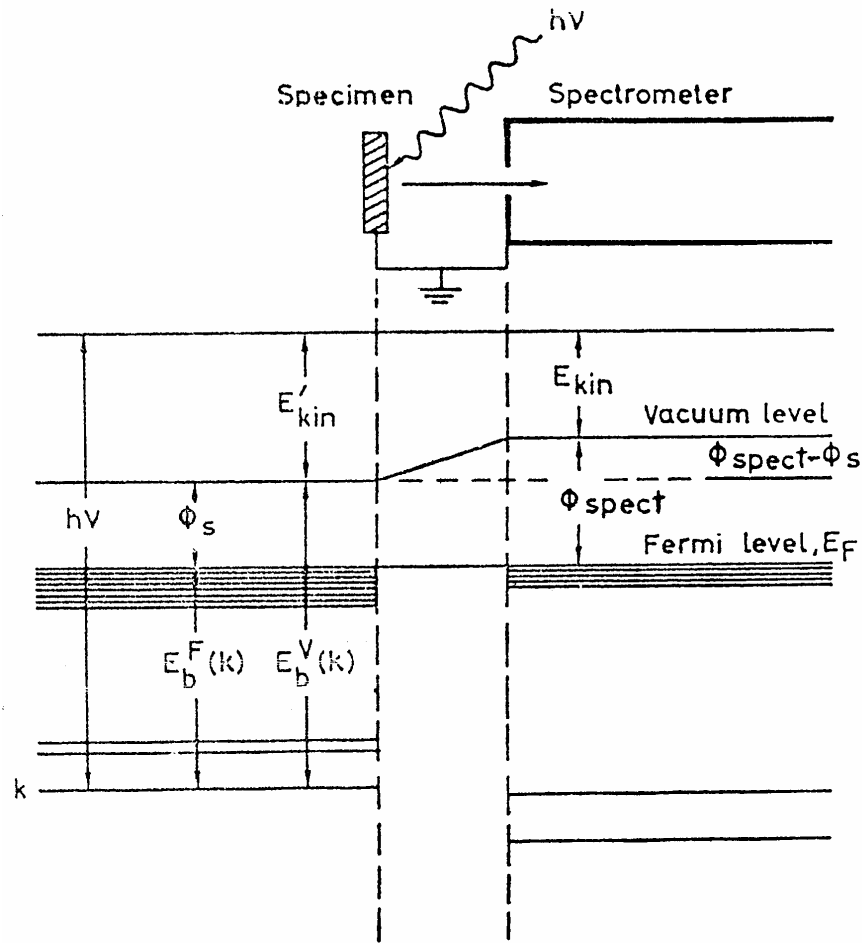
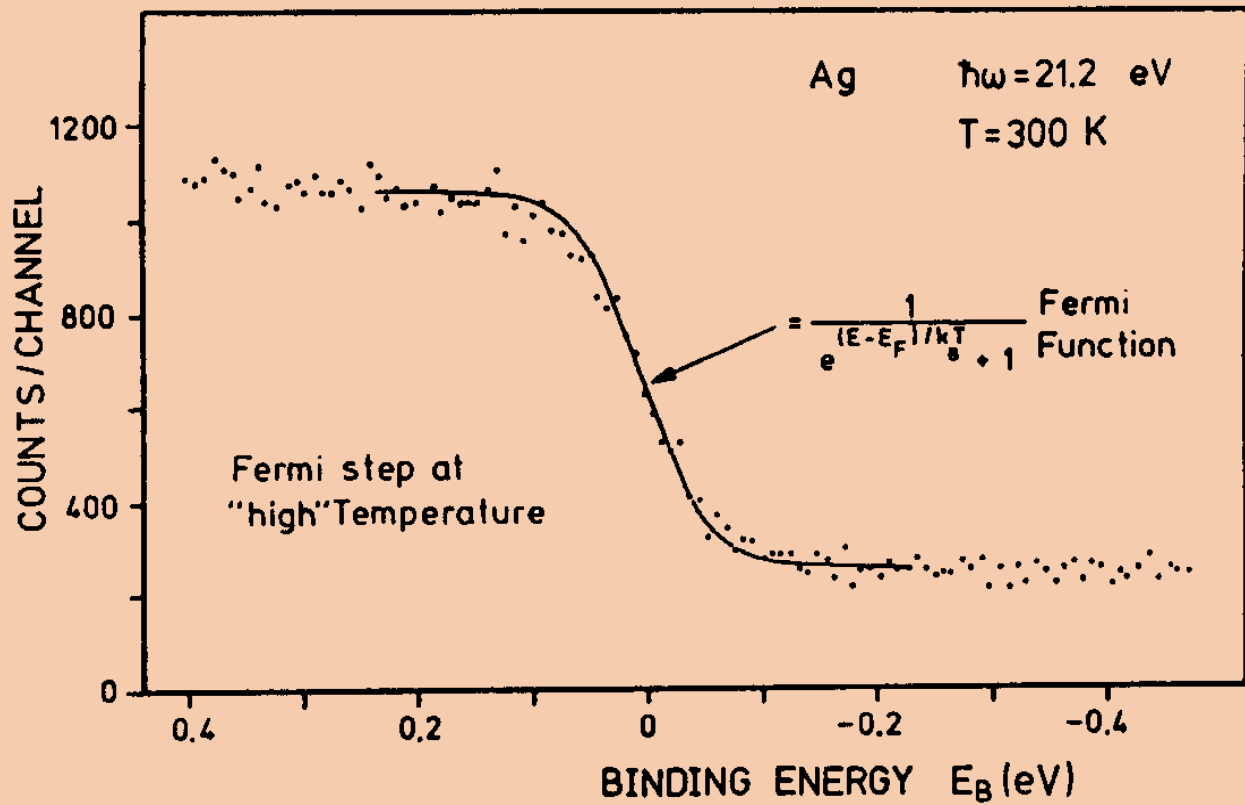


XPS/UPS

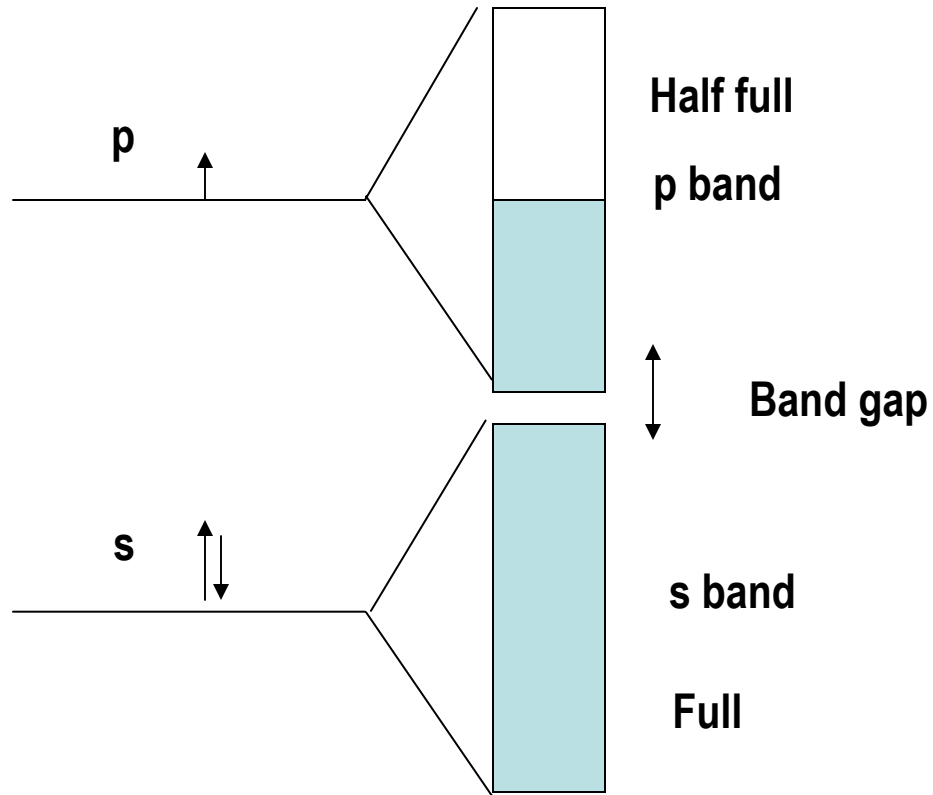


Energy level diagram for a metallic specimen in electrical equilibrium with an electron spectrometer. The closely spaced levels near the Fermi level E_F represent the filled portions of the valence bands in specimen and spectrometer. The deeper levels are core levels. An analogous diagram also applies to semi-conducting or insulating specimens, with the only difference being that E_F lies somewhere between the filled valence bands and the empty conduction bands above.



EDC around E_F in an UPS spectrum of Ag. Solid line is the Fermi function at RT

Electronic structure of solids



In a piece of metal, there are 10^{23} electrons.

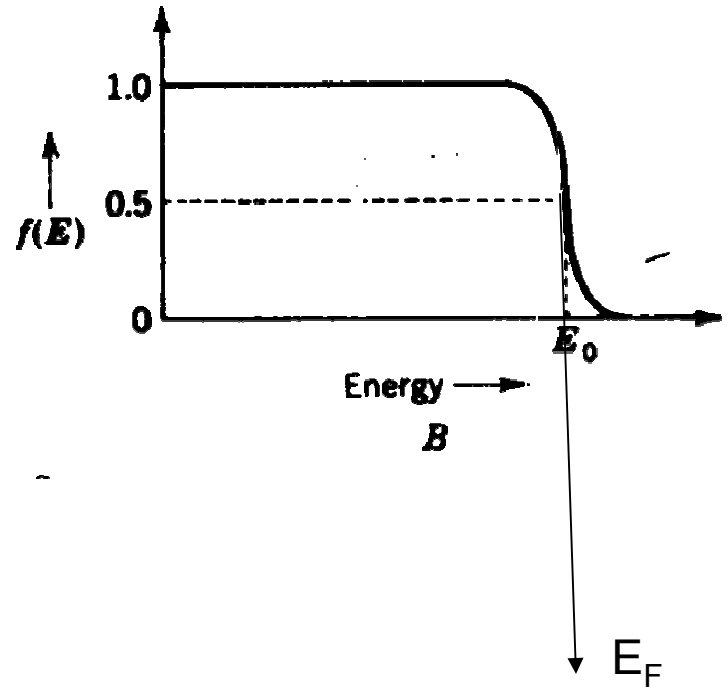
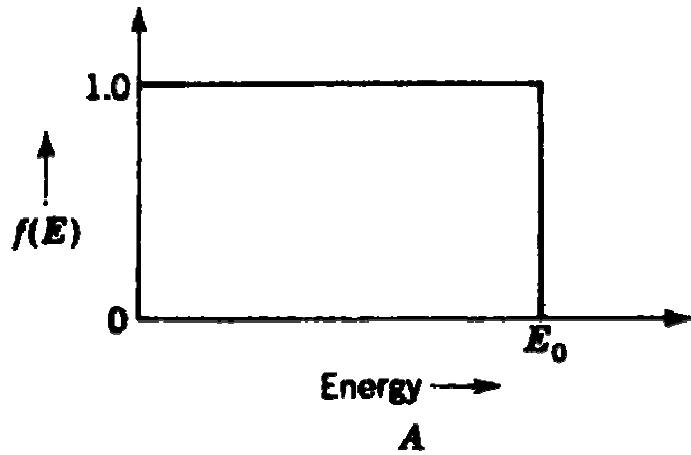
We have high quantum states for most electrons.

Probability that a given quantum state is occupied is given by the **Fermi factor,**

$$f(E) = 1/[e^{(E-\mu)/kT} + 1]$$

Plot of this is given here which gives a definition of Fermi level.

μ is chemical potential, is the energy of the level for which $f(E) = \frac{1}{2}$



How the given energy states are occupied at a given temperature is given by Fermi-Dirac distribution.

$$N(E)dE = f(E)S(E)dE \\ = S(E)dE/[e^{(E-\mu)/kT} + 1]$$

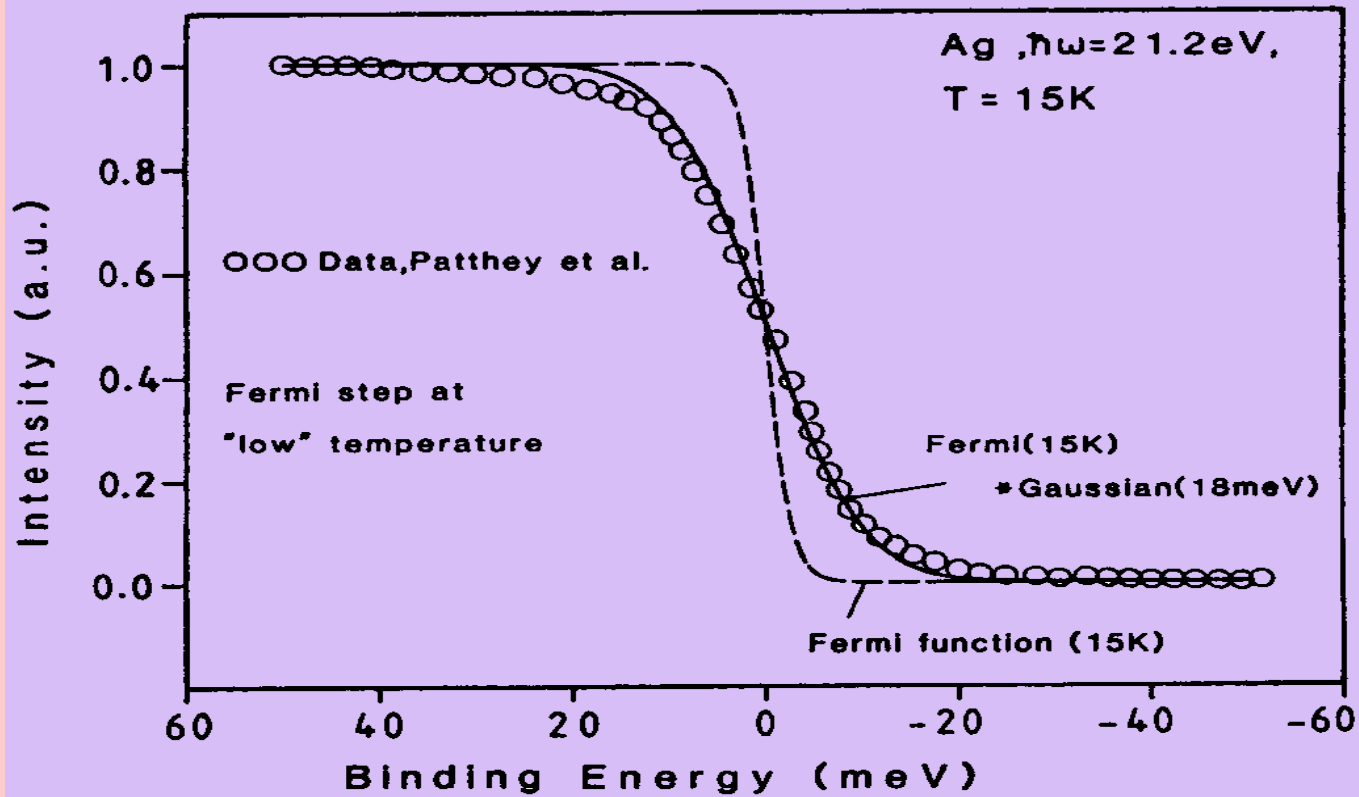
$N(E)$ = number of electrons per unit volume, having energy between E and $E + dE$
 $S(E)$ = number of available quantum states in this energy range.

This distribution obeys Pauli exclusion principle.

Number of electrons $N(E)$ can never be larger than the number of available states $S(E)$ as the denominator is always greater than one.

For states with energies well above μ , 1 in the denominator can be neglected.

$N(E)dE \approx e^{-(E-\mu)/kT}$ This resembles Boltzmann distribution



UPS EDC at E_F of Ag (15 K). Resolution, ΔE is obtained by convoluting a Fermi function with a Gaussian function

PE spectrum gives many other information

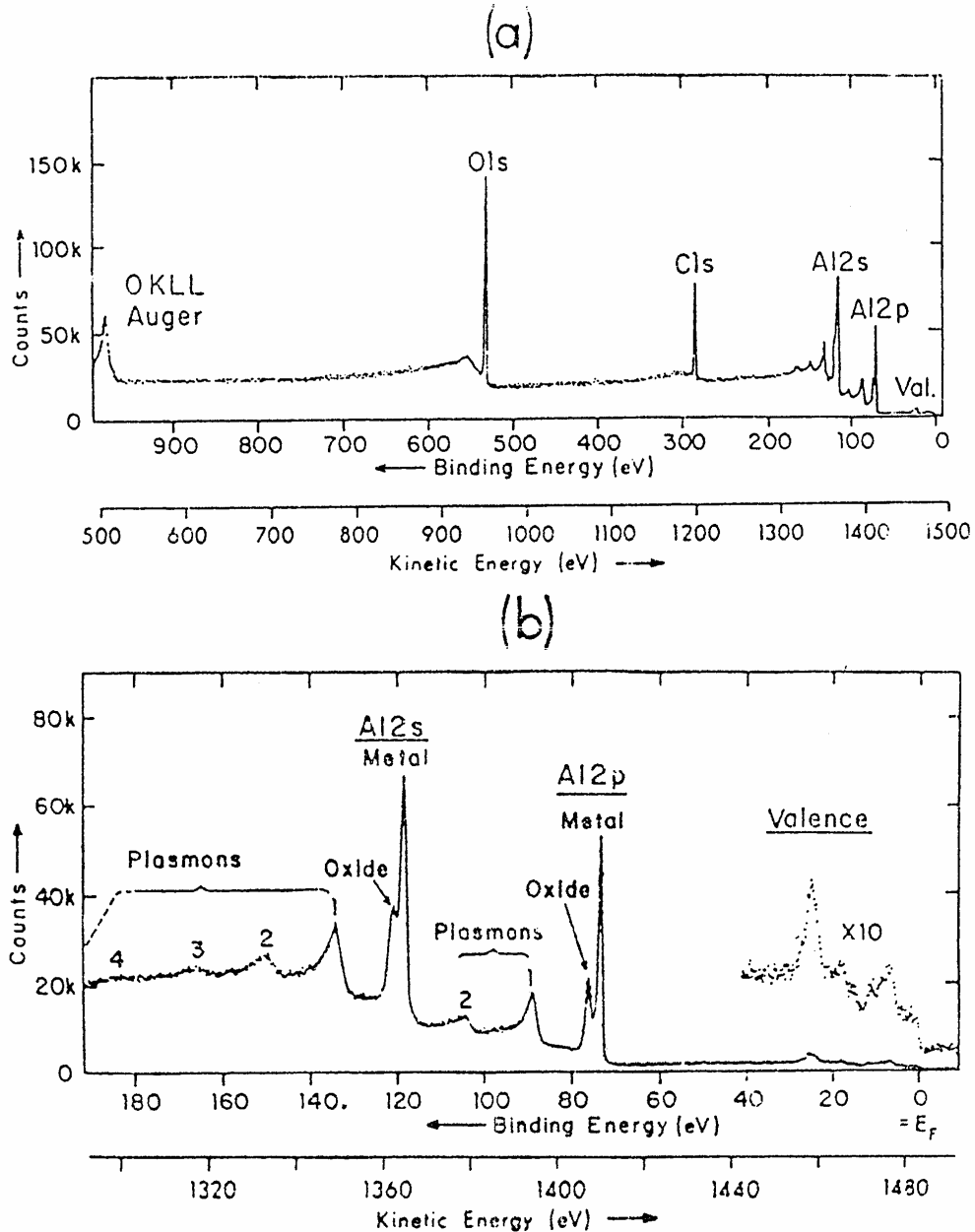


Fig. 1. Typical XPS spectra obtained from an oxidized aluminium specimen with carbonaceous contaminant overlayer. Monochromatized AlK α radiation was used for excitation. (a) Overall spectrum with all major no-loss features labelled. (b) Expanded-scale spectrum of the Al2s, Al2p, and valence regions. Chemically-shifted oxide- and metal-co peaks are indicated, as well as inelastic loss peaks due to bulk plasmon creation.