

## **17.4 Terms related to surface analysis**

The terms are not given in alphabetical order.

### **In situ microanalysis**

This is a term used for direct analytical investigation of the microstructural domains of a solid by focused beams of particles and radiation. Analytical characterization includes obtaining information about the type, quantity and distribution of the element and the state of chemical bonding, morphology and crystalline (geometric) and electronic structure of the individual phase. The combination of this information serves as a basis for the property-relevant characterization of solids.

### **The energy scale**

Three designations of the energy scale, *ionization energy*, *binding energy* or *electron kinetic energy*, are in common usage in the presentation of diagrams of spectra derived from X-ray or UV excitation. The first two of these are alternative names for the same quantity, but the electron kinetic energy, although linearly related to the others (it is the difference between the energy of the exciting photon and the ionization energy), increases in magnitude as the others decrease. *Ionization potential* (in volts) is also used as an alternative to ionization energy (in electron volts).

The general use of ionization energy,  $E_i$ , is recommended for the scale at the top of all spectral diagrams. It is also recommended that the experimentally measured parameter, *electron kinetic energy*, should be plotted along the bottom of the spectral diagram in the same units. The latter parameter is meaningful whether the electrons measured derive from photoionization or Auger processes. When using high energy excitation by X-rays, this should be indicated clearly by asterisks because the ionization energy scale is not applicable to them.

The customary unit for  $E_i$  or electron kinetic energy per molecule is the electron volt, eV. Alternatively, where there is need to relate these energies to other quantities expressed in SI units, the unit recommended for the molar ionization energy is joule per mole,  $\text{J mol}^{-1}$ .

The direction of the ionization energy scale is not well defined in the literature. For X-ray excitation, ionization (binding) energy is usually plotted so as to increase from right to left. For ultraviolet He I or He II excitation the literature shows a limited preference for ionization increasing from left to right. For consistency between the two related fields it is recommended that the spectra be plotted with electron kinetic energy increasing to the right, i.e., ionization energy increasing to the left. This presentation is consistent with other branches of electronic spectroscopy where spectral features involving higher levels of molecular excitation are normally found to the left of the spectral diagram.

## **The film**

A material which has been deposited or adhered to a substrate and has a uniform thickness within 20% of its average thickness, which is less than about 10  $\mu\text{m}$ .

## **Interface**

A boundary between two condensed phases. Experimentally, the portion of the sample through which the first derivative of any concentration vs. location plot has a measurable departure from zero. An interface between a solid phase and a gaseous phase is called a surface.

## **Surface**

It is recommended that for the purpose of surface analysis, a distinction be made between *surface in general*, *physical surface* and *experimental surface*.

### **Surface (general)**

The "outer portion" of a sample of undefined depth; to be used in general discussions of the outside regions of the sample.

### **Physical surface**

That atomic layer of a sample which, if the sample were placed in a vacuum, is the layer "in contact with" the vacuum; the outermost atomic layer of a sample.

### **Experimental surface**

That portion of the sample with which there is significant interaction with the particles or radiation used for excitation. It is the volume of sample required for analysis or volume corresponding to the escape for the emitted radiation or particle, whichever is larger.

### **Concentration in experimental surface**

Often called *surface concentration*. The amount of the material of interest divided by the total amount of substances in the volume of interest. Concentration may be defined in terms of number of atoms (particles) (ppma) or in terms of weight ( $\mu\text{g/g}$ ).

## **Monolayer**

Coverage of a substrate by one atomic or molecular layer of a species. The term monolayer expresses that all elementary units of the adsorptive atoms or molecules are in contact with the surface as opposed to the term *multilayer*, which designates that more than one layer of the adsorptive species covers the surface and not all units are in contact with the surface layer of the substrate.

## **Monolayer capacity**

For *chemisorption* the amount of adsorbate which is needed to occupy all adsorption sites as determined by the structure of the adsorbent and by the chemical nature of the adsorptive. For *physisorption*, the amount needed to cover the surface with a complete monolayer of atoms or molecules in a close packed array, the kind of close packing having to be stated explicitly when necessary.

## **Surface coverage**

For both *monolayer* and *multilayer* coverage defined as the ratio of the amount of substances covering the surface to the monolayer capacity. Coverage is unity when one complete monolayer is deposited onto the sample.

## **Surface contamination**

Material in the experimental surface which is either not characteristic of the sample or which would not be present if the sample had been prepared in an absolute vacuum by methods not contacting other substances to the sample.

## **Clean surface**

An experimental surface having no surface contamination observable by means of the used method.

## **Chemical shift**

The displacement of photoelectron or Auger peak energies originating from changes in

electron binding energies as a consequence of differences in the chemical environment of the atoms.

### **Auger electron yield**

The fraction of the atoms having a vacancy in an inner orbital which relax by emission of an Auger electron.

### **Photoelectron yield**

The number of photoelectrons emitted by the sample per incident photon.

### **Secondary ion yield**

The number of secondary ions generated at the surface of the sample per primary ion.

### **Sputter yield**

The number of particles sputtered from the surface of a target per primary ion.

### **Escape depth**

The distance into the sample measured from the physical surface from which all but a fraction of  $1/e$  of the particles or radiation detected have originated.

### **Depth profile**

Dependence of concentration on depth perpendicular to the surface in a solid sample. It can be obtained by a simultaneous or sequential process of erosion and surface analysis or by measurement of the energy loss of primary backscattered or particles produced by nuclear reactions.

### **Depth resolution**

The distance between the 84 and 16 percent level of the depth profile of an element in a perfect sandwich sample with an infinitesimally small overlap of the compounds. These limits correspond to the  $2\sigma$ -value of the Gaussian distribution of the signal at the interface.

### **Sputtering**

Removal of surface material (atoms, clusters and molecules) by particle bombardment.