16. RADIOANALYTICAL METHODS

16.1 Introduction

This chapter is different from the corresponding chapter of the second edition of the Compendium, which was based on the Glossary of Terms used in Nuclear Analytical Chemistry published in 1982 (PAC 34 1533-1554). Beside the terms of analytical interest it also included terms from nuclear technology, nuclear physics and radioactivity measurements.

In the present compilation, as well as the basic radioanalytical terms many new terms are included which are relevant in radiometric analysis, in radioimmunoassay and related techniques. However many of the nuclear technology and nuclear physics have been omitted.

The fundamental physico-chemical terms and units which are also relevant in radioanalytical chemistry can be found in Chapter 1.

16.2 Terms and definitions

The terms are arranged in alphabetical order.

Absolute Activation Analysis

See *activation analysis, absolute*.

Absolute Counting

See *counting, absolute*.

Activation

The process of inducing radioactivity by *irradiation*. In general, a specification is added of the type of incident *radiation* (e.g. nuclear,neutron, photon) or its *energy* (e.g. thermal, fast).

Activation Analysis (Nuclear)

A kind of elemental or isotopic analysis based on the measurement of characteristic radiation

from *nuclides* formed directly or indirectly by *activation* of the test portion. In general, a specification is added of the type of the incident radiation (e.g. neutron, photon) and/or its *energy* (e.g. thermal, fast).

Activation Analysis, Absolute

A kind of activation analysis in which the elemental concentrations in the material are calculated from known nuclear constants, irradiation and measurement parameters, rather than by comparing with known standards.

Activation Analysis, Instrumental

A kind of *activation analysis* in which element specificity is obtained by using appropriate *irradiation* conditions, *radiation* measurement techniques and mathematical techniques for the interpretation of the measurement results.

Activation Analysis, Radiochemical

A kind of *activation analysis* in which, after the *irradiation*, chemical or physical separation is applied.

Activity (of a Radioactive Material)

The number of *nuclear decays* occurring in a given quantity of material in a small time interval, divided by that time interval. Synonymous with: *disintegration rate* or *decay rate*. Symbol: $A = -\mathrm{d}N/\mathrm{d}t$

Activity, Molar

For a specified *isotope*, the *activity* of the compound divided by the amount of the compound in moles. Symbol: $A_\mathrm{m} = A/n$.

Activity, Specific

For a specified *isotope*, or mixture of isotopes, the *activity* of a material divided by its mass or volume although the latter in usage is to be discouraged. Symbol: $a = A/m$.

Assay

A set of operations having the object of determining a value of a quantity. In analytical chemistry, this term is synonymous of measurement process.

Assay Kit

A set of components (reagents and other necessary materials) and procedural instructions packaged together and designed for the estimation *in vitro* of a value of a specified quantity, when used according to the instructions.

Autoradiograph

A *radiograph* of an object containing *radioactive* substance, produced by itself when it is placed upon a photographic plate or film or a fluorescent screen.

Autoradiolysis

Radiolysis of a *radioactive* material resulting directly or indirectly from its *radioactive decay*.

Average life

The average life of an atom or nucleus in a specified state and equal to the reciprocal of the *decay constant* λ. For an exponentially decaying system, it is the average time for the atoms or nuclei in a specified state to decay by a factor equal to the natural number "e". It is synonymous with mean life.

Background Radiation

Radiation from any *source* other than the one it is desired to detect or measure.

Barn

A former unit of area used in expressing nuclear *cross-sections*. (1 barn = 1 b = 10^{-28} m^2).

Becquerel

SI unit of *activity* equal to one *nuclear decay* per second (symbol: Bq).

Branching Fraction or Probability

In decay that can proceed in two or more different ways, it is the fraction of nuclei which decay in a specified manner.

Capture

A process in which an atomic or nuclear system acquires an additional particle. In general a specification is added of the type of the captured particle or its *energy*.

Capture Cross-section

The cross-section for *capture*.

Capture Gamma Radiation

The gamma *radiation* emitted in radiative capture.

Carrier

A substance in appreciable amount which, when associated with a *tracer* of a specified substance, will carry the tracer with it through a chemical or physical process, or prevent the tracer from undergoing nonspecific processes due to its low concentration.

Carrier-free

See: *no carrier added*, which term should be preferred.

Carrier, Hold-back

A *carrier* used to prevent a particular species from following other species in a chemical or physical operation.

Carrier, Isotopic

A *carrier* which differs only in isotopic composition from the trace it has to carry.

Chemistry, Nuclear

The part of chemistry which deals with the study of nuclei and nuclear reactions using chemical methods.

Comparator

A known amount of an element that is simultaneously irradiated with the test portion in the context of *activation analysis*. If one comparator is used (single comparator method), it is essentially identical to a *flux monitor* (except that this term is not necessarily linked to activation analysis).

Competitive Binding Assay

An *assay* based on the competition between a labelled and an unlabelled ligand in the reaction with a receptor binding agent (e.g. antibody, receptor, transport protein).

Conversion, Internal

A transition between two energy states of a nucleus where the energy difference appears as that of an orbital electron which is thereby ejected from the atom.

Count

1. Information corresponding to a pulse processed for counting.

2. Number of pulses recorded during a measurement.

Counter, Radiation

Radiation measuring assembly comprising a *radiation detector* in which individual ionizing events cause electrical pulses and the associated equipment for processing and counting the pulses. Often an expression is added indicating the type of radiation detector (e.g. *scintillation*, *semiconductor*).

Counting, Absolute

A measurement under such well-defined conditions that the *activity* of a sample can be derived directly from the observed *counting rate*.

Counting Efficiency

The ratio between the number of particles or photons counted with a *radiation counter* and the number of particles or photons of the same type and *energy* emitted by the radiation *source*.

Counting Rate

The number of *counts* occurring in unit time.

Cross Reaction

Ability of substances other than the analyte to bind to the binding reagent and ability of substances other than the binding reagent to bind the analyte in *competitive binding assays*.

Cross-section (Microscopic)

A measure of the probability of a specified interaction or reaction between an incident radiation and a target particle or system of particles. It is the reaction rate per target particle for a specified process divided by the flux density of the incident radiation. In general, a specification is added of the type of radiation (e.g. neutron, photon), the *energy* of the incident radiation (e.g. thermal, epithermal, fast) and the type of interaction of reaction (e.g. *activation*, *fission*, scattering). Symbol: σ.

Cross-section, Activation

The *cross-section* for the formation of a *radionuclide* by a specified reaction.

Cross-section, Capture

The *cross-section* for *capture*.

Cross-section, Effective Thermal

A fictitious *cross-section* for a specified reaction, which, when multiplied by the 2200-metre-per-second flux density, gives the correct reaction rate for thermal neutrons.

Cross-section, Macroscopic

The *cross-section* per unit volume of a given material for a specified process. For a pure *nuclide*, it is the product of the *microscopic cross-section* and the number of target nuclei per unit volume; for a mixture of nuclides, it is the sum of such products.

Cross-Section, Westcott

See *cross-section, effective thermal*.

Curie

A former unit of *activity* equal to exactly 37×10^9 *nuclear decays* per second or 37×10^9 Becquerel (37 GBq).

Daughter Product

Any *nuclide* which follows a specified *radionuclide* in a *decay chain*.

Dead Time

Constant and known value imposed on the *resolving time* by a paralysis circuit, usually in

order to make the correction for resolving time losses more accurate.

Dead Time Correction

Correction to be applied to the observed number of pulses in order to take into account the number of pulses lost during the resolving or dead time.

Decay Chain

A series of *nuclides* in which each member transforms into the next through *nuclear decay* until a stable nuclide has been formed. Synonymous with: radioactive chain and radioactive series.

Decay Constant

For a *radionuclide*: the probability for the *nuclear decay* of one of its nuclei in unit time. It is given by $\lambda = (dN_t/dt)/N_t$, in which N_t is the number of nuclei of concern existing at time t. Synonymous with: disintegration constant.

Decay Curve

A graph showing the relative amount of *radioactive* substance remaining after any time interval.

Decay, Nuclear

A spontaneous nuclear transformation.

Decay, Radioactive

Nuclear decay in which particles or electromagnetic radiation are emitted or the nucleus undergoes spontaneous fission or electron capture.

Decay Rate

See *activity*.

Decay Scheme

A graphical representation of the energy levels of the members of a *decay chain* showing the path by which nuclear decays occur.

Detector Efficiency (Intrinsic)

The ratio of the number of particles or photons detected to the number of similar particles or photons which have struck the envelope limiting the sensitive volume of a *radiation detector*.

Detector, Radiation

An apparatus or substance for the conversion of *radiation energy* to a kind of energy which is suitable for indication and/or measurement.

Detector, Scintillation

See *scintillation detector*.

Detector, Semiconductor

See *semiconductor detector*.

Disintegration Rate

See *activity*.

Dose Absorbed

The energy imparted to matter by *ionizing radiation* in a suitable small element of sample volume divided by the mass of that element of sample volume.

Effective Cadmium Cut-Off Energy

In a given experimental configuration, the *energy* value determined by the condition that the *detector* response would be unchanged if the cadmium cover surrounding the detector was replaced by a fictitious cover opaque to neutrons with energy below this value and transparent to neutrons with energy above this value.

Efficiency (of a Counter)

See *counting efficiency*.

Efficiency, Intrinsic

See *detector efficiency*.

Energy (of a Radiation)

Energy of the individual particles or photons of which a *radiation* consists.

Energy Resolution

A measure, at given *energy*, of the smallest difference between the energies of two particles or photons capable of being distinguished by a radiation spectrometer.

Energy Threshold

The limiting kinetic *energy* of an incident particle or energy of an incident photon below which a specified process cannot take place.

Equilibrium, Radioactive

Among the members of a *decay chain*, the state which prevails when the ratios between the *activities* of successive members remain constant.

Excitation Function

In nuclear reactions, the dependence of the *cross-section* for the reaction upon the energy of the projectile.

Fission, Nuclear

The division of a nucleus into two or more parts with masses of equal order of magnitude, usually accompanied by the emission of neutrons, gamma radiation and, rarely, small charged nuclear fragments.

Fluorescence

Luminescence which occurs essentially only during the *irradiation* of a substance by electromagnetic *radiation*.

Fluorescence Yield

See *yield, fluorescence*.

Flux Density, Particle (or, Photon)

At a given point in space, the number of particles (or photons) incident in a time interval on a suitably small sphere centred at that point, divided by the cross-sectional area of that sphere and by that time interval. The particle flux density is identical with the product of the particle density and the average speed of the particles.

Flux Depression

The lowering of the particle (or photon) *flux density* in the neighbourhood of an object due to absorption of particles (or photons) in the object.

Flux Monitor

1. A substance or device to measure a *flux density*.

2. A known amount of material irradiated together with a test portion; the induced *radioactivity* is used as a measure for a particular *flux density* during the *irradiation*.

Flux Perturbation

The change of the *flux density* or *energy* distribution of particles or photons in an object as a result of effects such as *flux depression* and *self-shielding*.

Foil Detector

A small piece of metallic foil used to measure *flux density* by *activation*.

Fraction, Bound (in Radioassays)

The fraction of the incubation mixture which, after separation, contains the analyte bound to the binding reagent.

Fraction, Free (in Radioassays)

The fraction of the incubation mixture which does not contain the bound analyte.

Geometry (Counting)

A term used colloquially to signify the arrangement in space of the various components in an experiment, particularly the *source* and the *detector* in *radiation* measurements.

Geometry factor

The average solid angle in sterradians at a *source* subtended by the aperture or sensitive volume of the detector divided by 4π.

Growth Curve (of activity)

Curve giving the *activity* of a *radioactive nuclide* as a function of time and showing the

increase of the activity through the *decay* of the precursor or as a result of *activation*.

G-Value

The number of specified chemical events produced in an irradiated substance per 100 eV of energy absorbed from *ionizing radiation*.

Half Life, Biological

For a substance the time required for the amount of that substance in a biological system to be reduced to one half of its value by biological processes, when the rate of removal is approximately exponential.

Half Life, Effective

For a *radioactive* substance, the time required for the amount of that substance in a biological system to be reduced to one half of its value by both *radioactive decay* and biological processes, when the rate of removal is approximately exponential.

Half Life (of Radionuclide)

For a single *radioactive decay* process, the time required for the activity to decrease to half its value by that process.

Half Thickness

The thickness of a specified substance which, when introduced into the path of a given beam of *radiation*, reduces the value of a specified radiation quantity by one half.

Hold-back Carrier

See *carrier, hold back*.

Hot Atom

An atom in an excited energy state or having kinetic energy above the ambient thermal level, usually as a result of nuclear processes.

Hot Cell

A heavily shielded enclosure for highly *radioactive* materials. It may be used for their handling or processing by remote means or for their storage.

Immunoassay

Assay based on the immunological binding of a specific antigen or antibody with the component under study.

Immunoradiometric Assay

Assay based on the reversible and non-covalent binding of an antigen by a specific antibody labelled with a *radioactive nuclide* as a *tracer*. Synonymous with *radioimmunoassay* which is preferred.

Immunoradiometric Assay, Two-site

Immunoradiometric assay involving two sets of antibodies, one of which is labelled, that combine with different immunoreactive sites of an antigen molecule.

Ionizing Radiation

Any *radiation* consisting of directly or indirectly ionizing particles or of photons with *energy* higher than the energy of photons of ultraviolet light or a mixture of such particles and photons.

Irradiation

Exposure to *ionizing radiation*.

Isomers

Any of two or more *nuclides* having the same mass number A and atomic number Z, but existing form measurable times in different nuclear energy states.

Isomeric Transition

A spontaneous transition between two *isomer* states of a nucleus or between the isomeric state and ground state of the nucleus.

Isotopes

Nuclides having the same atomic number but different mass numbers.

Isotope Dilution

Mixing of a given *nuclide* with one or more of its *isotopes*.

Isotope Dilution Analysis

A kind of quantitative analysis based on the measurement of the isotopic abundance of a *nuclide* after *isotope dilution* with the test portion.

Isotope Dilution Analysis, Direct (Radiochemical)

Isotope dilution analysis used for the determination of a non-radioactive element with the aid of one of its radionuclides.

Isotope Dilution Analysis, Substoichiometric

A kind of *isotope dilution analysis* in which the elemental abundance is estimated from the fraction of radionuclide determined to be accompanying a known quantity of the element separated from the sample.

Isotope Effect

Any difference in behaviour between two substances in which only the mass numbers of constituent atoms differ.

Isotope Exchange

The exchange of chemical forms, chemical phases or molecular positions between *isotopes* of atoms.

Isotope Exchange Analysis

A kind of quantitative analysis based on the *isotope exchange* between *isotopes* of the element to be determined and other isotopes of this element in different valency states or in different molecules.

Isotopic Carrier

See *carrier, isotopic*.

Isotopic Tracer

See *tracer, isotopic*.

Label

A marker, tag or indicator and used to identify a *tracer*.

Labelling

Incorporating a *label* into a substance.

Labelling, Conjugation

Labelling of a substance by conjugation with a labelled molecule.

Labelling, Exchange

Labelling of a substance by *isotope exchange*.

Labelling, Isotopic

Labelling in which the resulting product is only different from the initial one by its isotopic composition.

Labelling, Non-Isotopic

Labelling in which the resulting product has a different chemical composition from the initial one.

Labelling, Recoil

Labelling by a chemical reaction initiated by *recoil*.

Labelling, Wilzbach

Labelling of a substance by exposing it to tritium gas.

Linear Energy Transfer

The average energy locally imparted to a medium by a charged particle of specified energy, per unit distance traversed.

Liquid Scintillation Detector

A *scintillation detector* in which the test portion is mixed with a liquid *scintillator*.

Live Time

For a measurement, the time during which a *radiation* measuring assembly is capable of processing event occurring in the radiation detector. It equals the clock time minus the

integrated resolving or *dead time* (to be distinguished from "life time").

Logit

In *competitive binding assays*, the logit-log dose relationship, in which the response is defined by: $R = \text{logit}(y) = \log [y/(1-y)]$ where $y = b/b_0$ with b = fraction of tracer bound and b_0 = value of b with no unlabelled *ligand* in the system. Logit transformed assay data frequently yield straight-line dose-response curves, amenable to statistical analysis.

Luminescence

A phenomenon in which the absorption of *energy* by a substance gives rise to the subsequent emission of electromagnetic *radiation* characteristic for this substance.

Mean Life, Radioactive

The average lifetime of a *radioactive nuclide*.

Moderator

A material used to reduce the neutron *energy* by scattering without appreciable *capture*.

Neutron Density

The number of free neutrons divided by the containing volume. Partial densities may be defined for neutrons characterized by such parameters as *energy* and directions.

Neutrons, Epicadmium

Neutrons of kinetic *energy* greater than the *effective cadmium cut-off energy*.

Neutrons, Epithermal

Neutrons of kinetic *energy* greater than that of thermal agitation. The term is often restricted to energies just above thermal.

Neutrons, Fast

Neutrons of kinetic *energy* greater than some specified value. This value may vary over a wide range and will be dependent upon the application.

Neutrons, Resonance

Neutrons whose *energy* corresponds to the resonance energy of a specified *nuclide* or element. If the nuclide is not specified, the term refers to resonance neutrons of ^{238}U, although this non-specificity is discouraged.

Neutrons, Thermal

Neutrons in thermal equilibrium with the medium in which they exist (in general at room temperature).

No Carrier Added

A preparation of a *radioactive isotope* which is essentially free from stable isotopes of the element in question.

Nuclear Chemistry

See *chemistry, nuclear*.

Nuclear Decay

See *decay, nuclear*.

Nuclide

A species of atom, characterized by its mass number, atomic number and nuclear energy state. Usually restricted to situations in which the mean life is long enough to be observable.

Partial Decay Constant

For a *radionuclide*, the probability in unit time for the decay of one of its nuclei by one of several different modes of decay.

Peak Analysis

The extraction of relevant peak parameters (i.e.position, area) from a measured spectrum.

Peak Area Method

A kind of *peak analysis* in which a peak area is calculated by subtracting an estimate of the underlying continuum in a relevant part of a measured spectrum.

Peak Fitting

A kind of *peak analysis* in which a relevant part of a spectrum is fitted with a theoretical response function.

Pile-up

The processing by a *radiation* spectrometer of pulses resulting from the simultaneous absorption of independent particles or photons in a *radiation detector*. As a result they are counted as one single particle or photon.

Precursor

Of a *nuclide*, any *radioactive nuclide* which precedes that nuclide in a *decay chain*.

Purity, Radiochemical

For a material, that fraction of the stated *isotope* present in the stated chemical form.

Purity, Radionuclidic

For a material, that fraction of the total *activity* which is present in the form of the stated *radionuclide*, including *daughter* products.

Quenching

(1) The process of inhibiting continuous or multiple discharges following a single ionizing event in certain types of *radiation detectors*, particularly in Geiger-Müller counter tubes.

(2) The deactivation of an electronically excited state by non-radiative processes. This may lead to spectral shift or counting losses.

Quenching Correction

Correction for error due to different *quenching* for standards and test portions. When using *liquid scintillation detectors*, these corrections can be based e.g. on the standard addition or sample channels ratio method or the use of automated external standardization.

Radiation

A term embracing electromagnetic waves as well as fast moving particles. In radioanalytical chemistry, the term usually refers to radiation emitted during nuclear process (*radioactive decay*, nuclear reactions, *nuclear fission*).

Radiation Chemistry

The part of chemistry which deals with the chemical effects of *ionizing radiation*, as distinguished from photochemistry which is associated with the chemical effects of visible and ultraviolet electro-magnetic *radiation*.

Radiation Detector

See *detector, radiation*.

Radioactive

Having the property of undergoing spontaneous nuclear transformations with the emission of *radiation*.

Radioactive Decay

See *decay, radioactive*.

Radioactive Source

See *source, radioactive*.

Radioactivity

The property of certain *nuclides* of showing *radioactive decay*.

Radioanalytical Chemistry

The part of analytical chemistry in which the application of *radioactivity* is an essential step in the analytical procedures.

Radiochemical Purity

See *purity, radiochemical*.

Radiochemical Separation

See *separation, radiochemical*.

Radiochemical Yield

See *yield, radiochemical*.

Radiochemistry

That part of chemistry which deals with *radioactive* materials. It includes the production of *radionuclides* and their compounds by processing irradiated materials or naturally occurring

radioactive materials, the application of chemical techniques to nuclear studies, and the application of *radioactivity* to the investigation of chemical, biochemical or biomedical problems.

Radioenzymatic Assay

Assay of the catalytic activity of an enzyme based on the use of a *radioactive* substrate.

Radiograph

A visual representation of an object produced by placing the object between a source of *ionizing radiation* and a photographic plate or film, or a fluorescent screen.

Radiogravimetric Analysis

An analytical procedure in which the *activity* of a precipitate is used as a measure of its mass.

Radioimmunoassay

An analytical procedure based on the reversible and non-covalent binding of an antigen (hapten) by a specific antibody employing radioactively labelled antigen (hapten) to measure the fraction of the antigen (hapten) bound to a substoichiometric amount of antibody.

Radioimmunoassay, Solid Phase Antibody

A kind of *radioimmunoassay* employing an antibody bound to a solid phase.

Radioiodination

The process of incorporating the *radionuclides* of iodine (usually ^{125}I, ^{131}I or ^{123}I) into, or of covalently linking a radioiodinated substance to a substance.

Radioisotope

A *radioactive isotope* of a specified element.

Radioisotope Dilution Analysis

A kind of *isotope dilution analysis* making use of a *radionuclide*.

Radiolysis

The chemical effects of *ionizing radiation* on materials.

Radiometric Analysis

A method of analysis in which measurement of the *activity* is an essential step.

Radiometric Titration

A titration in which a *radioactive indicator* is used to monitor the end-point of the titration.

Radionuclide

A nuclide that is *radioactive*.

Radioreceptor Assay

Assay employing a radioactively *labelled* receptor protein as a *tracer.*

Radiorelease Analysis

An analytical procedure based on the release of *radioactivity* from the reagent by reaction with the analyte.

Recoil

The motion of a particle acquired through a collision with, or the emission of, another particle or electromagnetic *radiation*.

Relative Counting

A measurement in which the *activity* of a test portion is derived from the ratio between the count rates observed for the test portion and for a *radioactive source* of known activity.

Resonance Energy

The *energy* of a particle entering a nuclear reaction, this energy being just sufficiently high to lead to the formation of reaction products in one of their excited states.

Resonance Integral

The integral, over all or some specified portion of the *resonance energy range*, of the *cross-section* divided by the *energy* of a *radiation*.

Saturation

Of an irradiated element for a specified *isotope*, the steady state reached when the *disintegration rate* of the *nuclide* formed is equal to its production rate.

Saturation Activity

For a specified *isotope*, the value of the *activity* of an irradiated element, when a state of *saturation* is reached.

Scavenging

(1) In *radiation chemistry*: binding radicals or free electrons with a receptive (or reactive) material.

(2) In *radiochemistry*: the use of a precipitate to remove from solution by absorption or coprecipitation, a large fraction of one or more *radionuclides*.

Scintillation

Burst of *luminescence* of short duration caused by a single energetic particle.

Scintillation Detector

A *radiation detector* using a medium in which a burst of *luminescence radiation* is produced along the path of an ionizing particle.

Scintillator

A finite quantity of scintillating material intended to be the component sensitive to radiation, in a *scintillation detector*.

Self-Absorption

The absorption of *radiation* by the emitting *source*.

Self-Absorption Factor

Of a *radiation source*, the ratio between the quantity of the *radiation* emitted by the source and the quantity of the radiation as produced by the *radioactive* nuclei present in the *source*. Synonymous with: source efficiency.

Self-Shielding

The lowering of the *flux density* in the inner part of an object due to absorption in its outer layers.

Semiconductor Detector

A *radiation detector* using a semiconductor, in which free electric charges are produced along the path of an ionizing particle.

Separation, Radiochemical

Separation by a chemical means of the *radioactive isotopes* of a specific element or elements from a mixture of *radionuclides*.

Source, Radioactive

Any quantity of *radioactive* material which is intended for use as a source of *ionizing radiation*.

Szilárd-Chalmers Effect

The rupture of the chemical bond between an atom and the remainder of the molecule of which the atom is originally a part, as a result of a nuclear reaction of that atom.

Tracer

Labelled members of a population used to measure certain properties of that population.

Tracer, Generally Labelled

A *tracer* in which the position of the *label* is not defined.

Tracer, Isotopic

A *tracer* which only differs in isotopic composition from the substance to be traced.

Tracer, Nominally Labelled

A *tracer* in which the *label* is present mainly in a specified position.

Tracer, Specifically Labelled

A *tracer* in which the *label* is present in a specified position.

Tracer, Stereospecifically Labelled

A *tracer* in which the *label* is present in a stereospecific position.

Tracer, Uniformly Labelled

A *tracer* in which the *label* in uniformly distributed over its possible positions.

Track, Nuclear

Of an *ionizing particle*, its path as revealed by a *track detector*.

Track Detector, Nuclear

A detector which makes the paths of *ionizing particles* visible, either directly (e.g. cloud chamber) or after suitable treatment (photographic emulsion, polymers).

X-Radiation, Characteristic

X-radiation consisting of discrete wavelengths which are characteristic for the emitting element.

X-Ray Emission Analysis, Particle Induced

A method of analysis based on the measurement of the *energies* and intensities of *characteristic X-radiation* emitted by a test portion during *irradiation* with charged particles other than electrons.

X-Ray Emission Analysis, Radioisotope Induced

A method of analysis based on the measurement of the *energies* and intensities of *characteristic X-radiation* emitted by a test portion during *irradiation* with a *radioactive source*.

X-Ray Fluorescence

The emission of *characteristic X-radiation* by an atom as a result of the interaction of electromagnetic *radiation* with its orbital electrons.

X-Ray Fluorescence Analysis

A method of analysis based on the measurement of the *energies* and intensities of *characteristic X-radiation* emitted by a test portion during *irradiation* with X-rays of wavelength shorter than their characteristic wavelengths.

X-Ray Fluorescence Analysis, Energy-Dispersive

A kind of *X-ray fluorescence analysis* involving the measurement of the *energy* spectrum of the emitted *radiation*, e.g. by a *semiconductor detector*.

X-Ray Fluorescence Analysis, Wavelength-Dispersive

A kind of *X-ray fluorescence analysis* involving the measurement of the wavelength spectrum of the emitted *radiation* e.g. by using a diffraction grating or crystal.

Yield, Fluorescence

For a given transition from an excited state of a specified atom, the ratio of the number of excited atoms which emit a photon to the total number of excited atoms.

Yield, Radiochemical

For the isotopes of a specified element the yield of a *radiochemical separation* expressed as a fraction of the *activity* originally present. (In *radiation chemistry* the numbers of species transformed by radiation per 100 eV of absorbed energy.)

16.3 References

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