Ian J. McColm

Dictionary of Ceramic Science and Engineering

Third Edition

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To Thomas, Lara, Joseph, Ewan and Aidan
who are following the family tradition as wordsmiths

Preface

The collection of words and terms for a science as large as ceramics and its related technology, industry and applications has been an on-going large task. When Head of the Department of Industrial Technology, more than 15 years ago, I became aware of the exponentially growing vocabulary needed by the students to understand and answer the examination questions passing across my desk at times throughout the year. This was particularly true for the burgeoning science of advanced ceramics and composites, magnetic, electrical and electronic ceramics and the new areas involving nanomaterials. A determined search of the sources these students were asked to consider involved many more text books, journals and information technology outlets than the large number involved in the second edition of this Dictionary.

The pace of change has been amazing with, for example, the discovery of all the new allotropes of carbon and their suggested applications as well as their actual applications. The methods of forming, shaping and consolidating ceramics expand all the time, and the science and use of composites containing ceramics has accelerated. Science has continued to precipitate ceramics into new areas of application as well as give explanations through concepts, such as **plasmons**, to the fascinating art of ceramics throughout millennia as exemplified by the **Lycurgus cup**. This is an example of the use made of bold text in this edition.

It has been an enormous effort to bring information from so many sources to a single collection. There is more science and a wider range of definitions in this greatly expanded text which the student communities I tried them out on found useful and many said "sped them on their way to a faster understanding".

The proven basis of the first two editions has been retained but a greater emphasis has now been given to guiding the reader to related information by emboldening words and concepts in the text that have their own entries. Double entries occur when a series of adjectives are used attached to the same word or concept and there has been a gathering together of items scattered throughout the text, such as equations. The wide use of acronyms and abbreviations has continued to grow and an effort has been made to keep pace in this edition. Further progress has been made to consolidate SI units, but some of the "beloved" older systems continue through many of the Appendix Tables and in definitions in the text.

The text has become somewhat more hybrid between straight dictionary and science encyclopaedia as trial users asked more about the range of sciences and techniques encompassed by ceramics. Striking a balance has been as hard as many ceramics are. I earnestly hope that this edition continues in the development of the ideals and concepts of the first edition and that this will be used as a first port of call by those puzzled by some of what they read or are just curious or perhaps crossword addicts.

I have learned so much doing the work and preparing the manuscript that it has enriched me greatly notwithstanding what may be forthcoming.

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A. *Symbol.* Stands for: (1) old chemical symbol for argon but superseded by Ar; (2) the symbol in **cement notation** for Al_2O_3.

Å. *Symbol*. Used for **angstrom unit** this is a convenient size for discussing crystal structure and lattices. 1 Å = 10^{-8} m.

@. *Symbol.* Used to indicate that a metal is incorporated into a **fullerene** cage e.g. Mn@C_{60}.

aa. *Noun.* A volcanic rock found in angular blocks with a very rough surface formed from molten lava.

abacus. *Noun.* The flat upper part of the capital of a column.

abampere. *Noun.* The **cgs unit** of current; equivalent to 10 A. It is the constant current that, when flowing through two parallel straight infinitely long conductors 1 cm apart, will produce a force between them of 2 dyn cm^{-1}.

Abbé value. ν. *Noun.* A number designating the dispersion of light waves by an optical glass, expressed as the reciprocal dispersive power of the glass by the equation $\nu = (n_D - 1)/(n_F - n_c)$, in which n_D is the **index of refraction** of the glass for the sodium line at 589.3 nm, and n_F and n_c are the indices for the hydrogen lines at 486.1 and 656.3 nm, respectively. Also known as **Abbé number, nu value** and **constringence**.

abcoulomb. *Noun.* A **cgs** unit of charge given as the charge per second passing any cross section of a conductor through which a steady current of 1 **abampere** is flowing. It is equivalent to 10 **coulombs**.

abfarad. *Noun.* The **cgs** unit of capacitance; the capacitance of a capacitor having a charge of 1 **abcoulomb** and a potential difference of 1 **abvolt** between its conductors. Equivalent to 10^9 **farads**.

abhenry. *Noun.* The **cgs unit** of inductance. Defined as the inductance that occurs when a rate of change of current of 1 **abampere** per second generates an induced emf of 1 **abvolt**. Equivalent to 10^{-9} **henry**.

abherent. *Noun.* A coating that prevents surfaces from adhering to each other. Such materials are also known as **release agents** or **abhesives**.

abhesive. *Noun.* See **abherent** and **release agent**.

ab initio. *Latin.* From the start. Calculations, often of molecular structure, made from first principles without empirical data. For solid-state calculations this usually involves the **Schrödinger equation** and the method of self-consistent fields.

ablate. *Verb trans.* To remove something by **ablation**.

ablation. *Noun.* The process of wearing or wasting away of the surface of an object by erosion, melting, evaporation, or vaporisation. See **laser ablation**.

ablative generation. *Noun.* The production of acoustic emission by the recoil force of rapid vaporisation of surface material caused by laser pulses impinging on the surface.

ablative material. *Noun.* A body or a coating of low thermal conductivity, such as a ceramic or a glass-reinforced plastic, which a pyrolytic process removes resulting in the absorption or dissipation of heat from a substrate.

ablator. *Noun.* A material that dissipates heat by eroding, such as silicone resin containing cork used to insulate the space shuttle external fuel tanks.

abopon. *Noun.* Sodium borophosphate complex; a viscous liquid used in porcelain enamels and glazes as a suspension agent and binder.

ABR. *Abbreviation*. Standing for **abrasive**.

abrade. *Verb trans.* To roughen or wear away a surface especially by friction.

Abrams' law. *Noun.* The strength of a concrete or mortar is governed by the quantity of mixing water employed, so long as the mix is of workable plasticity; it may be calculated by the equation: $S = A/B^r$, in which S is the strength, A and B are constants, and r is the **water to-cement ratio** of the compacted mortar or concrete.

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abrasion. *Noun.* The wearing, grinding, or rubbing away of the surface of a solid by friction induced by moving solids, liquids, or gases.

abrasion hardness. *Noun.* The relative hardness of a solid substance in terms of its capacity to scratch or abrade another solid material or itself be scratched or abraded. See also **Brinell test, Knoop hardness, Mohs hardness, Rockwell hardness**, and **Vickers hardness**.

abrasion resistance. *Noun.* Measures of the ability of a material to resist wear by friction. Samples may be evaluated on the basis of loss in weight, loss of gloss, or by the degree of permanence of discolouration when a lead pencil, dye, or fine powder of contrasting colour is drawn or rubbed across the abraded area.

abrasion tester. *Noun.* A laboratory device, usually provided with a scouring, cascading, or jet-propelled abrasive acting on the surface of a solid, employed in the evaluation of the abrasion-resistant properties of surfaces. See **Kessler abrasion tester**, **Tabor abrader**.

abrasion-wear index. *Noun.* The comparative degree of wear on the surface of a solid material produced by constant test conditions.

abrasive. *Noun.* Any substance, which, by virtue of its hardness and wear-resistance, is used for grinding, cutting, or polishing. Ceramics, such as **diamond**, **silicon carbide**, **alumina**, **sand**, **ceria**, **rouge**, etc., are the most commonly used abrasives.

abrasive belt. *Noun.* A band or endless loop of cloth, paper, leather, or sheet of other flexible substance to which an abrasive product has been bonded for use in grinding and polishing operations.

abrasive cloth. *Noun.* A strong, usually pliable fabric or cloth to which an abrasive has been bonded, and which is used in manual or mechanical grinding and polishing operations.

abrasive cone. *Noun.* A solid, cone-shaped, bonded abrasive product mounted on a spindle for use in high-speed grinding and machining operations.

abrasive disk, bonded. *Noun.* See **bonded abrasive disk.**

abrasive disk, coated. *Noun.* See **coated abrasive disk**.

abrasive-jet cleaning. *Noun.* The process of removing dirt and soil from a solid surface by the impingement of an abrasive-bearing stream of liquid or gas on the surface of the solid.

abrasive, levigated. *Noun.* See **levigated abrasive**.

abrasive machining. *Noun.* The technique of forming or shaping a solid item by grinding, drilling, or some similar mechanical process.

abrasive, mild. *Noun.* See **mild abrasive**.

abrasive paper. *Noun.* A paper sheet of high **tearing strength** to which an abrasive has been glued; used in grinding and polishing operations; sandpaper and emery paper are examples.

abrasive sand. *Noun.* Sharp-grained sand, usually graded to a **mesh size**, used as an abrasive.

abrasive tumbling. *Noun.* A process used to improve the surface finish or to deburr solid materials by tumbling in a rotating cylinder containing abrasive particles.

abrasive wheel. *Noun.* A grinding wheel or disk composed of an abrasive grit and an appropriate bonding material used for the grinding, polishing, shaping, or cutting of a solid surface.

absolute density. *Noun.* The weight of a unit volume of a pore free substance under specified conditions of pressure and temperature. See also **X-ray density** and **theoretical density**.

absolute electric constant. ε_o. *Noun.* A constant in Coulomb's Law when it is expressed in SI units; value 8.854×10^{-12} Fm^{-1}. Also known as the **absolute permittivity of free space**.

absolute humidity. *Noun.* The weight of water vapour contained in a unit volume of air. Several units used but gram per cubic metre is common.

absolute permittivity of free space. ε_o. *Noun.* See **absolute permittivity of free space**.

absolute specific gravity. *Noun.* The ratio of the weight of a given volume of a substance in a vacuum at a given temperature to the weight of an equal volume of water in a vacuum at the given temperature.

absolute temperature. *Noun.* Thermodynamic temperature. Temperature measured from absolute zero on an accepted scale of temperature measurement, such as the Celsius (Kelvin) or the Fahrenheit (Rankine) scale. Also called **Kelvin temperature**, **thermodynamic temperature**.

absolute unit. *Noun.* (1) A unit of measurement forming part of the **cgs system** of electromagnetic units, such as the **abampere**. (2) A unit of measurement in a system that does not have its unit of force defined by the acceleration of free fall.

absolute viscosity. *Noun.* The complete name for **viscosity** that differentiates it from **specific viscosity** and **kinematic viscosity**.

absolute zero. *Noun.* Temperature characterised by the complete absence of heat, or at which all particles whose motions constitute heat cease to move: believed to be equivalent to −273.16 °C.

absorb. *Verb trans.* (1) To soak or suck up liquids. (2) To take in incident radiated energy and retain it without reflection or transmission. (3) To undergo or cause a process in which a gas or liquid permeates and is dissolved in a solid.

absorbance. *Noun.* A measure of the light-absorbing ability of a material or object expressed as $\log_{10}$ of the reciprocal of the **internal transmittance**.

absorbent. *Adjective.* (1) Able to **absorb**. (2) *Noun.* A material that absorbs.

absorbency. *Noun.* The ability of a fluid material to penetrate into another material; specified as the weight of fluid absorbed to the weight or volume of the dry specimen.

absorber. *Noun.* (1) A material or structure that **absorbs**. (2) A material that absorbs radiation or causes the radiation to lose energy.

absorption. *Noun.* (1) The process in which fluid molecules are taken up by, and distributed through, a solid or another liquid. (2) The reduction of the intensity of any radiation as a result of energy conversion in the material such as sound to heat. (3) An optical effect whereby the energy of a photon of light is taken into a substance by electronic polarisation or electron excitation.

absorption centres. *Plural noun.* Dye molecules, transition metal ions or small particles of metal that cause attenuation of light of certain wavelengths to be more heavily attenuated and so giving a transparent body a resultant colour.

absorption characteristics. *Noun.* A combination of factors affecting the ability of a ceramic to absorb infrared radiation, e.g., crystal structure, reflectivity, and transmissivity.

absorption coefficient. *Noun.* A parameter, characteristic of the interaction of a beam of radiation with the material under investigation. It is μ in the equation $I = I_o\, e^{-\mu x}$, where I is the beam intensity measured at a distance x inside the material.

absorption-dye, test. *Noun.* See **dye-absorption test**.

absorption factor or absorptance. *Noun.* A measure of a materials ability to absorb radiation. It is equal to the ratio of the absorbed radiant flux to the incident flux. For a layer of material the ratio of the flux absorbed between the entrance and exit surfaces to the flux leaving the entry surface is the **internal absorptance**.

absorption rate. *Noun.* The amount of water absorbed by a brick or other body during partial or complete immersion for a specified period, usually 1 min; expressed in grams per unit of time for a sample of specified size.

absorption ratio. *Noun.* The ratio of the weight of water absorbed by a masonry unit during immersion in cold water to the weight absorbed during immersion in boiling water for an equivalent period of time. See **absorption test (2)**.

absorption test. *Noun.* (1) See **dye-absorption test**. (2) A test in which a body is immersed in a selected or specified solution for a designated time and temperature, and the ratio of the weight of solution absorbed to the weight or the volume of the dry specimen is reported as the **absorbency** of the body.

absorption, x-ray. *Noun.* **See x-ray absorption**.

absorptivity. *Noun.* The fraction of the incident radiant energy, at a given wavelength, absorbed by a unit area of surface. A **black body** has absorptivity of unity. If the absorptivity varies with wavelength, the surface is termed coloured.

abutment. *Noun.* The portion of a structure that receives the thrust or pressure of the **arch** in a furnace or kiln, and which generally consists of a **skewback brick** and steel support.

abvolt. *Noun.* The **cgs system** of potential difference in the electromagnetic system. The potential difference between two points when 1 **erg** of work must be done to transfer 1 **abcoulomb** between them. It is equivalent to 10^{-8} V.

abwatt. *Noun.* The **cgs system** of power in the electromagnetic system. Equals the power dissipated when 1 **abampere** flows across a potential difference of 1 **abvolt**. It is equivalent to 10^{-7} W.

A/C. *Abbreviation.* Used to denote **asbestos cement**.

ac. *Abbreviation.* Standing for alternating current.

acacia gum. *Noun.* A water-soluble gum derived from various acacia plants; used as a binder in porcelain-enamel and glaze slips; also known as **gum Arabic**, **gum Senegal**, and **gum Kordofan**.

acanthite. *Noun.* The primary mineral source of silver; usually occurs as **blebs** within **galena**.

accelerated-service life. *Noun.* The elapsed time required to reach the end point in a service test conducted under conditions more severe than those that will be encountered during the normal use of a product.

accelerated test. *Noun.* Any test of a property which is conducted under conditions more severe than will be encountered during the normal life of a product or material.

accelerator. *Noun.* (1) A chemical admixture introduced into a batch of concrete, **stucco**, mortar, plaster, or similar material as a catalyst to hasten hydration or other setting reaction, thereby causing the batch to develop strength more rapidly than normally would be attained; examples are the **alkali carbonates**, **potash alum**, and powdered **gypsum**. (2) A device that increases the speed and thus the energy of charged particles.

acceptability. *Noun.* The quality of a product in terms of its ability to meet minimum standards specified for its use.

acceptance level. *Noun.* The maximum and minimum limits of quality standards between which a product is considered to be acceptable for its intended use.

acceptance limits. *Noun.* The test levels used in the sorting of specimens that establish the rating group into which a material or product under test should be assigned.

acceptance number. *Noun.* The maximum number of defective pieces allowable in a sample of specified size.

acceptance standard. *Noun.* A specimen of a material or product selected to be used as a reference standard to indicate the acceptable measure of quantity, weight, extent, value, or quality of a material or product.

acceptance test. *Noun.* A test to determine the conformance of a product to a purchase order or contract, or to determine the degree of uniformity of the product, as a basis for its acceptance by the purchaser.

acceptor. *Noun.* (1) Impurity atoms added to a semiconductor. An acceptor is in a lower periodic group e.g. boron when added to a group IV semiconductor. Called acceptors because they have energy levels in the **forbidden zone** just above the **valence band**, thus creating **holes** in the electronic structure when electrons from the valence band rise into them. It is common for thermal energy to raise electrons from the valence band into them. (2) The atom or group that accepts electrons in a coordinate bond.

acceptor level. *Noun.* An energy level lying within a forbidden zone but close to the top of the valence band in an insulator or semiconductor. The existence of such levels is responsible for **holes** in energy bands and the properties associated with semiconductors. Also called **acceptor state**.

acceptor state. *Noun.* See **acceptor level**.

accessory mineral. *Noun.* A mineral found in a subordinate quantity in another mineral, but which is not essential and which does not affect the character or the properties of the parent mineral.

accuracy. *Noun.* The degree of precision existing between an experimentally determined value and an accepted reference value.

ACE. *Acronym.* Standing for amethyst contrast enhancer. See **amethyst contrast enhancer**.

A. Cer. S. *Abbreviation.* The official abbreviation for The American Ceramic Society.

acetylene black. *Noun.* A very pure form of graphitic carbon powder; made by controlled combustion of acetylene in air under pressure.

ACF. *Abbreviation.* Cement notation for a product of composition $Al_2O_3 + CaO + Fe_2O_3$ or $CaAl_2Fe_2O_7$. See **ferrite (3)**.

Acheson process. *Noun.* An industrial process for the manufacture of **graphite** and/or **silicon carbide** by heating coke and clay mixtures in an arc furnace. First SiC is prepared which loses silicon at 4,150 °C to yield graphite. Patented in 1896.

Acheson SiC. *Noun.* Silicon carbide lump and powder made by the **Acheson process**.

achondrite. *Noun.* A rare form of meteorite consisting mainly of silicate minerals but containing no **chondrules.**

achromatic. *Adjective.* (1) Without colour. (2) Capable of reflecting or refracting light without chromatic aberration.

achromatic colour. *Noun.* Colour, such as white, black and grey, which is devoid of **hue**.

achromatic glass. *Noun.* Glass that will transmit light without dispersing it into its constituent colours.

achromatic lens. *Noun.* A combination of two or more lenses of different focal powers that will transmit light free of undesired colours.

achromic or achromous. *Adjective.* Colourless.

acierate. *Verb trans.* To change iron into steel by removal of free carbon and development of **cementite**, iron carbide.

acicula. *Noun.* Needle-shaped component, such as a crystal in a microstructure.

acicular. *Adjective.* Needle-like.

acicular interlocking. *Adjective.* A microstructural description of some glass-ceramics where interlocking rod- or bladelike crystals serve as a toughening and strengthening system.

acid. *Noun.* In the ceramic context, an oxide, R_xO_y, in which R represents an element with a high charge and small size such as silicon, titanium, zirconium, tin, or boron that will react chemically as an acid.

acid annealing. *Noun.* A process for preparing metal shapes for **porcelain-enamelling** in which the metal is coated with acid followed by annealing to remove oils, rust, and other soil from the surface by scaling, and to relieve stresses in the metal prior to application of the enamel coating.

acid bottom and lining. *Noun.* The exposed bottom and lining of a steel-making furnace composed of materials such as silica brick, sand, siliceous rock, or other refractories, which will react as an acid with the molten metal and slag at operating temperatures. See **acid open-hearth furnace**, **acid refractories**, **acid slag**, and **acid steel**.

acid clay. *Noun.* Clay that releases hydrogen ions on contact with water.

acid embossing. *Noun.* The process in which the surface of glass is obscured by treatment with hydrofluoric acid or its compounds. See **frosted**.

acid etching. *Noun.* A technique used to obtain translucent surfaces on glassware by immersing it, or an area of it, in solutions containing hydrofluoric acid. Patterns are obtained by covering some glass areas with **wax resist**.

acid-extractable material. *Noun.* Substances, which may be dissolved and removed from a material by treatment with an acid, usually under specified conditions.

acid frosting. *Verb int.* To etch glass, particularly glass tableware, by treatment with hydrofluoric acid or its compounds.

acid gold. *Noun.* A decoration of gold applied to the surface of a glaze, which previously was etched with hydrofluoric acid or other fluoride to improve adherence.

acidic. *Adjective.* Of an oxide: yielding an acid in water.

acidic oxide. *Noun.* Any oxide that will display acidic properties. such as SiO_2, TiO_2, ZrO_2, SnO_2, CeO_2 GeO_2, PrO_2, Sb_2O_3, As_2O_3, B_2O_3, and P_2O_5.

acid lava. *Noun.* Magma that has an acidic content and flows very slowly, often cooling in volcano vents leading to plugs that trap gases that can later explode producing **pyroclastic rocks**. Rocks and minerals formed from acid lava often have distinctive bands due to the very slow flow prior to solidification.

acid open-hearth furnace. *Noun.* **An open-hearth furnace** lined with a highly siliceous refractory brick. the lining sometimes being coated with a fritted layer of silica sand.

acid polishing. *Verb int.* The process of polishing glass surfaces by means of an acid treatment to minimize roughness.

acid refractories. *Noun.* Refractories containing substantial amounts of silica which may react with basic refractories, slag, or fluxes at high temperatures.

acid-refractory furnace. *Noun.* A furnace or **cupola** lined with an acid-type refractory, such as silica brick.

acid resistance. *Noun.* The degree to which porcelain enamels, glazes, glasses, and other ceramic surfaces are resistant to attack by acids.

acid-resisting brick. *Noun.* A fired clay brick with high resistance to corrosion by acids. This situation is achieved by use of raw materials with low alkaline content and by firing to high **vitrification** such that low-water absorption is achieved.

acid-resisting enamel. *Noun.* A porcelain enamel exhibiting high resistance to attack by acids, particularly household cleaners, fruit, and cooking acids.

acid scaling. *Verb int.* The process of dipping or spraying raw metal with acid followed by annealing at a red heat as a means of removing oils, rust, and other soils prior to the application of a porcelain-enamel to the metal.

acid slag. *Noun.* Slag in which the silica content is greater than the content of basic ingredients, such as lime and magnesia.

acid spar. *Noun.* A fluorspar containing 98 % or more of calcium fluoride and 1 % or less of silica.

acid steel. *Noun.* A grade of steel produced in furnaces lined with silicate refractories.

acid, white. *Noun.* See **white acid**.

ACL kiln. *Noun.* A type of traveling-grate preheater employed to preheat a Portland cement batch before it is charged into the rotary cement kiln as a means of minimising the length of the kiln required for the clinkering operation.

acmite. *Noun.* $NaFe(SiO_3)_2$. An iron containing fibrous silicate.

acoustic atom. *Noun.* A concept proposed for **phononic crystals**, which are **artificially structured materials** with a periodicity of structural changes where each different repeat structure has a characteristic but different elastic moduli and mass densities. If the wavelength of an acoustic wave in the material is very much smaller than the modulations in the structure and the structure can be made to contain a layer of different material in some of the modulating blocks of structure these layers act like single acoustic centres and carry the name acoustic atom. These "atoms" change the excitation and propagation of acoustic waves leading to unexpected properties such as, negative refraction, negative mass and negative elastic constants. For example two interpenetrating spherical lattices of a polaritonic material such as $LiTaO_3$, or SiC plus a plasmonic material like MgB_2 give negative refractive index effects for acoustic waves in the composite. These new structures are called **acoustic metamaterials**.

acoustic emission testing. *Noun.* A non-destructive test method that monitors energy released when cracks nucleate and move or when phase changes occur; wave frequency and amplitude are monitored.

acoustic impedance. Za. *Noun.* the ratio of the sound pressure in a medium to the rate of alternating flow of the medium through a specified surface due to the sound wave.

acoustic insulation. *Noun.* Foamed or highly porous plaster, tile, or other product of very low density employed to diminish the intensity of sound.

acoustic metamaterial. *Noun.* An artificially structured solid that shows some novel and counterintuitive effects for sound wavelengths much greater than the periodicity of the engineered structure. See **acoustic atom.**

acoustic microimaging. *Noun.* A non-destructive examination technique that uses sound waves in the 5–200 MHz range to analyse internal features and defects in ceramics. Echoes of sound pulses from air gaps and grain boundaries are captured and presented as a relative intensity picture after computer processing.

acoustic microscope. *Noun.* A microscope in which sound is used to scan a sample. See **acoustic microscopy**.

acoustic microscopy. *Noun.* A technique used to study features beneath the surface of light-opaque materials. Sound waves, generated by a **piezoelectric transducer**, are focused by a **sapphire** crystal, through water onto a reflecting object. The reflected sound wave is used to electronically build up a picture of the structure on a video screen.

acoustic mobility. *Noun.* See **acoustophoretic measurement**.

acoustic phonic crystal. APC. *Noun.* See **phonic crystals**.

acoustic phonon. *Noun.* See **phonon**.

acoustic plaster. *Noun.* A plaster with a chemically or mechanically textured or roughened surface that absorbs or prevents the transfer of sound.

acoustic solid. *Noun.* A three-dimensional image formed from **C-SAM** scans. A solid is treated as a sequence of planar acoustic images.

acoustic spectroscopy. *Noun.* Measurement of the attenuation and velocity of ultrasonic pulses as they pass through concentrated suspensions and slurries. Measurements are made over a large range of frequencies to generate spectra from which particle size distributions in the range 5 nm to 100 μm can be measured. The rate of change of signal level as an acoustic pulse travels a distance in a colloidal suspension over a series of distances corresponds to the attenuation due to losses in the colloid. The attenuation is normalised by frequency and the particle size distribution is obtained by computing an expected attenuation against that observed.

acoustic streaming. *Verb.* Stimulated displacement in liquid particles caused by ultrahigh-frequency agitation that leads to production of ultrasound.

acoustic tile. *Noun.* A thin, decorative tile of plaster, ceramic, fibre or other material having sound-absorbing properties, which is used as a covering for walls, ceilings, and other surfaces.

acoustic waves. *Noun.* This is an **elastic wave** passing through a solid as **phonons** passing through the solid.

acoustoelectronic. *Adjective.* Describing a device in which electronic signals are converted into acoustic waves.

acousto-optic. *Adjective.* Relating to the use of **ultrasound** to modulate or change the direction of light in glasses and transparent ceramics.

acoustophoresis. *Noun.* An extension of **acoustophoretic measurement**. A ceramic powder suspension is subjected to a high frequency alternating electric field. The movement of charged particles generates an acoustic wave that is sensed by transducers. A dynamic mobility spectrum is generated as a function of the ac field frequency and this allows **zeta potentials** and particle sizes to be calculated. The method works for much higher volume fractions than traditional **electrophoresis**.

acoustophoretic measurement. *Noun.* An ultrasonic technique used to study acoustic mobility, AM, and **zeta potential**, ζ, through the expression $\zeta = (AM)\ \eta/\varepsilon$, where η and ε are the viscosity and dielectric constant, respectively, of water. The ceramic powder is suspended in water and subjected to a compressive ultrasonic wave of 200 kHz which induces periodic polarisation of the **Stern layer** and this alternating potential is measured and used to derive AM.

acousto-ultrasonics. AU. *Noun.* A non-destructive examination method using a combination of the principles of acoustic emission and conventional ultrasonics. Stress waves are stimulated in a material by a sending transducer, but unlike normal ultrasonics, these are detected by a receiving transducer and analysed using **acoustic emission** methods. It aims to give an overall assessment of the state of the material between the transducers but does not locate or size defects.

acrylic polymer. *Noun.* A thermosetting resin used as a binder in laminated products; made by polymerisation of acrylic acids, acrylates, etc.

actinic. *Adjective.* Of or concerned with radiation producing a photochemical effect.

ACTFELD. *Acronym.* Stands for alternating current thin film electroluminescent device. See **alternating current thin film electroluminescent device**.

actinic glass. *Noun.* A glass that transmits more of the visible components of light and less of the infrared and ultraviolet components.

actinide series. *Noun.* Chemical elements of atomic number 89–103.

actinolite. *Noun.* $CaFe_5(Si_4O_{11})_2(OH,F)_2$. A natural mineral with a fibrous habit. One of the amphibole silicates, useful as a reinforcing fibre in plastic matrices. See **jade**.

activated alumina. *Noun.* A highly porous, granular form of Al_2O_3 made by thermal decomposition of **gibbsite**, $Al(OH)_3$, at 350–400 °C. Used as an absorbent, a catalyst itself, and as a catalyst carrier. It is chemically inert to most gases, will not swell, soften, or disintegrate in water, exhibits high resistance to thermal and mechanical shock, to abrasion, and will hold moisture without change in form or properties.

activated carbon. *Noun.* See **activated charcoal**.

activated charcoal. *Noun.* A family of highly porous carbonaceous substances of high surface area per unit of volume; manufactured in powdered, granular, or pelletised form by processes that develop high absorptive properties. Exposing it to superheated steam markedly enhances its adsorbing power. Used chiefly for removing impurities from alcohols, occluding gases, etc. Also known as **activated carbon**.

activated carbon, granular. *Noun.* See **granular activated carbon.**

activated clay. *Noun.* Clay, such as **bentonite**, that has been treated with acid to improve its bleaching and adsorptive properties.

activated diffusion bonding. *Noun.* See **diffusion bonding**.

activation. *Noun.* Any process, such as chemical treatment, heat or radiation, which is employed to improve the reactivity or absorptive properties of a material.

activation analysis. *Noun.* A sensitive technique for the identification of trace elements based on the induced radiation characteristics of a specimen exposed to neutrons in a nuclear reactor. The energy of the emitted x-rays identifies the elements and their flux gives the composition.

activation energy. Q. *Noun.* (1) The minimum energy required for a chemical reaction to take place. It is the energy barrier that has to be overcome for reaction to proceed. It determines the way in which the reaction rate varies with temperature. (2) The energy required for initiating a physical process such as diffusion.

activation polarisation. *Noun.* A state reached in an electrochemical reaction when the rate is controlled by the slowest step in a sequence of steps that the reaction proceeds by.

activator. *Noun.* (1) An ion or group within a host lattice that can absorb photons and readmit at a slightly changed wavelength. (2) A chemical used to initiate a polymerisation process.

active current. *Noun.* The component of an electric current in a branch of an alternating current circuit that is in phase with the voltage. Also known as **watt current**.

active material. *Noun.* The electrode material in a dry cell that takes part in the electrochemical reaction that stores or delivers electrical energy.

active material utilisation. *Noun.* The fraction of the **active material** that reacts during the discharge before the **cell** can no longer deliver the required current at a useful voltage.

active site. *Noun.* A position on the surface of a solid catalyst at which chemical activity occurs.

active substrate. *Noun.* Semiconductor or ferrite materials in which active elements are formed that also acts as a mechanical support for the other elements of a semiconductor device or integrated circuit.

activity. a. *Noun.* (1) A general term describing the ability or capacity of a material to absorb or to react in a desired manner. (2) The effective concentration of an aqueous electrolyte solution or **solid solution**, which empirically accounts for the interactions between molecules that interfere with the behaviour of the solutes. (3) It is defined mathematically in terms of either the partial molar free energy of mixing, G_i, or in terms of chemical potential, μ, by the equations: $RT\ln a_i = \Delta G_i$ and $RT\ln a_i = \mu_i - \mu_i^o$, where a_i is the activity of the i-th component in a solution. Activity is determined by measuring a property that changes with concentration, for example by measuring the vapour pressure above a solution containing the element of interest: $a_i = p_i/p_i^o$, where p_i is the partial pressure of the element of interest above a solution containing the element of interest and another element and p_i^o is the partial pressure above the pure element at the same temperature. See **chemical potential**.

activity coefficient. γ_i. *Noun.* The factor that relates the **activity** of a component in a solution to the concentration of the component: $a_i = x_i\gamma_i$, where x_i is the **mole fraction** of component i and a_i is the **activity** of component i. It indicates the degree of deviation of the solution from ideal behaviour

actuator. *Noun.* A ceramic crystal with **piezoelectric** or electrostrictive properties, such as **PZT**, in which strains can be very accurately generated by using controlled electric fields. Such strains are used in devices to position semiconductor chips to tolerances of 0.1 μm for surface treatment.

actuator materials. *Plural noun.* These include many materials that change their dimensions when subjected to stimuli, such as heat, a voltage or light. the result is a mechanical response much greater than the original input.

adamantine. *Adjective.* (1) Very hard; unbreakable. (2) An appearance and texture description of fracture surfaces of **glass ceramics**. It is rougher than a **glassy fracture** but smoother than a **waxy** fracture and appears as a function of crystal size and content; no crystals give the glassy fracture surface, nanosized crystals give the adamantine surface and micron sized crystals produce the waxy texture. (3) Having the lustre of **diamond**.

adamantine lustre. *Adjective.* A surface showing a brilliant appearance like a diamond.

Adams and Walrath test. *Noun.* A mechanical test used on composites involving double cantilever beam loading.

Adams chromatic value system. *Noun.* A colour measurement method based on lightness, the amount of red or green, and the amount of yellow or blue in the colour being measured.

adapter. *Noun.* (1) A type of flange used to mount a grinding wheel on a shaft of smaller diameter than the centre hole in the wheel. (2) A device or attachment designed to connect or attach two dissimilar sized parts in an apparatus.

adaptive structure. *Noun.* A load bearing structure whose geometrical configuration and inherent structural characteristics can be changed in order to adapt to environmental changes.

ADC. *Abbreviation*. Standing for analogue-to-digital converter. See **analogue-to-digital converter**.

addition. *Noun.* A material added in relatively small quantities to a ceramic coating, body, or other composition to influence the manufacturing, working, or performance properties of the composition.

additive. *Noun.* A substance added in relatively small quantities to bring about a change in, or to enhance, the properties of another substance.

adherence. *Noun.* (1) In general ceramic usage, the bond or union developed at the interface between two substances by fusion or by chemical or physical reaction during fusion. (2) The degree to which a porcelain enamel, glaze, or other ceramic coating adheres to its substrate. (3) A measure of the stress necessary to cause one material to separate from another at their interface.

adherence failure. *Noun.* The separation of a porcelain enamel from its base metal, usually exposing bright metal in the fractured area; the traditional measure of the degree of failure is the ratio of bright metal to adherent enamel fragments remaining in an indented area which was deformed by a plunger in a specified manner to a specified size.

adherence promoter. *Noun.* Oxides added to glass **enamelling frits** to ensure the correct conditions at the iron or steel-glass interface. They provide available oxygen by a reduction process; they lower the saturation concentration value for the substrate metal oxide in the glass and speed up dissolution of substrate oxide; CoO and TiO_2 are common examples.

adhesion. *Noun.* (1) The degree or strength of attachment of a material in contact with another. (2) Any mutually attractive force holding together two magnetic bodies.

adhesion-type ceramic veneer. *Noun.* Thin sections of a ceramic held in place by the adhesion of a mortar to the unit and to the backing without the use of metal or other fasteners.

adhesive. *Noun.* A mucilaginous or cementitious substance placed or spread between two solid surfaces to bind the surfaces together; usually a colloidal solution that gels.

adhesive strength. *Noun.* The stress required to separate two bonded surfaces.

adhesive-bonded nonwoven fabric. *Noun.* Ceramic textile material made of a **web** or **batt** of fibres; bonded by applying adhesive.

adiabatic. *Adjective.* (1) A process in which the change is associated with a change in the temperature of the system since the system is surrounded by a barrier that does not permit heat to pass. (2) An occurrence which takes place without the loss or gain of heat, such as the expansion or contraction of bodies during drying at constant temperature. (3) *Noun.* A curve or surface on a graph representing the change in two or more characteristics, such as the volume and pressure of a system undergoing an adiabatic process.

adiabatic compression. *Noun.* A reduction in volume of a substance without heat flows, in or out.

adiabatic cooling. *Noun.* A process in which the temperature of a system is reduced without any heat being exchanged between the system and its surroundings.

adiabatic demagnetisation. *Noun.* Also known as magnetic cooling; a method for producing very low temperatures, below 10^{-2} K, whereby a cooled salt such as ferric ammonium alum is first magnetised isothermally and then demagnetised adiabatically.

adiabatic envelope. *Noun.* A surface enclosing a thermodynamic system in an equilibrium which can be disturbed only by long-range forces or by motion of part of the envelope; intuitively, this means that no heat can flow through the surface.

adiabatic process. *Noun.* Any thermodynamic procedure that takes place in a system without the exchange of heat with the surroundings.

adiabatic vaporisation. *Noun.* Vaporisation of a liquid with virtually no heat exchange between it and its surroundings.

adion. *Noun.* A cation or anion in solution that is adsorbed on to a solid surface, such as an oxide in suspension. See **adsorbate**.

additive colouration. *Verb.* To produce colour by combining different intensities or amounts of three primary colours, red, green and blue.

adlattice. *Noun.* Structure formed in two dimensions by adsorbed atoms or molecules on the surface of an adsorbing solid.

admicelle. *Noun.* A bilayer of adsorbed surfactant molecules on the surface of a solid adsorbent formed by interaction of the non-polar parts of sorbed molecules.

admix. *Verb trans.* To mix or blend.

admixture. *Noun.* A material added in small quantities to a batch to alter the working or performance characteristics of the batch in a desired manner.

adobe. *Noun.* (1) A structure made of unfired brick or clay. (2) Clay from which unfired brick is made. (3) Large, roughly moulded, sun-dried brick of varying dimensions which sometimes are reinforced by the incorporation of straw in the batch.

adsorb. *Verb.* To undergo or cause to undergo a process in which a substance accumulates on the surface of a solid. In the air this is usually a monolayer of gas molecules.

adsorbant. *Noun.* The solid phase involved in a **sorption** process.

adsorbate. *Noun.* (1) A substance, which, in molecular, atomic, or ionic form, will condense on, penetrate into, and be retained by another liquid or solid. (2) The cation or anion partitioned from an aqueous solution to a solid surface in the process of **sorption**. Sometimes called an **adion**.

adsorbed water. *Noun.* A water layer, one or more molecules thick, held on the surface of a solid by molecular forces.

adsorbent. *Adjective.* (1) Capable of adsorption. (2) *Noun.* Any solid or liquid, such as **activated charcoal, activated alumina, silica**, water, and mercury, having the ability to attract and concentrate significant quantities of another substance on its surface and to be penetrated by this substance.

adsorption. *Noun.* The attraction and adhesion, in extremely thin layers, of molecules, atoms, or ions of gases, liquids, or dissolved substances to the surface of solid or liquid materials in which they come in contact.

adsorption, anion. *Noun.* See **anion adsorption**.

adsorption, cation. *Noun.* See **cation adsorption**.

adsorption, chemical. *Noun.* See **chemical adsorption**.

adsorption coefficient. *Noun.* This is the C term in the **BET equation** (see **nitrogen surface area**) which relates the difference between the energy of adsorption of a vapour onto a pristine surface, E_1 and the energy of liquefaction E_L as the equation: $E_L \cdot C = \exp(E_1 - E_L)$.

adsorption, countercurrent. *Noun.* See **countercurrent adsorption**.

adsorption, heat of. *Noun.* See **heat of adsorption**.

adsorption, hydraulic. *Noun.* See **hydraulic adsorption**.

adsorption, integral heat of. *Noun.* See **integral heat of adsorption.**

adsorption, irreversible. *Noun.* See **irreversible adsorption**.

adsorption isotherm, Freundlich. *Noun.* See **Freundlich isotherm**.

adsorption isotherm, Langmuir. *Noun.* See **Langmuir isotherm**.

adsorption, preferential. *Noun.* See **preferential adsorption**.

adsorption, reversible. *Noun.* See **reversible adsorption.**

adsorption theory, Langmuir. *Noun.* See **Langmuir adsorption theory**.

adsorption, Van der Waals. *Noun.* See **Van der Waals adsorption**.

adsorption zone. *Noun.* The area on an adsorbent in which the concentration of an adsorbate in a fluid decreases from the influent concentration to the lowest detectable concentration.

adsorptive capacity, dynamic. *Noun.* See **dynamic adsorptive capacity**.

adsorptive capacity, equilibrium. *Noun.* **See equilibrium adsorptive capacity**.

adularescent. *Adjective.* Describing minerals, such as **moonstone** that emit a bluish **iridescence**.

adularia. *Noun.* $KAlSi_3O_8$. A white, glassy variety of **orthoc1ase** with a prismatic habit occurring in metamorphic rocks that is used as a gemstone.

adulterate. *Verb.* To debase by adding inferior material.

advanced composite. (A/C). *Noun.* A combination of stiff strong, usually ceramic, fibres, with a compatible resin or metal **matrix**.

advanced local oxidation. LOCOS. *Noun.* The effect caused in very local areas of a silicon semiconductor wafer when it is ion bombarded with O^+ ions to produce localised insulating **mesas**.

AEA. *Abbreviation.* Stands for air-entraining agent. See **air-entraining agent**.

aeolian rock. *Noun.* Rock formed from wind-deposited dusts.

aerate. *Verb.* To introduce air into a slurry by stirring or other means of agitation.

aerated concrete. *Noun.* Concrete containing a substantial amount of entrapped air, which was introduced into the mass by foaming or other process.

aeration of concrete. *Noun.* The process by which air or other gas is introduced into concrete to produce a product having a density substantially less than that of normal concrete, and to reduce **bleeding** and segregation in the concrete; the gas-forming ingredients usually are introduced into the **cement clinker** during grinding or into the concrete batch during mixing.

aerator. *Noun.* A machine for breaking down lumps in a sand mixture.

aerogel. *Noun.* The porous product obtained when **alcogel** is dried under **supercritical** conditions. It is a **colloid** that has a continuous solid phase containing dispersed gas.

aerate. *Verb.* To expose to the action of the air.

aerosol. *Noun.* A colloidal dispersion of solid or liquid particles in a gas to form a smoke or fog.

aerolite. *Noun.* A stony meteorite consisting of **silicate** minerals.

aerugo. *Noun.* Synonym for verdigris. See **verdigris**.

AES. *Abbreviation.* Stands for Auger electron spectroscopy. See **Auger effect**.

AFA rammer. *Noun.* A device consisting of a 6.35 kg weight falling from a height of 5.1 cm onto a plunger of a 5.1 cm mould to form test specimens of particulate refractory compositions, foundry sands, and similar materials or products.

affinity. *Noun.* A measure of the tendency of a chemical reaction to take place measured in terms of the **free energy** change.

AFM. *Abbreviation.* Standing for atomic force microscopy. See **atomic force microscopy**.

African wonderstone. *Noun.* See **sculpture stones**.

after-expansion or after-contraction. *Noun.* The permanent linear change measured on a refractory material reheated to a specified temperature for a prescribed time; reported as a percentage of the original length.

afterglow. *Noun.* (1) The glow in a material after removal from an external ignition source. (2) A cause of shadow images on electronic display screens arising when **cathodoluminescence** decays at an expected rate until a threshold value is reached after which it decays much more slowly. Usually arises from impurities present in the ceramic **phosphor**.

A g^{-1}. *Abbreviation.* Stands for amps per gram of platinum; a unit used in the field of **fuel cells** to denote current density instead of the normal A cm^{-2}.

agalmatolite. *Noun.* $Al_2(Si_2O_5)_2(OH)_2(H_2O)_x$. A natural hydrous aluminium silicate of the **pyrophyllite** family. Density 2,800–2,900 kg m^{-3}; hardness (Mohs) 1–2.

agar. *Noun.* A complex gelatinous carbohydrate obtained from seaweed.

agarose. *Noun.* A purified derivative of **agar**; used as a gelation agent in **gel casting**.

agate. *Noun.* A variegated **chalcedony**, SiO_2, with its colours arranged in stripes, blended in clouds, or displaying moss like forms. Used in the production of **agate mortars and pestles**, as grinding balls in ball mills, and as a burnisher or polisher of gold in ceramicware decorations. Density 2,650 kg m^{-3}; hardness (Mohs) 6.5–7.0.

agate glass. *Noun.* A multicoloured glass resembling natural agate in appearance; made by blending glasses of two or more colours while in the molten or highly viscous state, or by rolling a transparent glass into other glasses of various colours.

agate mortar and pestle. *Noun.* A highly polished, blemishfree, abrasion-resistant mortar and pestle made of natural quartz; resistant to all acids and alkalies except HF and NaOH; used to pulverise materials when minimal contamination is required.

agateware. *Noun.* Ceramic and porcelain-enamelled ware characterised by veins of colour distributed through the body or coating in a pattern resembling the appearance of natural agate or marble..

age hardening. *Noun.* See **precipitation hardening**.

agglomerate. *Noun.* (1) An association of individual crystallites in a powder within which the interfacial area is small and the total binding forces are weak so that they can be dispersed in suspension by chemical or physical means. (2) A rock consisting of angular fragments of lava and **volcanic bombs**. (3) A confused mass. (4) *Adjective.* Formed into a mass. (5) *Verb.* To be formed or to form a cluster or mass.

aggregate. *Noun.* (1) An inert material, such as sand, gravel, slag, shell, or broken stone, which is to be mixed with cement to form concrete or mortar. (2) In powder making it is an association of individual powder crystallites with either a large interfacial boundary area or very strong bonding forces across the crystallite boundaries that are difficult to separate as opposed to agglomerate. (3) A rock composed of closely packed mineral crystals of a single type or various kinds of mineral rock fragments. (4) *Adjective.* Formed of separate units bound into a whole.

aggregate, coarse. *Noun.* See **coarse aggregate**.

aggregate, expanded. *Noun.* See **expanded aggregate**.

aggregate, exposed. *Noun.* See **exposed aggregate**.

aggregate, fine. *Noun.* See **fine aggregate**.

aggregate, heavy. *Noun.* See **heavy aggregate**.

aggregate, lightweight. *Noun.* See **lightweight aggregate**.

aggregate, reactive. *Noun.* See **reactive aggregate**.

aggregate, separated. *Noun.* See **separated aggregate**.

aggregation. *Noun.* (1) An irreversible physical process in which initially dispersed basic units, such as particles, stick together to form characteristic structures with relatively strong bonds whose size increases with time. (2) The basis of **colour centre** lasers where **F-centres** are converted into $F_{Li}(II)$ centres. X-ray irradiated, lithium doped KCl crystals are cooled to −10 °C and then exposed to white light. Trapped electrons are released from F-centres leaving behind normal **anion vacancies**, which diffuse through the lattice before recombining with e^- to reform F-centres next to a Li^+ and recombination with e^- forms the $F_{Li}(II)$-centre required for the laser process. This scheme is **aggregation** and it is permanent as long as the temperature remains below −10 °C.

aging. *Verb.* (1) To store porcelain-enamels, glazes, slips, slurries, or frit powders before use. (2) To cure prepared ceramic materials by storage for a definite period under controlled conditions. (3) To cure mortars and

cements for periods of sufficient duration to develop necessary strength before exposure to severe conditions of use. (4) *Noun.* The change occurring in slips, slurries, or frit powders with the passage of time. Also known as **maturing**, **souring**.

agitated media mill. *Noun.* A continuously operated mill for both **wet** and **dry grinding**. A rotating grinding pan has an eccentrically positioned grinding tool by which material is fed into the pan, creating a zone for high energy input. Several sources of energy are applied simultaneously and the material being ground rises continuously from bottom to top of the pan.

agitator. *Noun.* An instrument or apparatus employed to stir, shake, or mix.

A-glass. *Trademark, noun.* High-alkali glass used to make single-filament glass fibres; a general-purpose reinforcing glass cheaper than E-glass, used mainly with plastic matrices; composition (wt. %): SiO_2 (72.7), Al_2O_3 (1.5), CaO (5.3), MgO (3.5), Na_2O+K_2O (14.0).

agonic. *Adjective.* Having or making no angle, having no inclination as in agonic line, the irregular line connecting the magnetic north and south poles of the earth.

AGR cores. *Noun.* **Graphite bricks** formed into annular shapes 1 m long with internal and external diameters of 240 and 380 mm, respectively, together with smaller interstitial bricks, held together by keys. The whole is the centre core of advanced gas-cooled nuclear reactors.

agricultural pipe. *Noun.* A conduit, usually made from fired clay, used to drain water from agricultural land.

agricultural tile. *Noun.* An unglazed porous tile of tubular shape designed for burial in the ground to form a piping system to drain excess water from agricultural lands.

Ah. *Symbol.* Stands for ampere-hours. See **capacity**.

AIM. *Acronym.* Stands for aqueous injection moulding. See **aqueous injection moulding**.

air. *Noun.* The mixture of gases that forms the earth's atmosphere; sea level density 1.226 kg m^{-3}; consists of 78.08 % nitrogen, 20.95 % oxygen, 0.93 % argon, 0.03 % carbon dioxide, water vapour varies between 0 and 4 %, and very small quantities of ozone and other inert gases.

air bells. *Noun.* A defect in optical glass consisting of irregularly shaped bubbles formed during pressing and moulding operations.

airborne seal. *Noun.* A repair in which a refractory powder is blown and collected in a defective or leaking area of a hot retort to stop the leak.

air brick. *Noun.* A fired brick essentially of standard size in which holes are formed through its length, as opposed to its depth, to permit the circulation of air in structures.

air brush. *Noun.* An atomiser for spraying solutions through flames to make ultrafine powders.

air chain. *Noun.* A chain or string of air bubbles or inclusions contained in glass, glaze, porcelain-enamel, a vitreous or near-vitreous body, or similar product, usually as a defect.

air classification. *Noun.* The separation and grading of solid particles of a material by density or size by a technique of progressive suspension or settling as in a rising stream of air at a controlled velocity, each grading being reported as a percentage of the original sample.

air content. *Noun.* The volume of voids in a cement paste, mortar, or concrete, excluding the pore space in the aggregate particles; expressed as a percentage of the total volume of the paste, mortar, or concrete.

air conveyor. *Noun.* A device that transports powdered or granular material through a pipe by means of high-velocity air or by vacuum.

air-cooled blast-furnace slag. *Noun.* Molten blast-furnace slag cooled under normal atmospheric conditions or cooled in an accelerated manner by the application of water to the solidified slag surface.

air drying. *Verb.* To remove moisture from a material, glaze, porcelain-enamel, or body by exposure to air.

aired ware. *Plural noun.* Defective ceramic ware on which the glaze has become partially devitrified or some volatilisation of glaze ingredients has occurred.

air elutriator. *Noun.* A device designed to remove impurities from the air, as by washing or filtering.

air-entrained concrete. *Noun.* A concrete containing purposefully introduced air bubbles of minute sizes as a means of improving its **durability** and other properties. See **aeration of concrete**.

air-entraining agent. *Noun.* A material or admixture, such as a soap, resin, or grease-like substance, which reduces the surface tension of water in concrete to facilitate the entrapment of minute bubbles of air in the batch as a means of improving the durability or other properties of the concrete; the agent sometimes may be added to the cement during grinding.

air-entraining hydraulic cement. *Noun.* Hydraulic cement containing a sufficient amount of **air-entraining agent** to cause air to be entrained in the **mortar**.

air-floated. *Adjective.* Clays and other materials that are finely milled and separated or graded by density or size by the use of an air classifier. See **air classification**.

air-fuel ratio. *Noun.* The ratio of the air supply to the fuel supply during combustion, expressed in terms of volume or weight.

air-hardening refractory cement. *Noun.* A finely ground, refractory cement containing admixtures to promote setting of mortars and cements at temperatures at or above room temperature but below **vitrification** temperature.

air inclusions. *Noun.* (1) Small bubbles of air or other gas enclosed in glass, glazes, porcelain-enamels, or bodies which become evident after firing; usually a defect but sometimes intentional as a form of decoration. (2) Gaseous inclusions in **mica** that appear as greyish areas in transmitted light and as silvery areas in reflected light.

air jet loom. *Noun.* A loom using a jet of air to move the **yarn** through the process.

air jet spinning. *Noun.* A system of spinning that uses air to apply the twisting forces to the yarn while at the same time moving the yarn through the process.

air laying. *Noun.* A method used to form a **web or batt** of staple fibres whereby fibres are subjected to an air stream and then condensed downstream on to a permeable conveyor.

airless drying. *Noun.* A drying method in which the air in the drier is re-circulated and raised in temperature so that it is progressively replaced as the heat transfer medium by superheated steam produced from the moist product. No air is permitted to enter the drier during the drying process. The main advantages lie in the reduction of heating costs, and in heat recovery from the steam produced by the ware.

air line. *Noun.* (1) A fine, elongated **cord** or bubble having the appearance of a **hairline**, which is considered a fault in glassware, particularly in glass tubing where it arises from the drawing process. (2) A system of pipes and tubing moving compressed air from one point to another.

air permeability. *Noun.* The measure of the rate of flow or diffusion of air through a porous ceramic; expressed as a unit of volume or pressure gradient per unit of area.

air pocket. *Noun.* A sizable bubble of air found in clay bodies during **wedging** or **throwing**.

air, primary. *Noun.* See **primary air**.

air ramming. *Verb.* To shape refractory or other ceramic products by means of pneumatic hammers.

air-relief valve. *Noun.* A small automatic or manually operated valve placed at a high point in a pipeline to exhaust air or other gases from the line.

air, saturated. *Noun.* See **saturated air**.

air seal. *Noun.* A moving curtain of air across the entrance or exit of a furnace or other enclosed area as a means of minimising heat loss or to minimise the movement of air in or out of the area.

air, secondary. *Noun.* See **secondary air**.

air separator. *Noun.* A device in which a stream of air at a controlled velocity is used as a means of separating particles of solid material as they remain suspended in the stream or settle from the stream.

air set. *Adjective.* The property by which a material develops strength during the process of losing moisture by evaporation.

air-setting binder. *Noun.* A term used to describe any binder that will harden when exposed to the air at room temperature; however, it is commonly used to describe oil-oxygen binders that require baking to complete the hardening.

air-setting cement. *Noun.* A cement or mortar that develops high strength in air during the loss of moisture by evaporation.

air-setting refractories. *Plural noun.* Refractory mortars, **ramming mixes**, **gunning mixes**, cements, and similar compositions which are **tempered** with water for placement; the mixtures develop a strong bond and strength on drying which is retained during subsequent service at elevated furnace and kiln temperatures.

air surface devitrification. *Noun.* Devitrification at the surface of glass caused by the volatilisation of oxides at the molten surface with resultant silica enrichment.

air-swept ball mill. *Noun.* A continuous ball mill in which the finely milled particles of the mill charge are removed by a current of air as the coarser particles continue to be ground.

air, tertiary. *Noun.* See **tertiary air**.

air twist. *Noun.* A process in which twisted capillaries are incorporated in the stems of glass tableware to produce a pleasing decorative effect.

air void. *Noun.* An air-filled space of irregular shape sometimes occurring in freshly mixed concrete; the voids are larger in size than intentionally entrained air bubbles, and are considered to be defects.

akaganéite. *Noun.* β-FeOOH. A brown to yellow coloured, rare natural product. Iron ions occupy positions in an anionic close packed structure. Usually contains some Cl^- ions. It is also a product of the hydrolysis of ferric chloride solution in the presence of urea.

akermanite. *Noun.* $Ca_2MgSi_2O_7$. A discrete ionic **pyrosilicate**.

alabandite. *Noun.* MnS. Naturally occurring manganese sulphide; a special ceramic with the **rock-salt** structure.

alabaster. *Noun.* (1) Compact, fine-grained white or delicately shaded **gypsum**, $CaSO_4 \cdot 2H_2O$; used to make statues and vases. (2) A form of hard semi-translucent **calcite**; used in early windows.

alabaster glass. *Noun.* A glass containing inclusions of materials having different indices of refraction, and which shows no colour reaction to light; resembles **alabaster** or **onyx** in appearance.

Albany slip. *Noun.* Clay of high flux content and fine particle size found in the vicinity of Albany, New York; the clay fires in the temperature range of cones 6–9; it is used as a glaze for **electrical porcelain** and **stoneware** bodies, and as a bond in the manufacture of **vitrified grinding wheels**.

albedo. *Noun.* (1) The fraction of incident electromagnetic radiation reflected by a surface. Most commonly refers to light. (2) The probability that a neutron passing through a surface will return through that surface.

albertite. *Noun.* A black solid form of **bitumen** that exhibits conchoidal fracture.

albite. *Noun.* $Na(Al_{0.25}Si_{0.75}O_2)_4$. Triclinic crystalline soda feldspar used as an ingredient in ceramic bodies and glazes, and as a substitute for **Cornish stone**. It is colourless through a range of colours to black depending on the impurities present in the crystal structure. It occurs in sedimentary, igneous and metamorphic rocks. Weathers in basic conditions to form **kaolinite clay**. Sometimes known as **white feldspar**, **soda spar**, **white schorl**, and **sodaclase**.

albolite. *Noun.* A plastic cementitious material composed essentially of **silica** and **magnesia**.

Alborex. *Trademark, noun.* $Al_{1.63}B_{0.36}O_3$. An alumina-based, boron-containing, reinforcing **whisker** material 0.5–1.0 μm in diameter and 10–30 μm in length.

alcogel. *Noun.* The rigid product obtained in **sol–gel** processing when **metal alkoxide**-organic solvent solutions are hydrolysed.

alcoholate. *Noun.* A salt formed by replacing the H in OH-groups of organic alcohols by metal cations, for example $Ti(OC_2H_5)_4$; usually soluble in organic solvents and as a result are used extensively in **sol–gel** powder manufacture and processing. See **alkoxide**.

Alcorit. *Tradename, noun.* Porous commercial refractory, designed to have high thermal shock resistance for kiln furniture construction. Consists of **mullite** plus **cordierite**; working temperature 1,350 °C.

alcove. *Noun.* The narrow channel through which molten glass flows from the **fining chamber** to the **forehearth**, or to a revolving pot, for gathering by an Owens machine. See **Owens process**.

alcoxolation. *Noun.* A condensation polymerisation reaction in which a bridging oxo-group is formed by the elimination of an alcohol molecule.

alembic. *Noun.* A type of retort used for distillation.

alexandrite. *Noun.* $BeAl_2O_4{:}Cr^{3+}$. **Chrysoberyl** doped with chromium to generate **photoluminescent** properties and is used as a gemstone.

algal limestone. *Noun.* A sedimentary limestone that has included algae in the formation and when crystallised this produces microstructural features resembling trees etc. Also called **muddy limestone** and **landscape marble**.

alginates. *Plural noun.* Hydrophilic, colloidal salts of the alginic acids, chiefly sodium or ammonium alginate; used as **binders** and **suspension agents** in ceramic bodies, glazes, porcelain-enamels, and similar slurries, and as a waterproofing agent in concretes.

alginic acid. *Noun.* A polysaccharide isolated from brown kelp. It is a block copolymer of D-mannuronic acid and L-gluconic acid. The monovalent salts are called alginates and are used in ceramic processing. See **alginates**.

algorithm. *Noun.* A set of numerical operations designed to undertake a specific mathematical task.

aliquot. *Noun.* A representative sample of a large quantity of a material.

ALISO-B. *Trademark, noun.* $Al(OC_3H_7)_x{\cdot}(OC_4H_9)_y$, where x approx is equal to y and $x+y=3$. A commercially available aluminium **alkoxide** that is used as a **thixotropic** reagent for slips and the **sol–gel** processing of ceramic powders.

alite. *Noun.* $Ca_3(SiO_4)O$; in cement notation C_3S. A constituent of **Portland-cement clinker**. An ionic **orthosilicate** where regions of Ca^{2+} and O^{2-} packing can be seen reminiscent of the CaO structure. Several **polymorphs** exist depending on the degree of **isomorphous replacement** of Ca^{2+} by Mg^{2+}. Develops compressive strength rapidly when hydrated, i.e., 70 % of final value in 28 days.

alk. *Abbreviation.* Standing for **alkali**.

alkali. *Noun.* A general term applied to the oxides, hydroxides, and carbonates of sodium and potassium, the alkaline earth metals, and other alkaline metals; used primarily as **fluxing agents** in ceramic compositions.

alkali-aggregate reaction. *Noun.* A deleterious reaction between the siliceous parts of aggregates and the alkalis contained in **Portland cement**, the reaction usually occurring in concrete after it has hardened. See **alkali-silica reaction**, **concrete cancer**.

alkalic. *Adjective.* Igneous rocks that contain large amounts of sodium and potassium.

alkali carbonates. *Plural noun.* The carbonate salts of periodic groups 1 and 2. All are extensively used as **fluxing agents**, **accelerators** and in glass batch compositions.

alkali fullerides. *Noun.* M_3C_{60}. The product of the reaction of **buckminsterfullerene** with hot vaporised alkali metals. Chains of three alkali metal atoms are sequestered into the cage of carbon atoms. The proximity of a metallic to insulator transition makes them **high temperature superconductors**, for example Cs_3C_{60} has a T_c value of 38 K.

alkalimeter. *Noun.* (1) An apparatus for measuring the amount of carbon dioxide in carbonates. (2) An apparatus for determining the concentration of alkalis in solution.

alkaline. *Adjective.* Containing an alkali or having the properties of an alkali.

alkaline earths. *Plural noun.* The oxides of barium, calcium, magnesium, strontium, radium, and beryllium; the oxides of barium and calcium are used primarily as fluxes in porcelain-enamels and glazes, and magnesium oxide is used extensively in refractories. Barium oxide is an essential component in oxide superconductors. See **superconductor**.

alkaline glaze. *Noun.* Glaze containing high percentages of alkaline materials, such as Na_2O, K_2O, Li_2O, CaO, MgO, BaO, etc.

alkalinity. *Noun.* (1) The amount of alkali in solution; it relates to the **pH** of the solution. (2) The state of being alkaline.

alkali resistance. *Noun.* The relative degree to which porcelain-enamels, glazes, and other ceramic surfaces will resist attack by aqueous alkaline solutions, the term most frequently referring to the resistance of these products to alkaline materials used in the home, e.g., **alkaline-resisting enamel**.

alkali-resisting enamel. *Noun.* An enamel with overall composition close to a typical porcelain which requires a high application temperature; shows a high resistance to dulling from frequent applications of detergents, soaps, and general alkaline cleaning products.

alkali-silica reaction. *Noun.* A major cause of concrete deterioration caused by volume expansion when ordinary Portland cement, **OPC**, reacts with **acidic aggregate**. The cause of concrete cancer. See **concrete cancer** and **alkali-aggregate reaction**.

alkali zinc phosphate glasses. *Plural noun.* Chemically durable, low temperature glasses with formulae in the range: $xM_2O + yZnO + zP_2O_5$, where, in mole fractions, $x < 0.25$, $y < 0.5$ and $0.29 < z < 0.5$. M is Li, Na or K.

alkoxide-forming. *Noun.* A way to process ceramic fibre-ceramic matrix composites by infiltrating the matrix as an alcoholate (alkoxide) powder into the fibre preform and then the whole is hot pressed.

alkoxysilanes. *Plural noun.* Materials, such as $CH_2CHCH_2Si(OCH_3)_3$, which can be **gelled** by adding water and then heated to prepare silicon carbide, SiC, powders.

alkyd. *Plural noun.* Any of a group of thermoplastic resins prepared by the reaction of some polybasic alcohols, such as glycol or glycerine, with dibasic acids or anhydrides, such as phthalic anhydride; used extensively as adhesives for glass fibres.

allanite. *Noun.* $(Ca,Ce,La,Y)_2(Al,Fe,Be,Mn,Mg)_3(SiO_4)_3(OH)$. A brown-black mineral silicate occurring in **igneous** rocks and is a source of yttrium and beryllium.

allemontite. *Noun.* AsSb. A rare natural alloy of variable composition with all properties intermediate between arsenic and antimony; found in lithium-rich **pegmatites**.

allergens. *Plural noun.* Chemicals that produce allergies in a significant percentage of workers exposed to them.

alligator hide. *Noun.* A defect characterised by an extreme roughness of a porcelain-enamel surface that resembles the hide of an alligator in appearance; it is somewhat analogous to a severe case of **orange peel**.

allochromatic. *Adjective.* A material, usually a mineral, which can occur in a variety of colours.

allochthonous. *Adjective.* Describes rocks or mineral deposits found in a place other than where they or their constituents were produced.

allomerism. *Noun.* Similarity of crystalline structure in substances of different chemical composition.

allomorph. *Noun.* Any of two or more different crystalline forms of a mineral.

allomorphism. *Noun.* Variation in the crystalline form of a chemical compound.

allophane. *Noun.* $Al_2O_3 \cdot SiO_2 \cdot nH_2O$. A **gel**-like, naturally occurring amorphous hydrous **aluminosilicate clay mineral** sometimes containing appreciable amounts of Fe_2O_3. When the iron oxide content is 30–40 % it is called **hisingerit**e, and **iron allophane** when it contains 15–20 %. Density 1,800–1,900 kg m^{-3}; hardness (Mohs) 3.

allotrope. *Noun.* Different physical forms in which an element can exist; diamond and graphite are allotropes of carbon.

allotropy. *Noun.* The existence of two or more crystal structures for a substance. Usually the term is reserved for chemical elements; see **polymorphism**.

allowed direction. *Noun.* See **polars**.

allowed energy bands. *Noun.* The restricted regions of possible electron energy levels in a solid.

allowed transition. *Noun.* A transition between two **atomic energy states** which is permitted by the selection rules and which consequently has a relatively high priority.

alloy. *Noun.* A fused combination of two or more materials most commonly encountered in metallurgy but some ceramic composites are alloys of oxides. Not a mixture because the components cannot be physically separated.

alloyed junction. *Noun.* A semiconductor junction formed by alloying metal contacts, which act as **emitter** and **collector** regions, to a semiconductor base **wafe**r.

alluvial clay. *Noun.* Brickmaking clay deposited in or near river beds by flowing; water more plastic, less refractory, and darker in colour than **residual clays**.

alluvial fan. *Noun.* A fan-shaped accumulation of **silt**, **sand**, **gravels**, and **boulders** deposited by fast-flowing mountain rivers when they reach flatter land.

alluvial mining. *Noun.* The dredging of alluvial deposits, such as an **alluvial fan**.

alluvium. *Noun.* Fine-grained sand and silt deposited by flowing water.

almandine. *Noun.* The most common iron aluminium silicate **garnet** found as the mineral. **Almandite** is used in a variety of industrial applications mainly in the abrasives area because fracture is by lamella parting to give constant sharp edges. Naturally occurring large purple crystals of gem quality are found and can be cut or carved for decorations. Hardness (Mohs) 7.5–8.

almandite. *Noun.* A mineral in the **garnet** family, which fractures to give very sharp edges, and is therefore used as a coated abrasive. See **almandine**.

alpha activity. *Noun.* The spontaneous emission of doubly charged helium ions from the nucleus.

alpha alumina. *Noun.* α-Al_2O_3. Occurs naturally as **corundum** and is obtained by heating **alumina hydrates** to temperatures in excess of 900 °C but never to the melting point, 2,050 °C; the hardest, most chemically stable form of alumina. See **alumina**.

alpha case. *Noun.* A brittle ceramic alpha phase, similar to **case hardening**, which forms on surfaces during heating metals, such as titanium, in oxygen containing atmospheres. It can act as a crack initiator.

alpha phase. *Noun.* A rhombohedral **quartz polymorph**; stable below 573 °C.

alpha particle. *Noun.* A positively charged helium-4 nucleus emitted by several radioactive materials.

ALPO. *Acronym.* Stands for aluminophosphate. See **aluminophosphate**.

alternating current loss. *Noun.* Conventional superconductors exhibit losses in alternating current applications, such as in 60-Hz power transmission or in microwave devices. Although little is known about the alternating current characteristics of the new **high-temperature superconductors**, there is no reason to expect that the new materials will exhibit lower alternating current losses than other types of superconductor materials. Recent measurements on thin films in parallel, applied fields show the presence of a large surface barrier for the entry of flux, which indicates that **hysteresis losses** would be small.

Alternating current thin film electroluminescent device. ACTFELD. *Noun.* A device built-up of thin layers of ceramic phosphor and electrodes on a glass substrate. Used to provide strong, robust visual displays.

alum. *Noun.* (1) $KAl(SO_4)_2 \cdot 12H_2O$. Potash alum, a sulphate of potassium and aluminium with astringent and acidic properties. Used as an **accelerator**. (2) Any of various double salts with similar chemical formulae and crystal structure to potash alum. See **alum minerals**. (3) Colloquial name for **alumnite** and **alunogen**.

alumina. *Noun.* $A1_2O_3$. The old ceramic name for **aluminium oxide**. An **amphoteric** material second only to **silica** in importance to the ceramic industry; acts as a refractory in low-temperature products and as a **flux** in high-temperature compositions; used extensively in the manufacture of **abrasives**, **refractories**, **whiteware**, refractory coatings, protective surfaces for transistors, glass, and **cermet**s; examples of specific products include thread guides, clutch and brake linings, spark plugs, mill linings, blasting nozzles, welding-rod coatings, colour modifiers, jewel bearings for watches and scientific instruments, electron tubes, infrared windows, resistors, **semiconductors**, **lasers**, gas-turbine parts, **radomes**, rocket equipment, and prosthetics, such as artificial teeth and bones. When pure and unhydrated only one **polymorph**, **α-alumina**, exists. It has a hexagonal crystal structure. Other important forms are ternary phases, see **alumina-beta** and **alumina-gamma**. Technical forms of alumina, described as A-1 to A-16 dependent on particle size and Na_2O content (up to 0.4 %), contain α, β and γ-forms. Mp 2,030 °C; density 3,400–4,000 kg m^{-3}; hardness (Mohs) 9; 22 GN m^{-2} Vickers hardness.

alumina, activated. *Noun.* See **activated alumina**.

alumina-alumina composite. *Noun.* Ceramic alumina fibre preforms are infiltrated from the vapour phase by $AlCl_3$, which is then oxidised into an alumina matrix.

alumina balls. *Noun.* (1) High-density, abrasion-resistant balls used as grinding media in ball mills where contamination by iron or other metallic grinding media is to be avoided. (2) Spheres ranging from 6.25 to 18.75 mm in diameter that exhibit high heat and chemical resistance when used in chemical reactors or catalytic beds.

alumina-based fibre. *Noun.* Fibres with >60 wt.% Al_2O_3 usually prepared by extruding an aqueous **gel** through spinnerets, drying and then firing to 1,200 °C; high strength ~2.3 GN m^{-2} that is preserved to temperatures up to 1,000 °C.

alumina-beta. *Noun.* β-Al_2O_3. An ionically conducting ceramic of overall hexagonal structure in which each unit cell has, perpendicular to the c-axis, two mirror planes of $O^{2-}$and M^{n+} ions separated by a **spinel**-like block formed by four layers of close-packed O^{2-} ions with Al^{3+} in octahedral and tetrahedral sites. In β-Al_2O_3 the M^{n+} ions are Na^+ with an idealised formula of $Na_2O{\cdot}11A1_2O_3$. Many variations exist by changing the M^{n+} ions and by varying the size of the spinel blocks along the c-axis. Nomenclature is $\beta^{/}$, $\beta^{//}$, $\beta^{///}$, etc., depending on x in $M_2O{\cdot}xAl_2O_3$. Conductivity is 2-D in the mirror planes and not along the c-axis direction. Applications are in high temperature, high-energy-density electrochemical cells such as the sodium-sulphur battery.

alumina brick. *Noun.* Refractory brick containing 50 % or more of α-Al_2O_3; used in high-temperature applications, such as liners for kilns and furnaces, particularly in areas where the service conditions are severe.

alumina bubble brick. *Noun.* A lightweight, insulating refractory product made by pressing the brick or other shapes from Al_2O_3 into which air bubbles have been introduced by passing a stream of air through a molten Al_2O_3 batch.

alumina, calcined. *Noun.* See **calcined alumina**.

alumina cement. *Noun.* A **hydraulic cementitious** product formed by sintering mixtures of **bauxite** with **limestone**; the main constituent is $CaAl_2O_4$, **CA** in **cement notation**, which hydrates to CAH_{10}. Transformations of the hydrate can lead to very porous structures based on C_3A. This cement will set to maximum strength in about 24 h; used where cement resistant to elevated temperatures is required. Consists of Al_2O_3 (40 %), CaO (40 %), SiO_2 (10 %) plus 10 % impurities; density 3,000 kg m^{-3}.

alumina, exploded. *Noun.* See **exploded alumina**.

alumina fibre. *Noun.* A strong, usually short thread or fibre of Al_2O_3 used in the production of plastic-bonded insulating products and **dielectrics**. Most alumina fibre is in fact a form of **aluminosilicate**.

alumina, friable. *Noun.* See **friable alumina**.

alumina, fused. *Noun.* See **fused alumina**.

alumina-gamma. *Noun.* The name given to a number of phases that arise during the decomposition of hydrated, gelatinous $Al(OH)_3$ and AlO(OH). Structures are **spinel**-like stabilised by protons; occurs as an intermediate in the **kaolin**-to-**mullite** transformation.

alumina, hydrated. *Noun.* See **hydrated alumina**.

alumina, microcrystalline. *Noun.* See **microcrystalline alumina**.

alumina, natural abrasive. *Noun.* See **natural alumina.**

alumina porcelain. *Noun.* High-grade, dense, strong porcelain made of bodies in which Al_2O_3 is a major component; used in manufacture of spark plugs and electric insulators.

alumina, reaction-bonded. *Noun.* See **reaction-bonded alumina**.

alumina, regular. *Noun.* See **regular alumina**.

alumina, ruby. *Noun.* See **ruby alumina**.

alumina, semi-friable. *Noun.* See **semi-friable alumin**a.

alumina-silica refractories. *Noun.* A class of refractories consisting essentially of alumina and silica, including the **high-alumina**, **fireclay**, and **kaolin refractories**.

alumina, single-crystal. *Noun.* See **corundum**.

alumina, sintered. *Noun.* See **sintered alumina**.

alumina substrate. *Noun.* A sheet of sintered Al_2O_3 made from powder with particle sizes in the range 1–4 μm and usually made by the **doctor blade** method from suspension. Alumina substrates have advantages, such as high insulation resistance, stability in the presence of moisture, good thermal diffusivity.

alumina, tabular. *Noun.* See **tabular alumina**.

aluminates. *Plural noun.* (1) Salts containing $[AlO_2]^-$ or $[AlO_3]^{3-}$ ions that are formed when $Al(OH)_3$ or γ-Al_2O_3 are dissolved in solutions of strong bases. (2) Compounds of various metal oxides with **alumina**, and having the general formula $M_xO_y{\cdot}xAl_2O_3$ in the old notation but more usefully as $(M^{n+})_{5/n}[AlO_4]^{5-}$ or $(M^{n+})_{9/n}[AlO_6]^{9-}$ to indicate the anions present. These compounds are characterised by high-strength and oxidation resistance; melting points ranging from approximately 1,400–2,140 °C; employed most widely in structural applications.

alumina trihydrate. *Noun.* In old notation this was prefixed with β- and signified aluminium trihydroxide. See **bayerite.**

alumina, white. *Noun.* See **white alumina**.

alumina whiteware. *Noun.* Any ceramic product with an essentially white body, such as **artware**, **dinnerware**, wall tile, **sanitary ware**, spark plugs, and other products in which Al_2O_3 constitutes a major phase.

alumina-zirconia-silica refractory. AZS. *Noun.* A bonded brick consisting of alumina (68 %), zirconia (20 %) and silica (11.5 %); used as a refractory to build furnace superstructures.

aluminiferous. *Adjective.* Containing or yielding **alumina** or aluminium.

aluminite. *Noun.* $Al_2(SO_4)_3$. A white pigment often found as a deposit in stream beds as a result of mining pollution. Colloquially known as **alum**.

aluminium antimonide. *Noun.* AlSb. A special ceramic with the **zinc blende** structure; used in the production of semiconductors, transistors, rectifiers, and similar electronic products. One of the III-V compound semiconductors, energy band gap 1.52 eV; significant **hole conductivity**. Mp 1,080 °C.

aluminium borate. *Noun.* (1) $Al_4O_3(BO_3)_2 \cdot 3H_2O$. Employed as an ingredient in glass and other vitreous and semi-vitreous products. Dissociates at approximately 1,035 °C. (2) $Al_{18}O_{25}(BO_2)_4$. Employed in bodies requiring good thermal-shock resistance and refractoriness under load. Mp about 1,950 °C.

aluminium boride. *Noun.* Covers several special hard ceramics (1) AlB_2. Mp 1,654 °C; **Knoop hardness** 9.75 GN m^{-2}; dissociates at about 980 °C; density 3,160 kg m^{-3}. (2) AlB_{10}. Mp about 2,421 °C; density 2,540 kg m^{-3}; Knoop hardness 26.5 GN m^{-2} (3) AlB_{12}. Mp 2,163–2,213 °C; density 2,560–2,660 kg m^{-3}; Knoop hardness 22.5–24.5 GN m^{-2}. These borides have different degrees of covalent bonding between the boron atoms in the structure, e.g., AlB_{12} contains B_{12} icosahedral units connected at their corners to form a **cubic close-packed** arrangement; the $A1^{3+}$ occupy interstices in this structure. These, like most borides, have covalent + ionic + metallic components in their bonding and so have metallic appearance.

aluminium carbide. *Noun.* Al_4C_3. Ionic carbide in which the carbon ions are isolated and so is known as a methanide because hydrolysis yields methane gas. Mp about 2,704 °C; density 2,994 kg m^{-3}.

aluminium chlorhydrate. *Noun.* $Al_2(OH)_5Cl \cdot xH_2O$, where x = 2–2.5. Used in ceramic applications where high purity **alumina** is required, such as in ceramic fibre and catalyst support systems. Sold as a 50-wt% solution in water and called **chlorhydrol**.

aluminium enamel. *Noun.* A relatively low-melting porcelain enamel formulated specifically for application to aluminium and aluminium alloys.

aluminium fluoride. *Noun.* AlF_3. A source of **alumina** and fluorine and used for its fluxing and opacifying properties. Sublimes at about 1,260 °C; density 2,889 kg m^{-3}.

aluminium fluoride hydrate. *Noun.* $AlF_3 \cdot 3½H_2O$. Sometimes used in the production of white porcelain-enamels.

aluminium fluosilicate. *Noun.* $Al_2(SiO_4)(OH,F)_2$. Known as **topaz** and used as a gemstone. It is brittle with perfect cleavage in one direction; sometimes used in porcelain-enamels and glass manufacture. Density 3,490–3,570 kg m^{-3}; hardness (Mohs) 8.

aluminium hydroxide. *Noun.* (1) $Al(OH)_3 \cdot xH_2O$. A white gelatinous precipitate from solutions containing Al^{3+} ions. Used in the manufacture of glassware and glazes. Loses water at 300 °C; density about 2,400 kg m^{-3}. (2) $Al(OH)_3$. A white powder derived from **bauxite**; used in the manufacture of ceramics and glass.

aluminium metaphosphate. *Noun.* $Al(PO_3)_3$. Used in porcelain-enamels, glazes, and glasses and as a high-temperature insulating cement. Mp about 1,537 °C.

aluminium monohydrate. *Noun.* AlOOH. Used as an inorganic thickener and suspension agent, coating material, binder, high temperature adhesive, and as a source of **alpha-alumina** or **corundum** in bodies formed by hot pressing. Also called **diaspore**. Density 2,400 kg m^{-3}.

aluminium nitride. *Noun.* AlN. Special ceramic with a low coefficient of friction; used as a component in the manufacture of crucibles for the melting of aluminium. Mp 2,000 °C; density 3,260 kg m^{-3}; hardness (Mohs) 6–7.

aluminium orthophosphate. *Noun.* $AlPO_4$. A phase with several polymorphs isostructural with **tridymite** and **cristobalite**. They are used as binders in refractories and dental cements, and as partial replacement for SiO_2 to reduce liquidus temperatures and batch costs. Because they are analogous to the silica phases they are used to form a series of silicophosphate phases. See **aluminium phosphates**.

aluminium oxide. *Noun.* Al_2O_3. Used in the natural form, or as a prepared compound, as a component in abrasives, refractories, electrical insulators, electronic products, crucibles, laboratory ware, whiteware, and a wide variety of other ceramic products in which strength, toughness, thermal durability, chemical resistance, and similar properties are of primary importance. Mp 2,030 °C; density 3,400–4,000 kg m^{-3}; hardness (Mohs) 9. See also **alumina**, **bauxite**, **corundum**.

aluminium oxide, hydrous. *Noun.* See **hydrous aluminium oxide**.

aluminium phosphates. *Plural noun.* A general name used to describe phases occurring in **phosphate-bonding agents** that arise from the reaction of **phosphoric acid** with oxides and **siliceous** materials at elevated temperature. The main phases present up to 400 °C are: $AlH_3(PO_4)_2 \cdot 3H_2O$, $Al(H_2PO_4)_3$ and $Al(HPO_4)$ all of which are acid phosphates but above 400 °C **aluminium orthophosphate** is the main phase along with lesser amounts of $Al(PO)_3$ and $Al_4(P_2O_7)_3$.

aluminium phosphide. *Noun.* AlP. A fairly wide band gap, 2.5 eV, type semiconductor with the **zinc blende** structure; bulk modulus 86 GN m^{-2}; mp 1,500 °C.

aluminium silicate refractories. *Plural noun.* Two crystalline phases found in the Al-Si-O system of variable composition and structure: (1) **mullite** $Al[Si_{2-x}Al_xO_{5.5-0.5x}]$, where x varies from 1.25 to 1.40; long **acicular** crystals which give strength to pottery and

fireclay refractories; used in the manufacture of various refractory products and laboratory ware. Stable at high temperatures; mp 1,810 °C but softens at 1,650 °C; density 3,150 kg m^{-3}. (2) **Sillimanite**, **kyanite** and **andalusite** all have the same nominal composition, Al_2OSiO_4, and are stable up to 1,810 °C when they decompose into mullite needles and silica. Porcelain made from these minerals has high mp, low thermal expansion and low electrical conductivity and therefore find use as spark plugs. (3) A more general term used to describe ceramic material composed essentially of aluminium, silicon and oxygen; prepared from such materials as **bauxite**, **andalusite**, **diaspore**, **gibbsite**, kyanite, sillimanite and blends of Al_2O_3 and SiO_2.

aluminium sodium sulphate. *Noun.* $AlNa(SO_4)_2{\cdot}12H_2O$. Called **soda alum**; occurs in clay bearing rocks. See **alum minerals**.

aluminium titanate. *Noun.* Al_2TiO_5. Used in the production of special ceramics resistant to thermal shock. Mp 1,860 °C; stable from 1,150 to 1,865 °C, density 3,680 kg m^{-3}. See **tialite**.

aluminophosphate. ALPO. *Noun.* A catalyst with a **zeolite** structure made by heating **aluminium hydroxide gel**, **phosphoric acid**, cobalt acetate and a template molecule, 2-methoxycyclo hexamine, at 200 °C.

aluminosilicate. *Noun.* A compound in which some of the silicon in $[SiO_4]^{4-}$ tetrahedra have been **isomorphously** replaced by Al^{3+}; the resultant negative charge increase in the solid is compensated usually by intercalating other metal ions into the structure or occasionally by **oxygen vacancies**. The most refractory aluminosilicate is mullite. See **mullite**.

aluminothermic process. *Noun.* A method developed to make carbides using the aluminothermic reaction where mixtures of oxides, carbon and aluminium powder are ignited under inert gas pressure and after a violent **exothermic reaction** the molten **alumina** slag is removed from the carbide. Also called the **thermite process**.

aluminous cement. *Noun.* (1) See **alumina cement**. (2) Another name for **ciment fondu**.

aluminous porcelain. *Noun.* An alumina-glass composite used in dentistry containing as much as 50 % Al_2O_3.

alum minerals. *Plural noun.* A large and diverse group of ionic chemical salts having the general formula $M^+M^{3+}(SO_4)_2{\cdot}12H_2O$. Some have industrial use, e.g., $NaAl(SO_4)_2{\cdot}12H_2O$ and medical use as styptic pencil $KAl(SO_4)_2{\cdot}12H_2O$.

alumoxanes. *Plural noun.* See **carboxylate-alumoxanes**.

Alundum. *Trademark, noun.* Commercial **fused alumina** used as an abrasive or refractory material.

alunite. *Noun.* $KA1_3(SO_4)_2(OH)_6$. A naturally occurring white or reddish mineral with the hexagonal **tungsten bronze** structure formed from sheets of AlO_6 octahedra. The source of commercial alums and a calcined material employed in the production of **high-alumina refractories**. Density 2,600–2,800 kg m^{-3}; hardness (Mohs) 3.5–4.0.

alunogen. *Noun.* $Al(OH)SO_4$. Aluminium hydroxy sulphate; used as a white pigment and colloquially known as **alum**.

alunogenite. *Noun.* $Al_2(SO_4)_3{\cdot}18H_2O$. A mineral used in the paper industry which when heated produces **alumina**.

amazonite. *Noun.* A mineral rock suitable for **tumbling**, which produces attractive patterned decorative stones.

amber glass. *Noun.* A tinted glass with colours ranging from pale yellow to brown or reddish brown by the addition of iron oxide and sulphur compounds to the **batch**.

amber mica. *Noun.* Another name for the magnesium bearing mica, **phlogopite**.

ambetti. *Noun.* A translucent antique glass containing minute opaque specks of crystallised particles from the molten batch.

ambient. *Adjective.* Surrounding; a term describing the conditions or character of an encompassing environment, such as the atmosphere or fluid, in terms of its temperature, composition, pressure etc.

ambipolar. *Adjective.* A description of a material in which both electrons and holes can carry current; **graphene** is an example.

amblygonite. *Noun.* $LiAl(PO_4)(F,OH)$. Lithium aluminium fluophosphate; a mineral with obtuse angle crystals, hence its name from Greek amblus = blunt plus gonia = angle. A grey-white mineral source for lithium and used as a flux in low-temperature porcelain-enamels and to promote opacity in glass dinnerware. In ceramic bodies the F and Li decrease expansion and increase their strength; normally grey-white with a pearly lustre but can be pink, blue or pale green. Mp 1,170 °C; density 3,100 kg m^{-3}; hardness (Mohs) 6.

Amer. Ceram. Soc. *Abbreviation.* Stands for the American Ceramic Society.

American bond. *Noun.* The bond in which a **header** course of brick is used every fifth, sixth, or seventh course, with **stretcher** courses being used between the header courses. Also known as **common bond**.

American hotel china. *Noun.* A heavy, moderately translucent dinnerware of high strength and a water-absorption value of less than 0.3 %; the ware is coated with a glaze highly resistant to commercial soaps and detergents, food chemicals, and physical damage.

amethyst. *Noun.* (1) A purple or violet transparent variety of **quartz** and because the colour is rarely distributed evenly, tumble-polished stones have a pleasing mottled

appearance. The colours are caused by iron and titanium impurities. (2) A purple variety of **sapphire** known as **oriental amethyst**.

amethyst contrast enhancer. ACE. *Noun.* A type of optical glass filter used to improve colour discrimination. Normal spectacle glass compositions to which a mixture of **rare earth oxides** are added. Works by selectively positioning transmission in the blue, green, and red spectral region.

AMLCD. *Abbreviation.* Stands for active matrix liquid crystal display. See **liquid crystal display**.

ammonia. *Noun.* NH_3. Important base used to precipitate hydroxides; when added to iron oxide bodies of the **sgraffito-decorated** type it **deflocculates** and controls the segregation of iron oxide and stabilises the red colour over a firing range wider than normal.

ammonite. *Noun.* The shell of an extinct marine cephalopod occurring in fossils as a form of calcium carbonate.

ammonium alum. *Noun.* $NH_4Al(SO_4)_2{\cdot}12H_2O$. Used to increase the set of porcelain-enamel ground coats and acid-resisting cover coats.

ammonium bicarbonate. *Noun.* $(NH_4)HCO_3$. Used with fluorine compounds in an etching bath to produce frosted surfaces on glass, such as obtained on electric light bulbs.

ammonium bifluoride. *Noun.* NH_4HF. Used in combination with hydrofluoric acid to produce frosted surfaces on glassware.

ammonium dawsonite. *Noun.* $NH_4Al(OH)_2CO_3$. A source of **alumina** powder because thermal decomposition yields mono-sized, highly dispersed Al_2O_3 powder that is good for **slip casting** in a porous plastic mould before low-temperature, <1,200 °C, sintering to high density.

ammonium diuranate. *Noun.* $(NH_4)_2U_4O_{13}$. A precipitate made by adding ammonia to **uranyl nitrate** solution. Heating to 450 °C turns it into U_3O_8, which is the precursor for UO_2 or uranium metal.

ammonium metavanadate. *Noun.* NH_4VO_3. Used as a colorant to produce yellow, green and turquoie glazes and porcelain-enamels, frequently used in conjunction with the oxides of tungsten, molybdenum, and zirconium. Density 2,300 kg m^{-3}.

ammonium molybdate. *Noun.* $(NH_4)6Mo_7O_{24}{\cdot}4H_2O$. Sometimes used as an **adherence–promoting agent** in clear and white porcelain-enamel ground coats. Decomposes on heating; density 2,380–2,950 kg m^{-3}.

ammonium paratungstate. *Noun.* $(NH_4)_{10}W_{12}O_{41}{\cdot}11H_2O$. Very insoluble; used in the production of tungsten trioxide, WO_3, by calcination at 600 °C. Density 2,300 kg m^{-3}.

ammonium polymethylmethacrylate. APMA. *Noun.* Aqueous solutions act as a dispersing agent for very fine powders of **alumina** enabling them to be more easily cast.

ammonium stearate. *Noun.* $C_{17}H_{35}COO(NH_4)$. Employed as a waterproofing additive in hydraulic cements.

amorphatisation. *Noun.* The loss of order and crystalline structure. See **void swelling**.

amorphic diamond. The name is short for amorphous ceramic; a class of diamond prepared in vacuum by **laser ablation** of **graphite** at intensities in excess of 10^{11} W cm^{-2}. When condensed onto substrates nodules of amorphous diamond are formed as both the cubic and hexagonal modification of diamond intergrow in a random way. It consists of sp^3-bonded carbon in a matrix of sp^2-bonded carbons. Now used as a protective coating material.

amorphous. *Adjective.* Having only short-range order leading to no discernible crystalline structure.

amorphous carbon. *Noun.* Another **allotrope** of **carbon** manifest in a number of forms one of which is **carbon black**.

amorphous carbon nitride. *Noun.* C_3N_4. A semiconductor material made by reacting CO_2 with **lithium nitride** at 330 °C. The **exothermic** reaction also produces lithium cyanamide, Li_2CN_2, and so maybe an energy efficient way to fix atmospheric carbon dioxide.

amorphous graphite. *Noun.* A form of natural graphite formed by metamorphosis of coal seams exposed to high pressure and moderate temperatures. Not accurately described as amorphous but rather as **cryptocrystalline**; soft and black in appearance.

amorphous iron hydroxide. *Noun.* See **ferrihydrate**.

amorphous limit. *Noun.* An assumed limit to the high temperature **thermal conductivity** of materials culminating in the measured values found for **silica glass** at high temperatures.

amosite. *Noun.* $Fe_{5.5}Mg_{1.5}(Si_4O_{11})_2(OH)_2$. Also known as **grunerite**, an **amphibole** type fibrous silicate consisting of harsh, spikey brittle fibres grey in colour and diameters less than 0.1 μm. Used at 35 % level in calcined calcium silicate matrix as tiles for thermal insulation; also mixed with magnesia or sodium silicate as thermal tiles. Density 3,430 kg m^{-3}; hardness (Mhos) 5–6; has a high tensile strength at 2.5 GN m^{-2}.

amount of substance. n. *Noun.* A measure of the number of entities present in a substance. The entity may be an atom, molecule, ion, electron, photon etc., or any combination of these. The amount of substance of an element, for example, is proportional to the number of atoms present and the constant of proportionality is the **Avogadro constant**. The **SI** unit of amount of substance is the **mole**.

amp. *Abbreviation.* Stands for **ampere** or **amperage**. See **ampere**.

ampelite. *Noun.* Carbonaceous **schist** containing alumina, silica, and sulphur; sometimes used as a refractory.

amperage. *Noun.* (1) The strength of an electric current measured in amperes. (2) The rated current of an electrical component or device.

ampere. A. *Noun.* The basic **SI unit** of electric current; defined as the constant current that, when maintained in two parallel conductors of infinite length and negligible cross section placed 1 m apart in a vacuum, produce a force of attraction between them of 2×10^{-7} N m^{-1}. 1 A is equivalent to 1 C s^{-1}. Abbreviated a; A; amp.

Ampere currents. *Noun.* A postulated "molecular-ring" current used to explain the phenomenon of magnetism, as well as the apparent nonexistence of isolated magnetic poles.

Ampere law. *Noun.* A law giving the magnetic induction at a point due to given currents in terms of the current elements and their positions relative to the point. Also known as the Laplace law. A law giving the line integral over a closed path of the magnetic induction due to given currents in terms of the total current linking the path.

ampere metre squared. *Noun.* The **SI unit** of electromagnetic moment. Abbreviated A m^2.

ampere-minute. A min. *Noun.* A unit of electrical charge, equal to the charge transported in 1 min by a current of 1 A, or to 60 C.

ampere per square inch. *Noun.* A unit of current density, equal to the uniform current density of a current of 1 A flowing through an area of 1 square inch. Abbreviated A in^{-2}.

Ampere rule. *Noun.* The rule stating that the direction of the magnetic field surrounding a conductor will be clockwise when viewed from the conductor if the direction of current flow is away from the observer

ampere square metre per joule second. *Noun.* The **SI unit** of gyromagnetic ratio. Abbreviated A m^2 J^{-1} s^{-1}.

Ampere theorem. *Noun.* The theorem which states that an electric current flowing in a circuit produces a magnetic field at external points equivalent to that due to a magnetic shell whose bounding edge is the conductor and whose strength is equal to the strength of the current.

ampere-turn. *Noun.* A unit of magnetomotive force in the **SI system**. It is produced by a current of 1 A passing through one full turn of a coil. Measured as an ampere-turn it is equivalent to 1.257 **gilberts**. Abbreviated to amp-turn.

amphibole. *Noun.* Any member of a large group of **mineral silicates** containing calcium, iron, magnesium, sodium and aluminium often with **acicular crystal habit**, dark in colour. From the Greek amphibolos meaning uncertain. See **amphiboles**.

amphiboles. *Plural noun.* Widely found in **igneous** and **metamorphic rocks**. Double-chain silicate minerals formed from SiO_4 tetrahedra sharing corners in 2-D chains. Silicon can be partially replaced by Al. They commonly contain OH^-, F^- or O^{2-} ions. Examples are **asbestos**, **hornblende** and **tremolite**. The basic structural unit consists of infinite chains formed from two single $[(SiO_3)^{2-}]_n$ chains that share oxygen ions to form $[(Si_4O_{11}OH)^{7-}]_n$.

amphibolite. *Noun.* A **metamorphic** rock containing mainly **amphibole** and **plagioclas**e.

amphichroic. *Adjective.* A system producing two colours, one in an acid environment and the other in an alkaline medium.

amphiphilic. *Adjective.* Having a hydrophobic and a hydrophilic end.

amphora. *Noun.* A large ceramic jar with a narrow neck and with two handles that rise almost to the level of the mouth.

amphoteric. *Adjective.* Capable of reacting as an acid or as a base; for example, Al_2O_3, Fe_2O_3 and Cr_2O_3.

amplifier. *Noun.* A device that increases the amplitude of a signal at its input to give a larger signal at its output.

amplitude. *Noun.* The maximum displacement above or below the zero point of a wave or **wave function**. The energy of a wave is proportional to the square of the amplitude.

amplitude modulation. *Noun.* One of the main methods of transmitting audio or visual information; the amplitude of a radio frequency carrier wave is modulated by the information that is to be transmitted while the frequency of the carrier wave remains unchanged.

ampoule. *Noun.* A small bulbous glass container that may be filled and then sealed by fusion of the neck.

amu. *Abbreviation.* Stands for atomic mass unit. See **atomic mass unit**.

amygdale. *Noun.* An oval shaped pore in a solid, formed by escaping gas on cooling, that has subsequently become filled with another phase of lighter colour, such as **quartz** or **calcite**.

amygdaloidal. *Noun.* (1) A volcanic igneous rock containing **amygdales**. (2) Having a shape lie that of an almond.

amygdaloidal basalt. *Noun.* A rock that arises from **vesicular basalt** when the large pores are filled with another mineral, such as **calcite**.

anacoustic. *Adjective.* Unable to support the propagation of sound.

analcite. *Noun.* $NaAlSi_2O_6 \cdot H_2O$. A white or grey coloured cubic **zeolite** mineral also called **zedite**.

analogue. *Noun.* Something similar to something else, particularly in terms of features or properties on which comparisons may be made.

analogue signal processor. *Noun.* High-speed analogue signal processors performing such functions as filtering, convolution, correlation, Fourier transformation, and analogue-to-digital (A-to-D) conversion are important for many applications. Various high-speed A-to-D converters have been tested successfully at 4.2 K. If high-quality **Josephson junctions** can be fabricated from the new superconductors, these devices should perform comparably at 77 K. At this temperature, integration of the superconducting devices with some semiconducting devices (for example, **complementary metal oxide semiconductors**) becomes feasible, and new hybrid systems may well result in the fastest A-to-D converters available.

analogue-to-digital converter. ADC. *Noun.* A device for presenting data to a digital computer from an input varying directly with the property being monitored.

analyser. *Noun.* See **polariser**.

analysis. *Noun.* The separation and measurement of the constituents of a substance, and the interpretation of these results. Also identified as chemical content, mineral content, and physical properties.

analysis, gravimetric. *Noun.* See **gravimetric analysis**.

analysis, mechanical. *Noun.* See **mechanical analysis**.

analysis, optical. *Noun.* See **optical analysis**.

analysis, proximate. *Noun.* See **proximate analysis**.

analysis, qualitative. *Noun.* See **qualitative analysis**.

analysis, quantitative. *Noun.* See **quantitative analysis**.

analysis, screen. *Noun.* See **screen analysis**.

analysis, size. *Noun.* See **size analysis**.

analysis, statistical. *Noun.* See **statistical analysis**.

analysis, ultimate. *Noun.* See **ultimate analysis**.

analysis, volumetric. *Noun.* See **volumetric analysis**.

analysis, x-ray. *Noun.* See **x-ray analysis**.

analytical-reagent grade. *Noun.* A classification adopted by the American Chemical Society to designate the quality of a chemical or chemical reagent in terms of its composition and degree of purity.

anamorphism. *Noun.* Metamorphism in rocks in which complex minerals are formed from simpler ones. See **metamorphic**.

anatase. *Noun.* TiO_2. A blue or black mineral that is the tetragonal form of TiO_2; used as an **opacifier** and pigment in porcelain-enamels, glazes, and glass; the first polymorph to crystallise in enamels containing TiO_2 but on annealing it changes to rutile. Mp about 1,885 °C; density 3,900–4,200 kg m^{-3}; hardness (Mohs) 5.5–6 and Vickers 9.5 GN m^{-2}. See **titanium dioxide**, **rutile**, and **brookite**.

anchor. *Noun.* An L-shaped supporting device used to mount glass, masonry, concrete, or other panels or units to a wall or other surface.

anchored-type ceramic veneer. *Noun.* Any ceramic panel or sheet laid superficially over a permanent backing and then anchored in place.

anchor, storm. *Noun.* See **storm anchor**.

andalusite. *Noun.* Al_2OSiO_4. A **subsaturate** mineral which dissociates to yield principally **mullite** on firing at 1,350 °C; used as a component in refractories, spark plugs, insulators, and **whiteware** bodies. See also **kyanite** and **sillimanite**. Density 3,000–3,500 kg m^{-3}; hardness (Mohs) 7–7.5.

andesine. *Noun.* A soda-lime **feldspar** in which the principal constituents are **albite**, $NaAlSi_3O_8$ and **anorthite**, $CaAl_2Si_2O_8$.

andesite. *Noun.* An **amphoteric igneous** rock of intermediate **silica** content and small grain size formed by volcanic extrusion. It contains **andesine**, **amphibole**, **pyroxene** and **plagioclase feldspar**.

Andrades creep law. *Noun.* Flow under constant stress when the strain is characterised by $\varepsilon = \beta t^{1/3}$, where t is the elapsed time and β is a constant. It occurs at the beginning of creep tests where transient flow predominates.

Andreasen similarity condition. *Noun.* An equation that uses the **cumulative percent finer than** concept: $CPFT/100 = [D/D_l]^n$, where D is the particle diameter, D_L is the largest particle size and n is the distribution modulus.

andradite. *Noun.* $Ca_3Fe_2(SiO_4)_3$. A **garnet** whose colour varies from yellow-green to brownish-black; used as a gemstone. Different coloured varieties have different names, such as **topazolite**. Used as a gemstone.

Andreasen sedimentation pipette. *Noun.* An instrument in which differences in settling rate are employed as a means of determining the particle size distribution in clays and materials of similar character.

Andrews's elutriator. *Noun.* A device consisting of a sequence of classifiers and a graduated cylinder for use in making particle-size analyses. See **classifier**.

Andrieux-Weiss process. *Noun.* An electrochemical method involving the electrolysis of fused masses of carbonates to produce **carbide** and **oxide** mixtures from which the oxide can be chemically removed to leave behind refractory carbide material.

anechoic. *Adjective.* Having a low degree of reverberation.

anelasticity. *Noun.* Time-dependent elastic i.e., non-permanent, strain in response to stress in some materials.

aneroid. *Adjective.* Not containing a liquid.

aneroid barometer. *Noun.* A barometer in which variations in atmospheric pressure are measured by fluctuations of a thin elastic metal covering a partially evacuated chamber and indicated by a pointer on a calibrated dial.

anfractuous. *Adjective.* Convoluted; characterised by twists and turns.

angle bead. *Noun.* A slender, curved item of ceramic tile designed to finish the internal or external corners of a wall tile installation.

angle brick. *Noun.* A brick shaped to fit a corner.

angle of deviation. *Noun.* The angle between the **refracted ray** and the **incident ray** when a ray of light passes from one medium to another.

angle of drain. *Noun.* After dipping ware in a porcelain-enamel slip, the angle at which ware is placed on a rack to drain to obtain a desired coating thickness.

angle of incidence. *Noun.* The angle between a ray of light at a surface and a line perpendicular to that surface.

angle of nip. *Noun.* The maximum angle of the jaws, rolls, mantle, or ring of a **jaw crusher** which will accept and grip a solid mass for crushing.

angle of reflection. *Noun.* The angle a beam of reflected radiation makes with the normal to a surface at the point of reflection.

angle of refraction. *Noun.* The angle made by the refracted part of a light ray with a line perpendicular to the surface of the refracting medium through the point of incidence of the refracted ray.

angle of repose. *Noun.* The maximum angle to the horizontal that heaps of powders, aggregates. etc., will make before becoming unstable and sliding.

angle of wind. *Noun.* The angle of the **roving band** with respect to the **mandrel**. It is also described as the angle contained between a **warp** of **yarn** on the surface of a **package** and the diametrical plane of the package.

anglesite. *Noun.* $PbSO_4$. Oxidised layer of **galena** deposits; a source of lead oxide in ceramics.

angle tile. *Noun.* A tile designed or cut for placement in an angular space.

angstrom unit. Å. *Noun.* A length equal to 10^{-10} m; used primarily to express wavelengths in the x-ray region and to denote the size of x -ray unit cell dimensions of crystal structures.

angular acceleration. *Noun.* The rate of change of **angular velocity**.

angular frequency. ω. *Noun.* $\omega = 2\pi\upsilon$ or $2\pi c/\lambda$, where λ is the wavelength, c is the velocity of propagation of the electromagnetic wave, and ω is the angular frequency; used in mathematical treatments of electromagnetic waves.

angular momentum. *Noun.* A vector quantity. The product of the momentum of a rotating body and its distance from the axis of rotation.

angular velocity. *Noun.* The velocity of a body rotating about a fixed point measured as the rate of change of the angle subtended at that fixed point by the path of the body.

angulate. *Adjective.* Having angles; being angular shaped.

anharmonicity, electrical. *Noun.* See **electrical anharmonicity**.

anharmonicity, mechanical. *Noun.* See **mechanical anharmonicity**.

anhedral. *Adjective.* A solid having no planar surfaces.

anhydride. *Noun.* (1) An oxide which on addition of water produces an acid or a base. (2) A material formed from another by removal of water.

anhydrite. *Noun.* $CaSO_4$. Natural deposits in sedimentary rocks formed by evaporation of sea water above 25 °C. Used as a drying agent, as a substitute for **gypsum** in cement, and in the manufacture of ammonium sulphate fertiliser. Mp 1,450 °C; density 2,963 kg m^{-3}; hardness (Mohs) 3–3.5.

anhydrous. *Adjective.* Without water, both free water and water of crystallisation.

anhydrous borax. *Noun.* $Na_2B_4O_7$. A refined borate used in ceramics, glass frits and glass manufacture. See **borates**.

anhydrous boric acid. *Noun.* B_2O_3. See **boric oxide**.

anion. *Noun.* A negatively charged ion that is attracted to the anode during electrolysis.

anion adsorption. *Verb.* The adsorption of anions from solution on to free solid surfaces.

anionic dispersant. *Noun.* Polymeric materials used to generate steric hindrance at the surface of nanoparticles to prevent aggregation or agglomeration. Polyacrylic acid is a common dispersant used disperse TiO_2 and $BaTiO_3$. The amount used depends on the molecular weight of the polymer, pH, and volume fraction of solid. See **aggregate** and **agglomerate**.

anionic exchange. *Noun.* A type of ionic exchange in which the negative ions in a solution are exchanged with the negative ions in a solid, the superficial physical structure of the solid being unaffected. This process is preceded by **anion adsorption**.

anionic exchange capacity. *Noun.* A measure of the ability of a solid substance, such as clay, to exchange or adsorb ions; usually expressed in milliequivalents of ion per 100 g of solid.

anisometric. *Adjective.* Describes a crystal or artefact having unequal measurements.

anisotropic. *Adjective.* Physical properties that depend on the crystallographic direction in which they are measured. Even materials with the cubic crystal structure can have some anisotropic properties.

ankerite. *Noun.* A variety of **dolomite** in which considerable **isomorphous replacement** of Mg^{2+} and Ca^{2+} by Fe^{2+} has occurred.

annabergite. *Noun.* $Ni_3(AsO_4)_2{\cdot}8H_2O$. A green, monoclinic mineral that is a source of arsenic and nickel. Also called **nickel bloom**.

anneal. *Verb.* (1) The process of heating and cooling glass on a prescribed schedule to prevent or release stresses which contribute to brittleness. (2) The heating of metal shapes to a red heat or above as a means of removing scale, rust, and other surface contaminants prior to cleaning and pickling the ware prior to **porcelain-enamelling**. (3) Quenched or cold-worked solids in general will contain a considerable amount of **strain energy** stored in the crystals arising from an array of **dislocations**. If the material is heated to a temperature near the melting point, re-crystallisation can take place. This treatment, known as **annealing**, allows the grains to re-form themselves in strain-free distributions.

annealed glass. *Noun.* See **anneal**. Such glass breaks into **shards**.

annealing. *Noun.* A generic term used to denote a heat treatment designed to alter the microstructure and hence the properties of a material. See **anneal**.

annealing, abrasive. *Noun.* See **abrasive annealing**.

annealing, acid. *Noun.* See **acid annealing**.

annealing, bright. *Noun.* See **bright annealing**.

annealing, fine. *Noun.* See **fine annealing**.

annealing fire. *Verb.* (1) To heat treat glass and metals to remove internal stresses. (2) To heat treat metal shapes prior to cleaning for porcelain-enamelling to burn off scale, dirt, grease, and other contaminants, and sometimes to temper the metal.

annealing furnace. *Noun.* The furnace or oven in which the temperature, and sometimes the atmosphere, is controlled for the annealing of glass or metal.

annealing, glass. *Noun.* See **glass annealing**.

annealing point. *Noun.* The temperature, or the temperature-time relationship, at which internal stresses in a glass are substantially reduced or relieved in a time of about 15 min. The viscosity of the glass at this temperature is about 10^{12} Pa·s or 10^{13} P.

annealing, porcelain-enamelling. *Verb.* See **annealing fire (2)**.

annealing range. *Noun.* The range of temperatures in which the inherent internal stresses in glass can be reduced or relieved and which generally is at a rate considered feasible for commercial production.

annealing temperature. *Noun.* Any temperature within a temperature range at which internal stress in a glass can be substantially reduced or relieved, usually for commercially practical purposes, within a matter of minutes. In order to achieve this, the viscosity of the glass must be close to 10^{12} N s m^{-2}.

annealing twin. *Noun.* See **twinned crystal**.

annular coil. *Noun.* An electromagnetic coil of the encircling type.

annular kiln. *Noun.* A kiln of the type in which ware is placed in stationary compartments, and the firing zone is moved through each compartment in a successive manner by adjustment of the fuel input.

annular nozzle. *Noun.* A nozzle equipped with a ring-shaped orifice.

anode. *Noun.* The positive, electron-deficient electrode from which electrons flow in an electrochemical circuit. Oxidation occurs at the anode.

anodic cleaning. *Verb.* See **anodic pickling**.

anodic pickling. *Noun.* An electrolytic process for cleaning and pickling metal to be used for porcelain enamelling, or any other finishing treatment, in which the metal is used as the anode in a cleaning and pickling bath. Also known as **anodic cleaning**.

anomalous. *Adjective.* Deviating from the normal or the expected value.

anomalous dispersion. *Noun.* The existence of a large discontinuity in the dispersion curve of a material because at longer wavelengths the material has higher values of **refractive index**.

anorthic. *Adjective.* Synonym for **triclinic**.

anorthite. *Noun.* $CaAl_2Si_2O_5$. Low-thermal-expansion aluminosilicate of the **feldspar** group found mainly in igneous rocks; a calcium **feldspar** used in concretes, porcelain-enamels, glazes, abrasives, abrasive bonds, artificial teeth, glass, insulating compounds, and conventional ceramic bodies. Also known as **calcium feldspar**. Density 2,740–2,760 kg m^{-3}; hardness (Mohs) 6.0–6.5.

anorthoclase. *Noun.* A **feldspar** of a composition between **albite** and **orthoclase** formed by rapid cooling to yield a **perthite**, therefore metastable, but persists indefinitely at normal temperatures; occurs only in lavas. Also known as **soda orthoclase**, **soda microcline** and **anorthose**.

anorthose. *Noun.* See **anorthoclase**.

anorthosite. *Noun.* A coarse grained igneous rock consisting mainly of **plagioclase feldspar**.

anta. *Noun.* A **pilaster** attached to the end of a side wall.

antenna. *Noun.* A device to transform electromagnetic energy from a conducted mode to a radiated mode or vice versa.

anthophyllite. *Noun.* $Mg_7[Si_4O_{11}](OH,F)_2$. A natural fibrous mineral of the **amphibole** class used as a reinforcing fibre.

anthracite. *Noun.* The hardest and highest quality coal; shiny in appearance and clean to touch it gives out most heat with little smoke. The carbon content ranges from 86 to 98 % carbon with a calorific value about 3.4×10^7 J kg^{-1}. Also called **hard coal**. See **coal rank**.

anthracite-coal-based refractory. *Noun.* A refractory composition containing appreciable amounts of calcined anthracite coal as a source of carbon.

anthracite duff. *Noun.* Briquettes composed of mixtures of powdered **anthracite** and **bituminous** coals sometimes used in chain-grate stokers for cement kilns.

anthracitic. *Adjective.* Materials containing **anthracite** as a major ceramic constituent.

anthracoid. *Adjective.* Having the appearance of carbon, coal or charcoal.

anti bonding orbital. *Noun.* An **orbital** which when occupied tends to induce dissociation; viewed as being formed by electrons when electron waves of positive and negative amplitudes overlap.

anticatalyst. *Noun.* See **inhibitor**.

antifatigue. *Noun.* The occurrence of increased strength observed for glass objects that have been immersed in water with the absence of applied stress and then dried before testing.

antiferroelectric. *Adjective.* A **polar ceramic** with equal numbers of **dipoles** aligned in opposite directions.

antiferromagnetic material. *Noun.* A weakly magnetic material resulting from nearly equal magnetic moments in the structure being ordered antiparallel to each other. MnO is an example. Unless the moments completely cancel there is a significantly higher magnetic moment than paramagnetic materials possess.

antiferromagnetism. *Noun.* See **antiferromagnetic material**.

antimonate of lead. *Noun.* See **lead antimonate**.

antimony oxide. *Noun.* Sb_2O_3. Colloquially called antimony; used as an opacifier in porcelain-enamels and as a minor **adherence-promoting agent** in white porcelain-enamel ground coats, as a constituent in **Naples yellow pigments**, as a decolouriser and **fining agent** in glass manufacture, and as a component in glass which is transparent to infrared radiation. Density 5,200–5,700 kg m^{-3}. Also called **stibium oxide** and **valentinite**.

antimony spot. *Noun.* A type of dermatitis caused by exposure to **antimony oxide**.

antimony sulphide. *Noun.* Sb_2S_3. Used as an aid in the production of **ruby** and **amber glasses**, to promote **opacity** in **opal glass**, and occasionally as a minor adherence promoting agent in porcelain-enamels. Mp 546 °C; density 4,600 kg m^{-3}. Also known as **stibnite**, **antimony orange**, **antimony black**, **antimony needles** and **antimonous sulphide**.

antimony tin oxide. ATO. *Noun.* A ternary oxide with useful semiconducting properties. It can be deposited from solution to make thin films that are transparent for use in **LCD** displays and photovoltaics.

antimony yellow. *Noun.* See **lead antimonate**.

Antioch process. *Noun.* A technique for the production of plaster casting moulds in which an aqueous slurry of **plaster of Paris** is poured over a mould, following which the mould is steam-treated, allowed to set in air, oven-dried, and then cooled for use.

antique glass. *Noun.* A type of glass similar in appearance and character to the medieval glasses used in **stained-glass** windows, which usually is produced in the form of hand-blown cylinders that are cut in the soft or plastic state and allowed to sag to flatness on a suitable, smooth or textured surface.

antiscale compound. *Noun.* A preparation applied to alloy burning tools to protect them from oxidising and scaling during the firing of porcelain-enamels.

antiskid finish. *Noun.* A textured or intentionally roughened surface on porcelain-enamel, tile, concrete, or other facing area to prevent or minimise the possibility of accidental slipping or skidding.

antistatic agent. *Noun.* A substance applied to a **substrate** to prevent the accumulation of an electric charge.

antistatic tile. *Noun.* Floor tile containing a material, usually carbon, which will dissipate or disperse charges of static electricity, particularly for use in areas where sparking may be hazardous.

anti-Stokes bands. *Noun.* See **Raman effect**.

anti-Stokes fluorescence. *Noun.* See **frequency up-conversion.**

antlarite. *Noun.* $Cu_3SO_4(OH)_4$. A corrosion product of copper forming a green protective patina. Can be used as a green pigment.

Antonoff's rule. *Noun.* A statement that the surface tension at the interface between two saturated liquid layers at equilibrium is equal to the difference between the individual surface tensions of similar layers when exposed to air.

antozonite. *Noun.* An example of a fetid fluorite mineral. See **fetid fluorite**.

anvil. *Noun.* A piece of wood, a pebble, or other hard substance used to prevent the distortion of a pot during forming by pressing the anvil against the inside wall at the point opposite the point where the forming or shaping pressure is applied.

AP. *Abbreviation*. Stands for **annealing point**.

apache tears. *Noun.* A colloquial name for a stone that polishes easily to provide a shiny purple colour with some variegation.

apatite. *Noun.* $Ca_5(F,Cl,OH)(PO_4)_3$. A naturally occurring mineral consisting of either **calcium fluorophoshate** or calcium chlorophosphate in a hexagonal crystal. Used as an opacifier in the manufacture of **opal glass** and as a substitute for **bone ash** in whiteware bodies; the major constituent of teeth and bones in mammals. A source of phosphorus and is used as a fertiliser. Density 3,100–3,002 kg m^{-3}; hardness (Mohs) 5.

APC. *Abbreviation.* Stands for acoustic phonic crystal. See **phonic crystals**.

aperture. *Noun.* (1) A slit, gap, hole or other opening. (2) A circular variable opening in an optical instrument that controls the radiation entering the instrument.

aphthitalite. *Noun.* A very colourful rock with large well-formed crystals produced in the hot springs associated with dormant and dying volcanos.

aplasia. *Noun.* Failure to develop, to show growth, or to change.

aplastic. *Adjective.* (1) Showing **aplasia**. (2) A noncommittal term describing a mineral or similar substance difficult to identify, or appearing to be essentially fine gravel.

APF. *Abbreviation.* Standing for atomic packing factor. See **atomic packing factor**.

aplite. *Noun.* A light-coloured, fine-grained granitic mineral consisting mainly of **quartz** and **feldspa**r; used as a source of alumina in glass, porcelain and whiteware, pottery, and porcelain-enamel. Also called **haplite**.

APMA. *Abbreviation.* Stands for ammonium polymethylmethacrylate. See **ammonium polymethylmethacrylate**.

apochromat. *Noun.* Objective lenses in microscopes and cameras which have been carefully colour corrected by making the lens of three or more elements of different types of glass designed to bring light of three different colours to the same focal point.

apochromatic. *Adjective.* A lens almost free from spherical and chromatic aberration.

apophyllite. *Noun.* $KCa_4(Si_2O_5)_4(F,OH)\cdot 8H_2O$. A white, colourless, pink, or green, **sheet silicate mineral** of rare tetragonal structure in which the SiO_4 tetrahedra form 4- and 8-membered rings as opposed to the usual hexagonal sheet structure of 6-membered SiO_4 rings.

apparent dc resistance. *Noun.* The reciprocal of **dc conductance**.

apparent dc surface resistance. *Noun.* The reciprocal of apparent dc surface conductance.

apparent dc volume resistance. *Noun.* The reciprocal of apparent dc volume conductance.

apparent density. *Noun.* The mass per unit volume of a material, including voids present in the material. See **apparent specific gravity**.

apparent initial softening point. *Noun.* The initial or lowest temperature at which softening or viscous flow of a body, such as glass, glaze, porcelain-enamel, etc., begins, and the physical rigidity of the body is overcome.

apparent porosity. *Noun.* The ratio of the open pore space of a body to its bulk volume, expressed in percent; calculated by the formula: $P = [(W_s - W_f)/V] \times 100$, where P is the apparent porosity, W_s is the weight of the water saturated specimen in kilograms, W_f is the weight of the original fired specimen in kilograms, and V is the volume of the specimen in cubic meters.

apparent solid volume. *Noun.* The total volume occupied by a body, including open and sealed pores.

apparent specific gravity. *Noun.* The ratio of the mass of a unit volume of a body to the mass of an equal volume of water at the same temperature as determined by the formula: $G = W_f/V\ (W_s - W_f)$, where G is the apparent specific gravity, W_f is the mass of the fired specimen in kilograms, V is the volume of the fired specimen in cubic metres, and W_s is the mass of the water-saturated specimen in kilograms. Also known as **apparent density**.

apparent volume. V_a. *Noun.* The volume of a body, including its sealed pores, as indicated by the equation $V_a = V_T + V_S = D/d_a$, where V_a is the apparent volume, V_T is the true volume, V_S is the volume of the sealed pores, D is the dry weight, and d_a is the apparent density or **apparent specific gravity**.

application specific integrated circuit. asic. *Noun.* A methodology used to implement **system on a chip**.

application weight. *Noun.* The weight of an application of a porcelain-enamel coating per unit of area covered, usually expressed in grams per square metre for **cover coats** (one side of test panel) or grams per square metre (both sides of test panel) for **ground coats**; normally, the term refers to dry weight unless specifically indicated to be wet weight.

applicator. *Noun.* That part of a microwave or radio frequency heating installation in which the product is heated. It consists of an electrode system, which with the sample, constitutes a tuned circuit coupled inductively with the generator output.

applied stress intensity factor. K_I. *Noun.* A function of applied load and pre-existing crack size that denotes stress at the tip of a crack. K_I increases with load and when it attains the critical value, K_{Ic}, which has a value equal to $(2E\gamma_i)^{1/2}$, where E is **Young's modulus** and γ_i is the effective **surface energy**, the crack will progress abruptly and rapidly.

approval. *Noun.* A material is evaluated in order to achieve this state (approval) for a given application.

apron. *Noun.* (1) A protective refractory shielding arrangement designed to protect the undercarriage of kiln cars from hot gases emanating from the firing chamber of a tunnel kiln situated immediately above the cars; the system consists of vertical metal plates attached to the sides of the kiln car which slide through sand contained in troughs along the bottom of the inside walls of the kiln. (2) A slab of concrete, metal, wood, or other material over the opening to a cistern, barrel, drum, or similar vessel. (3) A platform of concrete, metal, wood, or other material protecting an item of machinery. (4) A ground covering of concrete laid to protect soil from water erosion. (5) A sheet of sand or gravel deposited in front of a moraine.

apron conveyor. *Noun.* A conveyor consisting of a series of metal or wood plates mounted at right angles on an endless chain to transfer materials or products from one location to another.

apron feeder. *Noun.* A modification of an apron conveyor designed to feed pulverised materials to a process or packaging unit at a controlled rate.

AQL. *Abbreviation.* Stands for acceptable quality level. See **acceptability**.

aquamarine. *Noun.* A gem variety of beryl. See **beryl.**

aqua regia. *Noun.* A powerful oxidising solution, which is a mixture of three parts by volume of, concentrated nitric acid, one part of concentrated hydrochloric acid, and one part water.

aqueous injection moulding. AIM. *Noun.* A process developed to use water in place of expensive organic binders in moulding compositions, that is, ceramic powder plus binder. Removal of environmentally unfriendly organic liquids is avoided. Gel cellulose additives need to be added to facilitate removal from the mould.

aqueous pressure casting. *Noun.* The application of pressure to an aqueous **slip** in a die with a porous bed. Developed to improve casting speed and produce thicker walled samples. **Filter cake** thickness develops with time as: $d^2 = 2k\Delta P/\eta[V_o/V_c - V_o]t$, where d is the filter cake thickness, k is the permeability of the porous bed, ΔP is the pressure difference, η is the slip viscosity, V_o is the solids volume content of the slip, V_c is the solid volume content of the cake and t is the time. this is an application of **Darcy's equation**.

aqueous solution. *Noun.* A solution in which water is the solvent.

aquifer. *Noun.* Water-bearing rock; **sandstone** is an example.

aquo. *Noun.* $[M\text{-}H_2O]^{n+}$. A water molecule acting as a ligand when a metal salt is hydrolysed. See **hydroxo** and **oxo**.

arabesque. *Noun.* An ornate type or style of decoration consisting of flowers, foliage, animals, and figures applied to pottery and artware by painting, low-relief carving, etc., so as to produce intricate patterns of interlaced lines.

Arabian lustre. *Noun.* A pottery **overglaze** containing carbonates or sulphides of copper or silver which are reduced during firing to produce a metallic appearance.

Arabic, gum. *Noun.* See **gum Arabic**.

aragonite. *Noun.* A rare metastable polymorph of calcium carbonate, $CaCO_3$. Used in refractories, whiteware, glass, electronic bodies, and similar products. Sometimes has a **coralloid habit**. Decomposes at 825 °C; density 2,930 kg m^{-3}; hardness (Mohs) 3.5–4.

Araldite. *Trademark, noun.* An epoxy resin used to repair china and glass.

arbor. *Noun.* A spindle or shaft on which a grinding wheel, cutting tool, or other rotating part is mounted.

arbor hole. *Noun.* The hole in the centre of a grinding wheel, cutting tool, or other rotating part by which the part is mounted on the spindle or shaft of a machine.

arc. *Noun.* (l) The luminous discharge of electricity between two electrodes separated by a small gap and a high potential difference. (2) Something curved in shape.

arcade. *Noun.* A set of arches and their supporting columns. (2) A part of a building with an arched roof.

arcanite. *Noun.* K_2SO_4. A phase present in the white **efflorescence** on the surface of fired-clay bricks after laying. It arises from **mortar**-brick interactions.

arcature. *Noun.* (1) A set of blind arches attached to a wall as decoration. (2) A small **arcade**.

arc furnace. *Noun.* A furnace in which the heat is generated by means of an **electric arc**.

arc furnace, direct. *Noun.* See **direct arc furnace**.

arc furnace, indirect. *Noun.* See **indirect arc furnace**.

arch. *Noun.* (1) A curved structure spanning an open space such as the working zone in a furnace or kiln, thereby forming the roof of the furnace or kiln. (2) *Verb.* To heat a crucible or glass-melting pot in a **pot furnace**.

Archaean. *Adjective.* Of or relating to the highly metamorphosed rock formed in the Precambrian era.

archaeomagnetism. *Noun.* A technique used to date clay objects by measuring the extent to which they have been magnetised by the earth's magnetic field after firing destroyed the original magnetisation.

Archard's coefficient. *Noun.* A value for the constant, C, in the **sliding wear equation**: $V_w = C.P.s/H$, where P is the load, s is the distance travelled and H is the material hardness. Archard showed C to equal K/3, where K is the probability that two asperities coming into contact will form a fragment during sliding.

arch, bearer. *Noun.* See **bearer arch**.

arch brick. *Noun.* (1) A wedge-shaped brick designed for use in an arch. (2) An extremely hard-fired or overburned brick from an arch of a kiln.

arch, catenary. *Noun.* See **catenary arch**.

arch, chimney. *Noun.* See **chimney arch**.

arch, cooling. *Noun.* See **cooling arch**.

arch, curtain. *Noun.* See **curtain arch**.

arch, drop. *Noun.* See **drop arch**.

arch, flat. *Noun.* See **flat arch**.

arch furnace. *Noun.* A furnace or kiln having a curved roof which spans and is supported by two walls.

arch, ignition. *Noun.* See **ignition arch**.

arch, jack. *Noun.* See **jack arch**.

arch, main. *Noun.* See **main arch**.

arch, pot. *Noun.* See **pot arch**.

arch, relieving. *Noun.* See **relieving arch**.

arch, rider. *Noun.* See **rider arch**.

arch rise. *Noun.* The vertical distance between the spring line and the highest point of the under surface of the arch.

arch, rowlock. *Noun.* See **rowlock arch**.

arch, saddle. *Noun.* See **saddle arch**.

arch, segmental. *Noun.* See **segmental arch**.

arch, sprung. *Noun.* See **sprung arch**.

arch, suspended. *Noun.* See **suspended arch**.

archetype. *Noun.* (1) The original pattern or model. (2) A perfect example or model of a structure.

Archimedes principle. *Noun.* A body immersed in a liquid undergoes an apparent loss in mass equal to the mass of the fluid it has displaced.

Archimedes screw. *Noun.* (1) A spiral tube around an inclined axis or an inclined tube containing a tight-fitting broad-threaded screw originally designed to raise water from one level to another. (2) Part of **extruder** equipment.

architectonics. *Noun.* The science of architecture.

architectural concrete. *Noun.* A concrete of particularly high quality and free from blemishes; used as the exposed surface on the interior or exterior faces of buildings and other structures.

architectural glass. *Noun.* Glass used in the building industry.

architectural terra cotta. *Noun.* Hard-fired, glazed or unglazed clay building units generally larger than brick or conventional facing tile; the units may be **machine-extruded** or hand-moulded, and they may be plain or ornamental.

architrave. *Noun.* (1) A moulding around a doorway, window, or other opening. (2) The lowest part of an entablature that bears on the columns.

archive sample. *Noun.* A sample retained for purposes of record.

archivolt. *Noun.* (1) A decorated moulding round an arch. (2) The under surface of an arch.

archless kiln. *Noun.* An **updraft kiln** having no permanent parts and is constructed with walls of either burned or unburned brick; after loading, the kiln is covered with brick, earth, or ashes and fired with solid, liquid, or gaseous fuels.

arc-image furnace. *Noun.* A furnace that produces very high temperatures by focusing the rays of an electric arc into a relatively small area by means of lenses and mirrors.

arc light. *Noun.* An intense light source produced by striking an arc between two carbon electrodes.

arc material transfer. *Noun.* The movement of contact material by the action of an electric arc.

arc melting. *Verb.* To melt a substance in or by means of an electric arc.

arc of contact. *Noun.* The portion of a grinding wheel in contact with the material or object being ground.

arc plasma spraying. *Noun.* Fine ceramic powder is injected into a **plasma** jet that heats and accelerates it onto a surface. Not all particles are melted since conventional **spray guns** inject the powder orthogonally and some particles remain in the cooler outer layers of the plasma flame.

arc spraying. *Noun.* The deposition of molten refractory materials, such as oxides, carbides, nitrides, and silicides, on ceramic or metal surfaces by blowing them in an atomised state at supersonic speeds by the use of a plasma jet.

arcuate. *Adjective.* Bent or shaped like an arch or bow.

arcuation. *Noun.* An arrangement of arches.

area, nitrogen surface. *Noun.* See **nitrogen surface area.**

area, surface. *Noun.* See **surface area**.

arenaceous. *Adjective.* Composed of sand or sandstone; of or concerning sedimentary rocks.

arenaceous clay. *Noun.* Sandy clay; sometimes known as **arenite** or **sandstone**.

arenite. *Noun.* Any **arenaceous** rock; sandstone.

Argand diagram. *Noun.* Two perpendicular axes, the x-axis, called the real axis, and the y-axis, called the imaginary axis, on which a complex number $z=(x-iy)$ can be represented as a point.

argentiferous. *Adjective.* Containing silver.

argentite. *Noun.* Ag_2S. A dark grey mineral with a cubic crystal structure; source of silver.

argil. *Noun.* Clay, especially **potters' clay**.

argillaceous. *Adjective.* Meaning composed of very fine material such as clay; being derived from **sedimentary rocks**.

argilliferous. *Adjective.* Containing or yielding clay.

argillite. *Noun.* Hardened **mudstone** or any sedimentary argillaceous rock.

argon. *Noun.* An inert gas used as a protective atmosphere surrounding materials that are sensitive to atmospheric gases during firing; used in plasma-jet torches during the application of highly refractory materials to metals and in arc furnaces.

aridised plaster. *Noun.* Plaster treated with **calcium chloride** during hydration as a means of increasing its strength and the uniformity of its properties.

aristotype. *Noun.* The classic named example of a structure type shared by several materials, for example **rock salt, zinc blende**. It is the parent structure from which other related structures can be derived by combinations of distortion, substitution of ions and intergrowth with other structures. See **hettotype**.

Arita. *Toponym.* A type of Japanese porcelain decorated with asymmetric designs. Made in the town of Arita.

ark. *Noun.* A large container or vat used for the mixing and storage of **clay slips**.

arkose. *Noun.* Sedimentary, course-grained **sandstone** composed of fragments containing a high ratio of **feldspar** and **quartz** cemented by **clay minerals**. Derived from rapid disintegration of granite. Also known as **feldspathic sandstone**.

armchair CNT. *Noun.* See **carbon nanotubes**.

Armco iron. *Trade name, noun.* A relatively pure grade of iron made by the open-hearth process; used in **porcelain-enamelling**.

armour ceramics. *Plural noun.* Ceramic materials used to neutralise and absorb kinetic energy threats to personnel and vehicles; **boron carbide**, and siliceous core materials are examples.

armouring. *Noun.* A metal encasement for refractory brick that is used to protect brick exposed to corrosive atmospheres at the top of the stack of a blast furnace.

arsenopyrite. *Noun.* FeAsS. A grey-white ore of arsenic consisting of monoclinic crystals of iron arsenide sulphide. Also called **mispickel**.

Arrentine ware. *Noun.* See **Samian ware**.

arris. *Noun.* The short edge or angle at the junction of a building brick and a **ridge tile** at the hip or ridge of a roof moulding, or raised edge.

arsenic. *Noun.* In the ceramic context, a term for arsenic oxide As_2O_3. See **arsenic oxide**.

arsenic acid. *Noun.* $H_3AsO_4 \cdot 0.5H_2O$. Sometimes used as a source of arsenic in glass. See **arsenic oxide**.

arsenic oxide. *Noun.* As_2O_3. Used as a fritting agent and as a decoloriser in glass and as an opacifier in glazes. Sublimes at 193 °C. Also known as **arsenious oxide**, **arsenic trioxide**, and **white arsenic**. See **white arsenic**.

arsenic trioxide. *Noun.* Another name for arsenic oxide. See **arsenic trioxide**.

arsenious oxide. *Noun.* See **arsenic oxide** and **white arsenic**.

arsenide. *Noun.* A compound of arsenic and a metal. One of the **pnictides**.

arsenious. *Adjective.* Containing arsenic in the trivalent state.

arsenopyrite. *Noun.* FeAsS. A monoclinic mineral with a metallic appearance that is a sulphide of iron and arsenic. Also called **mispikel**.

Artex. *Trademark, noun.* A coating for walls and ceilings that gives a textured finish.

artifact. *Noun.* Alternative spelling of **artefact**.

artificial aging. *Verb.* In a precipitation hardening process it is aging above room temperature. That is heating to achieve an improvement in hardness.

artificial discontinuity. *Noun.* Discontinuities such as, grooves, notches, or holes that are introduced into bodies intended to be used as reference standards to provide accurately reproducible sensitivity levels for electromagnetic test equipment.

artificially structured materials. *Noun.* Crystals fabricated with layers of inter-grown material that give a periodic modification in refractive index, mass, elastic moduli etc., with the wavelength of the modulation

able to interact with acoustic waves, light waves and elastic waves passing through the **composite crystal**. See **photonic crystals** and **phononic crystals**.

artificial weathering. *Noun.* A test, frequently accelerated, to estimate the resistance of a material or product to weathering in which specimens are subjected to infrared radiation, water, salt water, ultraviolet radiation, another conditions simulating those encountered in nature.

art-to-part. *Colloquial.* An expression for **solid free form fabrication** or **mouldless manufacturing**, where material is added to, rather than taken away from a component during fabrication. Usually involves **computer aided design**.

Artuff. *Trademark, noun.* A family of advanced ceramic composite materials made from **alumina**, Al_2O_3 matrices reinforced with **silicon carbide**, SiC **whiskers**.

artware. *Noun.* Porcelain-enamelled articles and ceramic pieces made for decorative and artistic reasons only.

asbestine. *Noun.* A fibrous variety of **talc** exhibiting properties similar to asbestos. See **asbestos**.

asbestos. *Plural noun.* A group of impure minerals mainly **amphibole**: which occur in fibrous form, such as **amosit**e, **tremolite**, **actinolite**, **crocidolite**, etc.; used for fireproofing, heat and electrical insulations, building materials, and similar applications. **Chrysotile** is a rolled sheet silicate variation.

asbestos board. *Noun.* A fire-resistant board made of a mixture of **asbestos**, **Portland cement**, and water.

asbestos cement. *Noun.* A mixture of asbestos and Portland cement used in the production of fire-resistant flat and corrugated sheets, **shingles**, tile, piping, **siding**, wallboard, and similar products.

asbestos cement pipe. *Noun.* A pipe manufactured from **asbestos cement** for use in drainage applications and in corrosive environments.

asbestos felt. *Noun.* **Asphalt**-impregnated asbestos; used as a vapour barrier for concrete.

asbestos fibre. *Noun.* Milled and screened asbestos in fibre form.

asbestos insulation. *Noun.* A fibrous asbestos used as thermal insulation at temperatures above 815 °C; frequently bonded with clay and **sodium silicate**.

asbestosis. *Noun.* A lung disease associated with use of fibrous ceramic material; characterised by deposition of scar tissue from build-up of collagen in the lungs.

asbestos shingle. *Noun.* A shingle resistant to weather, fire, and general deterioration which is formed by compressing mixtures of asbestos fibre and Portland cement; used as roofing, siding, and similar applications in building construction .

asbolane. *Noun.* See **asbolite**.

asbolite. *Noun.* $(Co,Mn)O{\cdot}2MnO_2{\cdot}4H_2O$. An impure earthy mixture of cobalt and manganese oxides used in the production of **underglaze** blue colours when fired under reducing conditions. Also known as **asbolane**, **black cobalt**, **cobalt, ochre**, **earthy cobalt**.

A-scans. *Plural noun.* A display of the variation of the magnitude of the reflected echoes of **ultrasound** with time. Amplitude is decreased by material discontinuities and so ceramic defects can be studied.

ash. *Noun.* The non-combustible solid residue remaining from the burning of a fuel or other organic material.

ashes. *Plural noun.* The residue of burned trees, land plants, bones, seaweed, and marsh plants; sometimes used as a flux in high-temperature bodies and glazes.

ashet. *Noun.* A ceramic dish or large plate.

ash furnace. *Noun.* A fritting furnace used in the production of materials for the production of glass. See **frit**.

ashlar. *Noun.* (1) A block of hewn stone with straight edges for use in building work. (2) Masonry made of ashlar.

ashlar brick. *Noun.* A brick produced with a rough-hackled face resembling the appearance of stone.

ashlar masonry. *Noun.* A type of masonry construction of **fired-clay** blocks of a size larger than conventional brick, and with the exposed faces of square or rectangular shape, laid in mortar in a uniform pattern; sometimes sawed, dressed, tooled, or quarry-faced stone is used in place of the ceramic block.

ashler. *Noun.* Alternative spelling for ashlar. See **ashlar**.

asic. *Acronym.* Stands for application specific integrated circuit. See **application specific integrated circuit**.

as-is basis. *Adjective.* A material or product offered and accepted in the condition or shape in which it exists at the time without making changes.

aspect. *Noun.* A surface that faces in a particular direction.

aspect ratio. *Noun.* A term used to define **chopped strand fibres** by dividing the fibre length by its diameter. See **critical fibre aspect ratio**, **Halpin-Kardos equation**.

asperity. *Noun.* Roughness of a surface.

asphalt. *Noun.* Any of several black semisolid mixtures containing bitumen and inert mineral material; occurs naturally or is the residue from petroleum distillation; used as a waterproofing material, in paints and dielectrics, and, mixed with gravel, is a road surfacing material. (2) *Verb trans.* To cover with asphalt.

asphalt felt. *Noun.* A sheet of feltlike material impregnated with **asphalt** for use in roofing and waterproofing application, frequently in conjunction with asbestos-cement products.

asphaltite. *Noun.* Any naturally occurring hydrocarbon that resembles asphalt but has a higher melting point.

asphalt rock. *Noun* A porous rock such as sandstone or dolomite, which has become impregnated with asphalt in its natural location.

aspirating screen. *Noun.* A sieve through which particles are drawn by a combination of vibration and suction.

ASR. *Abbreviation.* Standing for the alkali-silica reaction. See **alkali-silica reaction.**

assay. *Noun.* A qualitative or quantitative measurement of the components of a material.

assay, chemical. *Noun.* See **chemical assay**.

assay, physical. *Noun.* See **physical assay**.

assembler. *Noun.* A nanorobot that assembles nanomachines by precisely positioning components.

assembly, joint. *Noun.* See **joint assembly**.

assurance, quality. *Noun.* See **quality assurance**.

asteriated. *Adjective.* A star-like effect produced when light is dispersed about a six-fold axis in a transparent crystal.

asterism. *Noun.* The appearance of star-like figures in a transparent mineral when viewed in transmitted or reflected light; **phlogopite** shows this effect well.

ASTM. *Abbreviation.* Stands for the American Society for Testing and Materials.

astragal. *Noun.* (1) A small convex moulding with a semicircular cross-section. (2) A moulding in the form of a string of beads.

astringent clay. *Noun.* Clay containing an astringent salt such as **alum**.

Astroquartz. *Trademark, noun.* Commercial continuous quartz fibre. Density 2,200 kg m^{-3}; Young's modulus 69 GN m^{-2}; strength 3.45 GN m^{-2}.

atactic. *Adjective.* A random arrangement.

ATB. *Abbreviation.* Stands for aluminium tertiary butoxide. See **aluminium tertiary butoxide**.

ATH. *Abbreviation.* Stands for aluminium trihydrate. See **alumina trihydrate**.

athermal transformation. *Noun.* A reaction that is not thermally activated, and usually diffusionless. See **martensitic transformation**. Such reactions are usually extremely fast and the extent of reaction depends on holding temperature.

atm. *Abbreviation.* Stands for **atmosphere**; a unit of pressure.

atmolysis. *Noun.* A method of separating gases based on their different diffusion rates through porous ceramics.

atmometer. *Noun.* An instrument for measuring the rate of evaporation of water into the atmosphere.

atmosphere. *Noun.* (1) The gaseous mass surrounding the earth that is composed of 21 parts of oxygen and 78 parts of nitrogen by volume (23 parts of oxygen and 77 parts of nitrogen by weight), 1 % of argon, 0.02 % of carbon dioxide, and some aqueous vapour. (2) The gaseous environment existing in a furnace or kiln, particularly in the zone in which ware is being fired. (3) A unit of pressure equal to 1.013259×10^5 N m^{-2}, the air pressure at mean sea level.

atmosphere, controlled. *Noun.* See **controlled atmosphere**.

atmosphere, neutral. *Noun.* See **neutral atmosphere**.

atmosphere, oxidising. *Noun.* See **oxidising atmosphere**.

atmosphere, reducing. *Noun.* See **reducing atmosphere**.

ATO. *Acronym, noun*. Stands for antimony tin oxide. See **antimony tin oxide**.

atom. *Noun.* The smallest particle of an element that will enter into the composition of a molecule.

atom fraction. x_i. *Noun.* A basic way of expressing the concentration of a species in a solution in terms of the number of moles of each chemical species present. For a solution containing k components it is: $n_i/\Sigma_1^{\ k} n_j$.

atom percent. *Noun.* The **atom fraction** expressed as a percentage and so is 100 x_i.

atom, super. *Noun.* See **super atom**.

atomic absorption spectrometry. *Noun.* The measurement of light absorbed by the unexcited atoms of an element as a means of identifying the composition and properties of a substance.

atomic force microscopy. AFM. *Noun.* A mechanical profiling method that generates three-dimensional maps of surfaces by scanning an atomically sharp probe attached to a cantilever over a surface. The attractive forces that act between the tip of the cantilever and the surface are used to control the height of the probe above the surface. Unlike **STM** it can be used on insulating as well as conductive surfaces. The technique uses sharp tips to "feel" the shape and not light to see it. A scanning technique capable of imaging crystal surfaces as they grow with a resolution of about 0.3 nm. See **trolling atomic force microscopy**.

atomic heat. *Noun.* The product of an element's **atomic mass** number and its **specific heat capacity**.

atomic mass. *Noun.* The mass of an isotope of an element in **atomic mass units**.

atomic mass unit. amu. *Noun.* A measure used to define relative atomic mass; one twelfth of the mass of a ^{12}C atom.

atomic number. Z. *Noun.* The number of protons in the nucleus of an atom; locates an atom in the periodic table.

atomic orbital. *Noun.* The **wave function** for an electron in an atom that describes the distribution of electron density in an atom.

atomic packing factor. APF. *Noun.* The fraction of the volume of a **unit cell** that is occupied by the **hard sphere** atoms or ions.

atomic units. *Noun.* Scales of measurement, introduced to simplify the constants in the **Schrödinger equation**, in which the mass of the electron is 1.0, charge is a multiple of the proton's charge, length is a multiple of the **Bohr radius**, energy is in multiples of twice the ionisation potential of the hydrogen atom, and velocity is in multiples of the velocity of light.

atomic vibration. *Noun.* The vibration of an atom about its normal position in a material.

atomic volume. *Noun.* The **relative atomic mass** of an element divided by its density.

atomic weight. A. *Noun.* The weighted average of the atomic masses of an atom's naturally occurring isotopes. Can be expressed on an atomic basis in terms of **atomic mass units**, or the mass per **mole** of atoms.

atomise or atomize. *Verb.* (1) To convert liquids and solids to a fine spray, minute particles, or a fine dust. (2) To separate into free atoms.

atomised oil. *Noun.* Fuel oil combined with air under pressure to facilitate its combustion.

atomiser. *Noun.* A device fitted to a liquid supply that reduces the liquid to a fine spray.

atomising air. *Noun.* A stream of fast-moving air employed to convert liquids or solids to fine sprays or dusts.

atom percent. at%. *Noun.* A way of expressing the concentration of the components of a compound on the basis of the number of moles, or atoms, of a particular element relative to the total number of moles, or atoms, of all elements within the compound.

ATP. *Abbreviation.* Stands for acceptance test procedure. See **acceptance test**.

attapulgite. *Noun. Toponym.* $Mg_5Si_8O_{20}(OH)_2 \cdot 8H_2O$. A white fibrous clay mineral. Large deposits at Attapulgus in America. Used as a suspension agent in various ceramic slips. Also known as **palygorskite**.

attenuate. *Verb trans.* (1) To reduce in size, strength, density, or other value. (2) To cause an object to lessen in width or taper. (3) *Adjective.* (1) Attenuated. (2) Tapering gradually.

attenuation. *Noun.* (1) The loss of energy of radiation as it passes through matter as a result of scattering or absorption. (2) In fibre optics it is the loss of light intensity as a light pulse is transmitted along the fibre. It is measured in db km^{-1}. The attenuation equation is: $Att = -10\log_{10}[P_x/P_o]/x$, where P_o is the power at $x = 0$ and P_x is the power at x kilometres.

attenuation duct. *Noun.* Short tunnels, of small aperture, sited at inlet and outlets of continuous radio-frequency and microwave ovens and furnaces to prevent excessive leakage of radio-frequency and microwave energy.

attenuator. *Noun.* Any device that is designed to reduce the power of a wave without distorting it.

attic order. *Noun.* A low **pilaster** of any order set into the cornice of a building.

attribute. *Noun.* (1) An inherent property; a characteristic or quality of a material. (2) *Verb trans.* To regard something as the cause or influence of something.

attribute sampling. *Verb.* A method of quality-control inspection in which sampled ware is classified only as passable or defective.

attribute testing. *Verb.* A reliability test procedure in which specimens are evaluated and classified on the basis of qualitative properties or characteristics.

attrition. *Noun.* Wear and disintegration of a surface by rubbing or friction. Also known as **scouring**, **scoring**.

attrition mill. *Noun.* A machine in which materials are pulverised between toothed metal disks rotating in opposite directions.

attritus. *Noun.* Powder produced by **attrition**.

at. wt. *Abbreviation.* Stands for **atomic weight**.

AU. *Abbreviation.* Stands for acousto-ultrasonics. See a**cousto-ultrasonics**.

a. u. *Abbreviation.* Standing for **atomic unit**.

aubergine purple. *Noun.* See **Bishops purple**.

aubrite. *Noun.* An **achondrite** containing **enstatite**.

audibility. *Noun.* The minimum effective pressure of sound waves capable of producing a sensation in the ear.

audit. *Noun.* A way of checking at any given time whether the **quality assurance** system is operating in the way it has been designed.

augelite. *Noun.* $Al_2(OH)_3PO_4$. A colourless to white phosphate mineral.

auger. *Noun.* A machine which forces or extrudes moist clay and similar bodies through a die by means of a revolving screw contained in a closed cylinder or barrel.

Auger effect. *Noun.* A radiationless transition from an excited state to a dissociative state which diminishes the intensities of x rays by removing electrons from solids. If the energy of the Auger electron is measured information about the energy levels of electrons in solids can be obtained; See **Auger electron spectroscopy**.

Auger electron spectroscopy. AES. *Noun.* a surface analysis method used to identify elements and their oxidation state by measurement of excited low-energy secondary electrons.

augite. *Noun.* $(Ca,Na)(Mg,Fe,Al)(Si,Al)_2O_6$. A series of solid solutions formed between the **pyroxenes**, **diopside** and **hedenbergite**. Black or dark green. Found in **basalt** rocks.

aurene glass. *Noun.* An art effect produced in glass by adding metal oxides , such as silver oxide, to the glass batch. When these oxides are pulled to the surface of the hot formed glass object they create a mirror-like finish that becomes iridescent when sprayed with stannous oxide.

aurichalcite. *Noun.* $Cu_{5-x}Zn_x(OH)_6(CO_3)_2$. A basic copper-zinc carbonate mineral that when heated to 450 °C converts to a copper-covered ZnO catalyst material able to convert CO_2 to CO in the water-gas shift reaction.

auric chloride. *Noun.* See **gold chloride**.

Aurivillius phases. *Plural noun.* A group of layered perovskite materials characterised by Bi_2O_2 layers in their structures, which separate blocks of the perovskite structure $(A_{n-1}B_nO_{3n+1})^{2-}$, in antiphase relationship with each other. In the general formula, n is the width of the perovskite block in octahedra, A is Bi^{3+}, Ba^{2+}, Pb^{2+}, La^{3+}, Ca^{2+}, K^+, Na^+, and B is Nb^{5+}, Mo^{6+}, W^{6+}; many are **ferroelectrics** and may have high-temperature superconducting properties.

austenite. *Noun.* Face centred cubic iron.

autoclave. *Noun.* (1) An airtight vessel in which materials are subjected to high pressure. One variant uses high-pressure steam. (2) A vessel in which freshly made concrete bricks or sand-lime bricks are cured very rapidly by subjection to high pressure stream. (3) *Verb.* To heat a material in a pressure vessel.

autoclave cure. *Verb.* A means of accelerating the curing reactions of concrete, asbestos cement, and similar products at elevated temperatures and pressures in saturated steam, particularly when siliceous materials have been incorporated in a cementitious matrix such that a hydrothermal reaction takes place between the silica and the cement.

autocombustion. *Noun.* An automatic system designed to improve the efficiency of oil combustion by means of electric or electronically controlled impulses.

autogenous grinding. *Verb.* Grinding in a rotating cylindrical mill without the use of balls or rods, the grinding media being incoming additions of the coarse material to be ground.

autogenous healing. *Noun.* (1) A self-healing of cracks in concrete under favourable conditions of temperature, moisture, and lack of movement. (2) The self-healing of cracks, **pinholes**, etc., in porcelain-enamels and glazes under the influence of heat.

autogenous mill. *Noun.* A closed, rotating cylinder or mill in which the grinding medium is the coarse feed of incoming material to be ground.

automatic drier. *Noun.* A drier in which the temperature and atmosphere are controlled by means of an appropriate control device.

automatic snagging. *Verb.* The removal of surface defects and excess metal from a product by the use of automatic or semiautomatic grinding machines, where the pressure between the grinding surface and the work, as well as the traverse wheel over the work, is controlled mechanically or hydraulically from a control station away from the grinding wheel.

automaton. *Noun.* A mechanical device operating under its own power system; a robot.

autoradiograph. *Noun.* A photograph showing the distribution of radioactive substances in a specimen.

autotransformer. *Noun.* A transformer in which all or part of the winding is common to both primary and secondary circuits.

autunite. *Noun.* $Ca(UO_2)_2(PO_4)_2{\cdot}11H_2O$. A yellowish, fluorescent, tetragonal mineral with radioactive properties.

auxetic ceramics. *Plural noun.* Materials, such as **bismuth cuprate superconductors**, α-**cristobalite** and some composites, which have negative value for **Poisson's ratio** and so when stretched in tension, become wider because they have a positive lateral strain. Such behaviour often results from a nodule-fibril microstructure where the fibrils act as hinges. Negative υ-values lead to enhanced properties, such as **elastic moduli**, for example **shear modulus** is inversely proportional to $(1-\upsilon^2)$.

available energy. *Noun.* Energy existing in bodies or systems under conditions in which work may theoretically be obtained from them.

available heat. *Noun.* The amount of heat per unit mass of a substance that may be transformed into some form of work, such as in an engine or other system, under ideal conditions.

avalanche. *Noun.* A group of ions arising from the collision of a single ion with some other form of matter.

avalite. *Toponym.* A soft, green mineral that contains **chromium oxide** and is an ore of chromium concentrated around mount Avala in Serbia.

avanturine. *Noun.* See **aventurine.**

aventurine, aventurin or avanturine. *Noun.* (1) A dark-coloured glass or glaze usually green or black, containing coloured, opaque spangles of other materi-

als such as copper, gold, chrome, or **haematite** which give the glaze a shimmering appearance. (2) A variety of **quartz** containing red or green particles of iron oxide or **mica**; used as a gemstone. (3) A translucent form of **orthoclase feldspar** containing red-gold particles of iron compounds; also known as **sunstone**.

average coefficient of cubical expansion. *Noun.* The average change in the unit volume of a body or substance per unit change in temperature over a prescribed temperature range.

average coefficient of linear expansion. *Noun.* The average change in the unit length of a body per unit change in temperature over a prescribed temperature range.

average particle size. *Noun.* The average of the dimensions of particles of a material or a mixture of materials.

Avogadro's constant or number. N_A. *Noun.* The number of atoms in 12 g of ^{12}C. More generally it is number of atoms or molecules in a **mole** of a substance, equal to 6.02252×10^{23} mol^{-1}. Now used to define the mole by fixing its value at exactly 6.0221415×10^{23}. See **mole**.

axial-flow compressor. *Noun.* A machine for compressing a gas by accelerating it tangentially by means of bladed rotors, and then diffusing it through static vanes to increase its pressure.

axonometry. *Noun.* Part of **crystallography** concerned with measuring the axes of crystals.

azafullerene. *Noun.* **Buckyball**-type molecules containing nitrogen atoms in place of some carbon atoms in the structure.

azide. *Noun.* A compound containing the $[N_3]^-$ ion or $-N_3$ group.

azonal soil. *Noun.* A soil whose profile of texture, particle sizes and mineral composition is determined by non-local climatic conditions, such as glacial soil and volcanic soil.

azote. *Noun.* Obsolete name for nitrogen.

AZP glasses. *Abbreviation, plural noun.* Stands for alkali zinc phosphate glasses. See **alkali zinc phosphate glasses**.

AZS refractories. *Abbreviation.* Stands for alumina-zirconia-silicate refractories. See **alumina-zirconia-silicate refractories**.

azurite. *Noun.* $Cu_3(OH)_2(CO_3)_2$. Hydrous copper carbonate; a basic carbonate of copper used as a blue pigment with greenish overtones and as a gemstone. Density 3,770–3,830 kg m^{-3}; hardness (Mohs) 3.5–4.0. Also known as **blue copper**, **blue malachite**, **chessylite**.

Bb

b. *Symbol.* Standing for: (1) **barn**; (2) **bel**.

B. *Symbol.* Represents: (1) The chemical element **boron**; (2) **magnetic flux density**; (3) on pencils to signify the degree of softness of the lead, B, 2B, etc.

Babinet compensator. *Noun.* A crystal plate of variable thickness with faces cut parallel to the optic axis used to produce or analyse elliptically polarised light. **Quartz** crystal is commonly used.

Babo's law. *Noun.* The statement that the vapour pressure of a solution is reduced in proportion to the mass of solute added.

bacile. *Noun.* A deep ceramic dish or basin.

back bond. *Noun.* A chemical bond between an atom in the surface layer of a solid and an atom in the second layer.

back draft. *Noun.* A slight undercut in a mould that makes removal of the moulded part difficult.

back emf. *Noun.* An electromagnetic force appearing in an inductive circuit in an opposing direction to any change of current in the circuit.

back emission. *Noun.* The secondary emission of electrons from an anode.

backer strip. *Noun.* An asphalt-coated felt strip employed as a water-repellent backing for the vertical joint between asbestos-cement **shingles**.

background. *Noun.* In the detection of nuclear radiation, that part of the signal which arises from natural radio-activity or cosmic rays.

background fluorescence. *Noun.* The fluorescent residues observed on the surface of a test specimen during fluorescent-penetrant inspection.

backing. *Noun.* (1) The portion of a wall or structure installed behind a facing course to attain a particular property in the structure, such as strength, insulation, or economy. (2) A backing material such as cloth, paper, fibre, etc., used as the backing for coated abrasives. (3) The flexible carrier for the magnetic oxide coatings employed on magnetic tapes.

backing plate. *Noun.* A plate used to support the cavity blocks and guide pins in injection moulding.

backing sand. *Noun.* In moulding it is any sand mixture used to fill the flask after the facing sand mixture is in place.

back-off. *Verb trans.* To remove a cutting tool or grinding wheel from contact with an item being processed.

back pressure. *Noun.* (1) The resistance to forward flow of plastic material in an extruder. (2) In moulding the viscous resistance encountered when the mould is closing.

back scatter. *Noun.* The scattering of particles or waves, such as x-rays, sound waves, α-particles and electrons, by the structure through which they pass, in the backward direction. (2) The radiation or particles so scattered.

back stamp. *Noun.* A mark made on the back or bottom of a product to identify its origin or manufacturer; a hallmark.

back wall. *Noun.* The wall at the charging end of a glass-melting furnace.

backwear. *Noun.* A worn condition on the back of an abrasive belt caused by high speed, high pressure, or both that results in friction between the belt and its backup at the point of contact with a work piece.

baddeleyite. *Noun.* ZrO_2. Naturally occurring monoclinic form of **zirconia**; used in refractory and corrosion-resistant applications such as furnace linings and muffles and as an ingredient in low-expansion ceramic bodies but such use is limited to temperatures below 1,450 °C because of the monoclinic to tetragonal phase change that causes severe mechanical stress. Mp 2,850 °C; density 5,765 kg m^{-3}.

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badging. *Noun.* The marking of glassware and other ceramic products to identify the manufacturer, ownership, capacity, composition, or other information.

baffle. *Noun.* (1) A partition consisting of a panel, plate, screen, wall, or other device designed to check, regulate, or deflect the flow of something, such as a shield placed in a position to protect ware from combustion gases in a furnace or kiln during firing. (2) The part of a glass-forming mould designed to shut off the delivery of molten glass into the mould.

baffle mark. *Noun.* A mark or seam line visible on a bottle or other glass product caused by the joint between the mould and the **baffle**.

baffle wall. *Noun.* A wall constructed in a furnace or kiln to protect items being fired from flames and combustion gases.

bagasse. *Noun.* The crushed fibrous material remaining after the juice is extracted from sugar cane employed as a reinforcement and filler in plaster products, such as acoustic tile.

bag filter. *Noun.* An apparatus containing porous cloth, paper, or felt bags designed to collect dust from dust-laden gases passed through the apparatus.

baghouse. *Noun.* A chamber containing an arrangement of bag filters for the removal of airborne particles from air or gas streams emanating from furnaces, dry mixers, or other dust-producing equipment or operations.

baghouse dust. BHD. *Noun.* The fine particulate matter collected in the **baghouse**. It contains a mixture of starting materials in a form suitable for use in the manufacture of **cement clinker**.

Bagley plot. *Noun.* **Extrusion die** pressure plotted against length of die capillary divided by capillary diameter for a series of pre-set **extrudate** velocities. The lines this produces are used to compensate for die entry and exit effects.

bag moulding. *Verb trans.* A process whereby a flexible bag is used to apply uniform pressure over the surface of a ceramic fibre laminate during matrix impregnation.

bag wall. *Noun.* A refractory wall in a furnace or kiln designed and placed to deflect a flame to prevent it from striking ware being fired.

baidunzi. *Noun.* Small white bricks formed by dry pressing **porcelain stone**.

Bailey meter. *Noun.* A flow meter of helical vane construction used to measure the weight of powdered or granular materials passing through an essentially vertical shaft or other enclosed passage.

bainite. *Noun.* A composite of iron carbide, Fe_3C, and iron present in incompletely hardened steels annealed at temperatures between the **pearlite** and **martensite range**, 250–550 °C. An austenitic transformation product found in some steels and cast irons. The microstructure consists of α-**ferrite** and a fine dispersion of **cementite**.

bait. *Noun.* A tool dipped into a bath of molten glass to start a drawing operation.

baked core. *Noun.* A moulded mass of a sand mixture that has been baked to be used as a core in a sand moulding operation.

baking. *Noun.* Heat processing sufficient to promote bond formation of binder constituents.

balance. *Noun.* A weighing device consisting essentially of a horizontal beam having a fulcrum at the centre with a pan suspended from each end, one holding the object being weighed and the other holding equivalent weights.

balanced design. *Noun.* In a filament wound composite it is a winding pattern for the ceramic fibre so designed that all filaments have equal stresses.

balanced-in-plane contour. *Noun.* The contour of the head in a filament wound composite in which filament orientation within a plane and the radii of curvature are adjusted to balance the stresses along the filaments with loading pressure.

balanced laminate. *Noun.* A composite laminate in which all lamina angles except 0° and 90° occur only in + or – pairs symmetrically about a centre plane.

balanced runner. *Noun.* A runner system from an injection moulders made to place all cavities at the same distance from the **sprue**.

balance, dynamic. *Noun.* See **dynamic balance**.

balance, material. *Noun.* See **material balance**.

balance, static. *Noun.* See **static balance**.

balancing. *Noun.* Testing for balance by adding or subtracting weight to put a grinding wheel or other rotating part into either static or dynamic balance. See **static balance, dynamic balance**.

balas. *Noun.* A red variety of **spinel** often called **balas ruby**.

balas ruby. *Noun.* A mixed oxide of aluminium, iron, and manganese with the **spinel** structure having a pale red or orange colour. Found in Afghanistan; prized as a gemstone.

ballas. *Noun.* Diamond with a morphology of ball-shaped aggregates with a radial structure. It is formed when grains grow simultaneously and impinge while growing to produce grain boundaries that are disordered variants of the cubic diamond structure.

ball charge. *Noun.* Volume of balls loaded in a ball mill. Commonly one-third the total mill volume.

ball clay. *Noun.* Clay that has been transported by water from where it was formed to give secondary deposits in sedimentary **lenses**. Mainly **kaolinite** contaminated with organic matter but not with iron during deposition. Formed by superheated steam passing through granite fissures, which caused **feldspar** to become kaolinite. This process is known as **hydrothermal alteration**. Ball clay is characterised by high plasticity, fine-grained particles, high dry strength, long vitrification range, and a white to cream colour after firing; employed in ceramic bodies to provide plasticity during forming and to induce vitrification during firing, as a suspension agent in porcelain-enamels and glazes, and as a bonding agent in non-plastic refractories. The colloquial name is believed to come from the fact that plastic clay was mined by hand spade in Devon in lumps or balls weighing 14 kg.

ball, grinding. *Noun.* See **grinding ball**.

balling. *Noun.* The tendency of a material to agglomerate or cluster, particularly during mixing.

ballistic limit. *Noun.* The maximum velocity of a projectile that a given amount of **ceramic armour** will defeat.

ball mill. *Noun.* A closed-end rotating cylinder, usually consisting of a steel jacket with an abrasion-resistant porcelain or porcelain-like lining and containing pebbles or porcelain balls as the grinding media, in which materials are wet or dry ground as a means of mixing or reducing the particle size. The mill and grinding media may be of steel or alloy compositions if contamination is not a factor.

ball mill, air-swept. *Noun.* See **air-swept ball mill**.

ball milling. *Verb trans.* Using a ball mill to prepare materials.

ball mill, Krupp. *Noun.* See **Krupp ball mill**.

ball mill, vibrating. *Noun.* See **vibrating ball mill**.

ballotini. *Noun.* Minute glass spheres, 1–60 μm diameter. made to reflect light by flame-drawing and then allowing the molten glass to fall in an air jet. Used in the composition of reflective paints.

ball test. *Noun.* (1) A test in which a ball of specified size and weight is dropped or forced onto the surface of a body, glaze, porcelain-enamel, or other material under prescribed conditions as a means of evaluating a property such as resistance to impact, degree of adherence, etc. (2) An on-site test of the consistency of concrete.

Balmer series. *Noun.* The series of lines in the visible part of the spectrum of hydrogen which can be represented by the equation: $J_n = R(0.25 - 1/n^2)$, where $n = 3, 4, 5$, etc., J_n is the wave number, and R is the Rydberg constant for hydrogen.

bamboo ware. *Noun.* A type of brownish or cane-coloured **stoneware**.

Banbury mixer. *Noun.* A heavy-duty mixer consisting of two rotors, the faces of which turn in opposite directions; used in mixing viscous compositions and pastes.

band. *Noun.* A restricted range in which the energies of electrons in solids lie, or from which they are excluded, as understood in **quantum-mechanical** terms.

band gap. *Noun.* The energy difference from the top of the valence band to the bottom of the conduction band in semiconductor electron energy level diagrams. It is typically in the range 0.2–4.0 eV. The wider the gap, the more colourless the material, e.g., diamond 5.6 eV, SiC 3.1 eV is blue-green and Si 1.1 eV is opaque. Intrinsic materials electrons are forbidden to have energies within the energy range of the band gap.

banding. *Verb.* The application of a decorative line or band of colour to the edges, sides, and facial surfaces of chinaware, pottery, and similar products.

band-pass filter. *Noun.* (1) A filter passing only those currents having a frequency within specified limits. (2) An optical device consisting of absorbing filters, for transmitting electromagnetic waves of selected wavelength.

bandwidth. *Noun.* (1) The range of frequencies within a given wave band used for a particular radio frequency transmission. (2) The range of frequencies over which a receiver or amplifier should not differ significantly from its maximum value. (3) The width of a filament-wound band.

bank kiln. *Noun.* A kiln constructed on a slope or bank of earth, the incline serving in place of a flue for the removal of combustion gases.

bank run. *Noun.* Concrete aggregate in the condition as excavated from banks or pits.

banks. *Noun.* The sloping refractory section of an open-hearth furnace located between the hearth and the front and back walls.

bank sand. *Noun.* A sand of low clay content used in making casting cores.

bannering. *Verb.* The levelling of **saggers** in a kiln to facilitate stacking.

bar. *Noun.* A **cgs unit** of pressure equal to 10^6 dyn cm^{-2} or in the SI system 10^5 N m^{-2}; approx. 0.987 atm.

barbertonite. *Noun.* See **stichite**.

Bardeen-Cooper-Schrieffer theory. *Noun.* A theoretical explanation of the theory of superconductivity formulated by Bardeen, Cooper and Schrieffer in 1976. An electron moving through a crystal creates a small distortion in a nearby atom position by coulombic interaction. The distortion persists long enough for a second electron to have its passage helped. Thus bound pairs carry the current; they are called

Cooper pairs. Pair formation involves creation of an energy gap in what would normally be a continuum of electron energy states in a partly filled band. The electrons in the pairs have opposite spin and momentum. Once excited above the energy gap, single electrons cannot decay to their normal states and they become free to move through the structure without scattering by ion cores.

bare glass. *Noun.* Glass fibre yarns, rovings, etc. from which the **sizing** or other surface finish has been removed.

bar graph. *Noun.* A graph consisting of vertical or horizontal bars whose lengths are proportional to amounts.

baria. *Noun.* Ceramic name for barium oxide. Not used much in ceramics because it is unstable and reacts with water. See **barium oxide**.

barilla. *Noun.* An impure mixture of **sodium carbonate** and **sodium sulphate** obtained from the ash of plants, such as kelp.

barite. *Noun.* $BaSO_4$. The American name for **barytes**. An orthorhombic mineral employed in glasses as a flux to reduce **seeds**, increase toughness, improve brilliance, and reduce annealing time. Mp 1,580 °C; density 4,300–4,600 kg m^{-3}; hardness (Mohs) 2.5–3.5. Also known as **blanc fixe**.

barium aluminate. *Noun.* (1) $Ba_3A1_2O_6$; employed as a source of barium oxide in glass compositions to decrease the solubility and increase the brilliance of the glass; also used in cathode coatings for vacuum tubes. (2) $BaAl_2O_4$ barium aluminium **spinel**; mp 1,998 °C; density 3,990 kg m^{-3}. (3) $BaAl_{12}O_{19}$; mp 1,860 °C density; 3,640 kg m^{-3}.

barium aluminium silicate. *Noun.* $BaAl_2Si_2O_8$. Mp 1,716 °C; density 3,210–3,300 kg m^{-3}.

barium borate. BBO. *Noun.* BaB_2O_4 or $Ba(BO_2)_2$. A nonlinear optical ceramic capable of second harmonic generation and so is used as an optical parametric oscillator.

barium boride. *Noun.* BaB_6. Mp 2,270 °C; density 4,320 kg m^{-3}; hardness (Vickers) approx. 30 GN m^{-3}.

barium calcium silicate. *Noun.* $BaCa_2(SiO_3)_3$. A chain **pyroxene**.

barium carbide. *Noun.* BaC_2. An acetylide containing $(C\text{-}C)^{2-}$ ionic units; source of acetylene. Mp > 1,760 °C; density 3,570 kg m^{-3}.

barium carbonate. *Noun.* $BaCO_3$. Employed as a flux in porcelain-enamels and glazes to improve elasticity, brilliance, mechanical strength, acid resistance and to prevent scumming; used as an ingredient in flint glass, pressed tableware, television tubes, and laboratory glassware to lower the melting point, improve workability, improve brilliance and hardness, and to improve dielectric constants and resistivity; used to obtain maximum flux density in hard core permanent magnets; used in structural clay products to prevent **scum** and **effloresence**; and employed in **steatite**, **forsterite**, **zircon porcelain**, and titanate electronic components to reduce **dielectric loss**. Mp 1,360 °C; density 4,400 kg m^{-3}. See **witherite** which is a ceramic name for this material.

barium cerium oxide. *Noun.* $BaCeO_3$. A **perovskite** oxide developed as a proton-conductor in the 200–900 °C range; used as a hydrogen sensor device.

barium chloride. *Noun.* $BaCl_2$. Used as a **set-up agent** and **scum** preventative in porcelain enamels by precipitating soluble sulphates as insoluble barium sulphate. Mp 960 °C; density 3,097 kg m^{-3}.

barium chromate. *Noun.* $BaCrO_4$. Used in the production of yellow and pale green overglaze colours. Density 4,500 kg m^{-3}. Also known as **chrome yellow**.

barium crown glass. *Noun.* An optical crown glass containing barium oxide as a major component. See **optical crown glass**.

barium diuranate. BaU_2O_7. An orange-yellow powder used as a ceramic colourant, particularly for porcelain.

barium ferrite. *Noun.* $BaFe_{12}O_{19}$. A magnetic ceramic with the hexagonal **magnetoplumbite** structure; it has a high value of uniaxial anisotropy field and high coercive force which makes it stable in strong demagnetising fields; a high resistivity $10^6 \Omega$ m. Used as magnets in TV tubes. Several trade names: **Feroba**, **Magnadur**, **M-compounds**.

barium flint glass. *Noun.* An optical flint glass containing barium oxide as a major component. See **crown g1ass, optical**.

barium fluoride. *Noun.* BaF_2. Used as an opacifier and flux in porcelain-enamels. Mp 1,280 °C; density 4,832 kg m^{-3}.

barium fluosilicate. *Noun.* $BaSiF_6$. Used as a flux and an opacifier in porcelain-enamels and glazes. Decomposes at 300 °C; density 4,300 kg m^{-3}. Also known as **barium si1icofluoride**.

barium glass. *Noun.* A glass in which part of the calcium oxide component is replaced by barium oxide.

barium hydroxide. *Noun.* $Ba(OH)_2$. Used in some ceramic formulation as the source of barium oxide. Also known as **baryta**. See **barium octahydrate**.

barium iron arsenide. *Noun.* $BaFe_2As_2$. The **archetype** of a series of high temperature superconductors that do not contain CuO_2 layers in the structure. $Sr_{0.6}K_{0.4}Fe_2As_2$, for example has a T_c value of 32 K.

barium metaphosphate. *Noun.* $Ba(PO_3)_2$. Used as a precoating treatment for metals to prevent primary **boiling** in sheet steel enamels, and as an ingredient in certain types of **bright** glass. Mp 849 °C.

barium molybdate. *Noun.* $BaMoO_4$. Used as an opacifier and adherence-promoting agent in porcelain-enamel compositions. Mp > 1,300 °C; density 4,652 kg m^{-3}.

barium monohydrate. *Noun.* Precipitated barium hydroxide used in the manufacture of **barium ferrite** magnets.

barium niobate. *Noun.* $Ba_6Nb_2O_{11}$. An electroceramic with various applications. Mp 1,927 °C; density 5,982 kg m^{-3}.

barium nitrate. *Noun.* $Ba(NO_3)_2$. Used to improve homogeneity and opacity in porcelain-enamels and as an ingredient in optical glasses. Mp 575 °C; density 3,244 kg m^{-3}. Also known as **nitrobarite**.

barium octahydrate. *Noun.* $Ba(OH)_2{\cdot}8H_2O$. Used in ceramics as a source of high purity BaO. Loses water of crystallisation at 78 °C; mp of anhydrous $Ba(OH)_2$ 408 °C; density 1,656 kg m^{-3}. Also known as **barium hydroxide**.

barium osumilite. *Noun.* $BaMg_2Al_6Si_9O_{20}$. A refractory aluminosilicate **glass ceramic** with potential use in gas turbines for power generation.

barium oxide. *Noun.* BaO. A yellowish-white solid. Used as a fluxing ingredient in glass and in the Brin process to fix oxygen because when heated in air it goes reversibly to BaO_2. Mp 1,923 °C; density 5,722 kg m^{-3}; hardness (Mohs) 3.5. Also called **baryta** and **baria**.

barium peroxide. *Noun.* BaO_2. Has limited use in glass manufacture; strong oxidising agent; source of hydrogen peroxide when added to sulphuric acid. Mp 450 °C; decomposes at 800 °C; density 4,580 kg m^{-3}.

barium phosphate. *Noun.* $Ba_3(PO_4)_2$. An orthophosphate that is sometimes used as a gunnable refractory to repair furnace linings. Mp 1,727 °C; density 4,100 kg m^{-3}.

barium phosphide. *Noun.* Ba_3P. Source of phosphine when treated with acid. Density. 3,180 kg m^{-3}; hardness Vickers 3 GN m^{-2}.

barium propoxide. *Noun.* $Ba(OC_3H_7)_2$. An alkoxide soluble in propanol that is used to prepare ceramic precursor sols and gels.

barium silicate. *Noun.* Several ionic and sheet structured silicates (1) $BaSiO_3$. A **pyroxene** chain silicate containing two dimensional chains of $[SiO_4]^{2-}$ tetrahedra sharing two corners; mp 1,640 °C; density 4,400 kg m^{-3}. (2) Ba_2SiO_4. A discrete ionic **orthosilicate** containing $[SiO_4]^{4-}$ tetrahedral anions; mp approximately 1,755 °C; density 5,200 kg m^{-3}. (3) $BaSi_2O_5$. A two dimensional sheet silicate structure; mp 1,640 °C; density 4,405 kg m^{-3}. (4) $Ba_2Si_3O_8$. A fibrous silicate; mp 1,449 °C; density 3,930 kg m^{-3}.

barium sodium niobate. BNN. *Noun.* $Ba_2NaNb_5O_{15}$. A piezoelectric material used to detect infrared radiation.

barium stannate. *Noun.* $BaSnO_3{\cdot}3H_2O$. Used as an additive to barium titanate bodies to decrease the **Curie temperature** when they are needed for use as capacitors of high **dielectric constant**. Also used in glass-enamels to improve alkali resistance. Loses H_2O at 280 °C.

barium sulphate. *Noun.* See **blanc fixe**.

barium sulphide. *Noun.* BaS. Used to manufacture crucibles for melting cerium and uranium. Mp 1,660 °C and may be fired in bodies but it will vaporise at 1,600 °C; density 4,250 kg m^{-3}.

barium tantalum oxynitride. *Noun.* $BaTaO_2N$. A deep brown coloured **perovskite** dielectric capable of being sintered in a reducing atmosphere, which allows the use of metals other than Pt for electrodes to be sintered in place during processing.

barium thorate. *Noun.* $BaThO_3$. A perovskite phase; mp 2,299 °C; density 7,660 kg m^{-3}.

barium tin borate. *Noun.* $BaSn(BO_3)_2$. A low-sintering-temperature metaborate used as a multilayer substrate.

barium titanate. *Noun.* A general name for several barium titanium oxides used in devices involving **piezoelectric** effects and magnetic properties such as guided missiles, ultrasonic generators, electronic filters, accelerometers etc. Compositions are: (1) $BaTiO_3$; a **perovskite**; **ferroelectri**c ceramic with **polymorphic** phase transition enhancement of piezoelectric performance; $d_{33} = 190$ pC N^{-1} but low Currie temperature, $T_c = 120$ °C limits use to sonar and record player needles; mp 1,618 °C. (2) $BaTi_2O_5$; mp 1,320 °C. (3) $BaTi_3O_7$; mp 1,356 °C. (4) $BaTi_4O_9$; mp 1,420 °C; density 4,600 kg m^{-3}; a dielectric resonator ceramic with frequency 4 GHz. (5) $Ba_2Ti_9O_{20}$; a dielectric resonator ceramic.

barium titanium silicate. *Noun.* (1) $BaTiSiO_5$; mp 1,398 °C. (2) $BaTiSi_2O_7$; mp 1,248 °C; discrete ionic silicate containing the double tetrahedral $(Si_2O_7)^{6-}$ anion.

barium tungstate. *Noun.* $BaWO_4$. Used as a white pigment and as a phosphor in ultraviolet radiation. Density 5,040 kg m^{-3}.

barium zirconate. *Noun.* $BaZrO_3$. Another **perovskite** used as an addition to barium titanate bodies to improve their dielectric properties. Mp 2,620 °C; density 2,630 kg m^{-3}.

Barker-Truog clay treatment. *Noun.* An alkali treatment for clay to obtain pH values ranging from 7 to 10, depending on the original acidity of the clay; such clays exhibit improved plasticity, which aids the shaping of brick.

Barkhausen effect. *Noun.* The succession of abrupt changes in magnetisation occurring when the magnetising force acting on a magnetic material is varied.

Barlow's formula. *Noun.* Used to calculate wall thickness in composite laminate pipes t = P.r.d /2a, where t is the wall thickness, P the working pressure, d the pipe inside diameter, and a is the design stress.

bar mat. *Noun.* A mat of preassembled steel bars for installation as reinforcement in a concrete slab, usually a paving slab.

bar mould. *Noun.* A mould in which the inlets are arranged in rows on separate bars, each of which may be removed individually.

barn. b. *Noun.* A unit of area equal 10^{-28} m^2. Used as a convenient scale to measure the cross-sectional area of atomic nuclei. Colloquially derived from "as wide as a barn door" as far as nuclear bombardment is concerned.

barometer. *Noun.* An instrument designed to measure the pressure of the atmosphere.

barophoresis. *Noun.* The diffusion of suspended particles at a rate dependent on external forces.

baroque. *Noun.* (1) A style of decoration and architecture characterised by excessive ornamentation. Flourished from sixteenth to eighteenth centuries in Europe. (2) *Adjective.* Of pearls: irregularly shaped.

barrel. *Noun.* (1) A unit of measure of cement equal to 170.9 kg or four sacks. (2) The cylindrical portion of an extruder or injection-moulding machine containing the screw plunger.

barrel finishing. *Verb.* Improving the surface or removing burrs from the edges of work by tumbling the work in a rotating cylinder containing suitable particles or grains of abrasives.

barrel vault. *Noun.* An arch roof having the form of a half cylinder unbroken by joins.

barrier. *Noun.* A panel, wall, or other structure designed to bar or deflect the passage of something, such as a baffle placed to deflect combustion gases in a furnace from impinging on ware being fired.

barrier voltage. V_{gb}. *Noun.* The voltage drop across the grain boundary caused by the application of an extended voltage to a **varistor**; typically 2–4 V/grain boundary.

barrier, moisture. *Noun.* See **moisture barrier**.

bar, runner. *Noun.* See **runner bar**.

bars, Holdcroft. *Noun.* See **Holdcroft bars**.

barye. *Noun.* A unit of pressure in the cgs system equal to 1 dyn cm^{-2}. It is equivalent to 1 microbar.

baryon. *Noun.* Elementary particle with a spin of 1/2 involved in strong interactions. Baryons include protons and neutrons.

baryta. *Noun.* (1) $Ba(OH)_2$. A white solid mp 408 °C. See **barium octahydrate**. (2) Common name for **barium oxide**, BaO. See **barium hydroxide**.

barytes. *Noun.* $BaSO_4$. A colourless or white mineral of barium sulphate in its rhombic crystal form occurring in **sedimentary rocks**. Used as a flux in glasses to reduce **seeds**, increase toughness, improve brilliance, and reduce annealing time; also used in ceramic bodies, glazes, and porcelain-enamels to minimise or prevent scumming. Mp 1,580 °C; density 4,300–4,600 kg m^{-3}; hardness (Mohs) 2.5–3.5. Also known as **barite**, **blanc fixe**, and **heavy spar**.

basal plane. *Noun.* The plane perpendicular to the c-axis in a hexagonal or tetragonal structure. In the hexagonal system denoted as (0001), packing such planes in the sequence … ABABAB … generates an ideal close-packed hexagonal structure such that the c/a ratio is 1.633.

basalt. *Noun.* (1) A crystalline basic high-silica-content volcanic rock composed essentially of soda-lime **feldspar**, **pyroxene**, **magnetite**, **olivine**, **magnesite**, and **ilmenit**e, all with very small grain sizes. (2) A black unglazed form of pottery resembling **basalt**.

basalt, fusion-cast. *Noun.* See **fusion-cast basalt**.

basalt lava. *Noun.* Ground volcanic lava that melts into a dark brown glass at **stoneware** temperatures; used as a basis for coloured and **tenmoku** glazes. See **Pele's hair**.

basaltware. *Noun.* A hard, black, fine grained, unglazed vitreous **stoneware** having an appearance similar to that of **basalt** rock.

basanite. *Noun.* A black basaltic rock containing **plagioclase**, **augite**, **olivine** and **nepheline**. Formerly used as a **touchstone**.

base. *Noun.* (1) An alkaline substance, either ionic or molecular, that accepts protons from another substance or which will react with an acidic material. (2) The bottom of a container, bottle, or other item. (3) The compacted earth or granular material upon which a paving slab is placed. (4) The foundation that supports a printed circuit or the pins, leads, or other terminals of a bulb or tube to which an external electrical or electronic connection is to be made. (5) The middle region of a **transistor** between the **emitter** and the **collector**.

base coat. *Noun.* A fired coating over which another coating is applied.

base course. *Noun.* The concrete foundation over which a wall, pavement, or other structure is to be erected or placed.

base exchange. *Noun.* A surface property exhibited by colloidal inorganic materials, such as clays, whereby certain anions are replaced by other ions from a surrounding medium.

base metal. *Noun.* The metal to which porcelain-enamel is applied.

base unit. *Noun.* Any of the fundamental units in measurement system. The SI base units are: **metre**, **kilogram**, **second**, **ampere**, **kelvin**, **candela**, and **mole**.

basic. *Adjective.* (1) Of, denoting, or containing a base; alkaline. (2) Of a salt containing hydroxide or oxide groups all of which have not been replaced by an acid radical. (3) Of, concerned with, or made by a process in which the furnace or converter equipment is made from a basic material, such as **magnesia**. (4) Of **igneous rocks**, such as **basalt** containing less that 50 % **silica**.

basic brick, direct-bonded. *Noun.* See **direct-bonded basic brick**.

basic brick, pitch-bonded. *Noun.* See **pitch-bonded basic brick**.

basic brick, pitch-impregnated. *Noun.* See **pitch-impregnated refractories**.

basic fibre. *Noun.* Untreated glass fibre as it is obtained from the forming equipment.

basicity. *Noun.* The extent to which a substance is basic.

basic lava. *Noun.* Magma with a high alkaline content, which results in rapid smooth flow. The surface solidifies but the centre still flows and wrinkled rocks arise. Such wrinkled rocks are called **ropy lavas**. See **acid lava**.

basic lead carbonate. *Noun.* $Pb_3(CO_3)_2(OH)_2$. A white pigment. See **white lead** and **hydrocerussite**.

basic-lined. *Adjective.* A furnace, kiln, converter, or similar structure lined with basic refractory shapes made of materials such as lime, magnesite, chrome ore, etc.

basic open-hearth furnace. *Noun.* An open-hearth furnace constructed of basic refractories covered with **magnesite** or **burned dolomite**, and which is employed in the production of basic pig iron.

basic oxide. *Noun.* A metallic oxide that will react chemically with acidic materials.

basic refractory. *Noun.* A refractory composed of basic refractory materials, such as lime, magnesite, chrome magnesite, etc., and which will react with acidic slags or fluxes at elevated temperatures.

basic slag. *Noun.* A slag rich in basic ingredients produced as a by-product in the steel-making process; used in fertiliser formulations because it contains large amounts of calcium phosphate.

basic structural unit. BSU. *Noun.* A term now being used in the new polymorphs of carbon area where a BSU is an isolated polyaromatic entity less than 1 nm diameter.

basket, pickle. *Noun.* See **pickle basket**.

basket weave. *Noun.* One of the weaving formats where two more warp yarns are threaded through two or more yarns. Fabrics with these weaves are more pliable and easily formed to curved shapes.

basket-weave chequer work. *Noun.* An arrangement of corrosion-resistant refractory brick serving as flues in **regenerators** and other structures in which the ends of each brick are placed at right angles to the centre of each adjacent brick to form a pattern resembling the weave of the splints in a basket.

bas-relief. *Noun.* A type of **artware** in which the figures project slightly above the background surface.

basse taille. *Noun.* A process in which transparent or translucent porcelain-enamels are applied and fired over a metal background that has been carved in low relief.

bastard ganister. *Noun.* A mineral that has the appearance of **ganister** but having substantially different properties.

bastnäsite. *Noun.* $LnFCO_3$. A yellow-brown fluorcarbonate mineral containing amounts of **lanthanides** up to 70 % rare earth oxides by weight. A particular source of dysprosium oxide.

bat. *Noun.* (1) A plaster slab or disk upon which clay is worked, or upon which ware is formed and dried. (2) A fireclay slab upon which ware is placed and fired in a kiln. (3) A fragment of hardened clay or brick. (4) A slab of moist clay. (5) A brick cut transversely so as to leave one end whole. (6) A sheet of gelatine used in bat printing. A tangled mass of single filament fibres. Also called batt or **web**.

batch. *Noun.* A quantity of raw materials blended together for subsequent processing, such as a glass batch or furnace charge.

batch blanket. *Noun.* The solid layer of new ingredients added to a glass making furnace. The first part in the first stage in a modular melting industrial glassmelting process. It is where the batch materials enter and are heated to about 1,200 °C. This is achieved in part by a strong return flow of hot glassmelt and from the top by burning gas. See **modular glass making**.

batch blending. *Noun.* Stepwise changes in the composition of a batch to arrive at a desired composition of a final product.

batch charger. *Noun.* A mechanical device employed to introduce a batch into a smelter or melting tank.

batch drier. *Noun.* A periodic drier, in which the ware being dried remains stationary in a circulating stream of usually warm or hot air, until dry.

batcher. *Noun.* A type of equipment in which the ingredients of a batch are measured and collected before discharging into a process operation, such as a ball mill or concrete mixer.

batch feeder. *Noun.* A mechanical device, such as an **auger**, employed to charge a glass or porcelain enamel batch into a melting tank or smelter.

batch-free time. *Noun.* The time needed to complete the melting reactions in a glass melt. Consists of the time to heat the batch to reaction plus the time to complete the vigorous initial melt, plus the time to dissolve the residual sand grains.

batch furnace. *Noun.* A furnace into which ware is charged, fired, and removed before the introduction of another charge.

batch house. *Noun.* The area in a factory in which materials are received, stored, handled, weighed, and mixed preparatory for movement to a subsequent manufacturing operation.

batching sequence. *Noun.* The process of introducing raw materials into a batch mixer or process in an ordered, stepwise sequence.

batch operation, contact. *Noun.* See **contact batch operation**.

batch process. *Noun.* A manufacturing operation or process that is carried to completion before the same operation or process is repeated; that is, the process is not continuous.

batch, raw. *Noun.* See **raw batch**.

batch smelter. *Noun.* A periodic smelter or glass-melting tank into which a charge is introduced, melted, and discharged as a unit process in accordance with a prescribed time and temperature cycle.

batch truck. *Noun.* A dump truck in which the body is partitioned into compartments for the transport of weighed batches of cement and aggregate from the weighing areas to the mixer.

batch-type mixer. *Noun.* A machine into which all ingredients of a batch are weighed, mixed, and discharged as a unit operation before introduction of a subsequent charge.

bath. *Noun.* (1) A liquid preparation, such as water, cleaner, acid, neutraliser, or other solution, in which something is immersed for treatment. (2) Liquid penetrants into which parts are immersed for inspection.

batholith. *Noun.* Enormous igneous masses in the central core of major folded mountain ranges. During the cooling of these bodies major sulphide ore deposits are made.

Bath stone. *Noun.* A type of **limestone** found near Bath and used as a building stone.

batt. *Noun.* An alternative spelling of bat. See **bat**.

batten. *Noun.* A thin strip of material employed to seal, conceal, or reinforce a joint as, for example, a strip of flat or corrugated asbestos cement used to conceal butt joints of flat or corrugated asbestos-cement sheets.

batter. *Noun.* The upward slope or the angle at which the outer face of a wall slopes from the vertical.

batteries. *Plural noun.* Devices containing two or more primary **cells** usually connected in series. See **cell**.

battery management. *Noun.* The control of charging and discharging conditions by temperature, cut-off voltage and current.

batt printing. *Noun.* A process for printing on ceramic ware in which a design is transferred from an engraving plate to ware by means of a **bat** of solid glue or gelatine.

bat wash. *Noun.* A slurry of refractory materials applied to **kiln setters** to prevent the sticking of ware during firing.

Baumé. *Noun.* Either of two calibrated hydrometer scales to estimate the specific gravity of liquids. For liquids less dense than water, the specific gravity equals $140/(130+{}^{o}\text{Be})$ at 15.6 °C; for liquids more dense than water, the specific gravity equals $145/(145-{}^{o}\text{Be})$ at 15.6 °C.

Bauschinger effect. *Noun.* The observation that if a specimen is lightly deformed in one direction and then immediately reloaded in the opposite direction it begins to flow in this direction at a reduced yield stress.

bauxite. *Noun.* $Al_2O_3{\cdot}nH_2O$. Aluminium ore, found as clay-like rocks consisting largely of hydrates of **alumina**, together with varying amounts of iron and titanium oxides, silica, and other impurities. Bauxites fuse at 1,800 °C and above, and have densities varying from 2,450 to 3,250 kg m^{-3}. As a major source of alumina, bauxites are employed extensively in the manufacture of grinding wheels, abrasive stones, abrasive cloth and paper, polishing and grinding powders, refractories for **kilns** and **glass tanks**, **electroceramics**, and quick-setting alumina cements.

bauxite clay. *Noun.* A natural mixture of bauxite and clay containing not less than 47 % or more than 65 % of alumina on a **calcined** basis.

bayerite. *Noun.* α-$Al(OH)_3$. α-Aluminium trihydroxide which in old notation was called beta **alumina trihydrate**. The structure contains $Al(OH)_6$ octahedra in layers, stacked in the hexagonal sequence with the layers linked together by hydrogen bonds; rarely found in nature but made by several commercial methods.

Bayer process. *Noun.* A process in which aluminium ores are digested in hot solutions of caustic soda and the aluminium is removed as soluble **aluminates**. Further treatments can either lead to pure **alumina** or aluminium metal.

Bayer red mud. *Noun.* A complex mixture of waste products arising in large amounts from the **Bayer process**. It typically contains silica, alumina, iron oxide, titania, sodium compounds and has an alkaline pH. For every tonne of alumina powder produced in the **Bayer process** there is 1 tonne of red mud.

B-basis. *Noun.* Any stated mechanical property value above which 90 % of all test values should fall within a confidence limit of 95 %.

BBO. *Abbreviation.* Stands for barium borate. See **barium borate**.

BCS theory. *Noun.* See **Bardeen-Cooper-Schrieffer theory**.

°Be. *Symbol.* Stands for Baumé. See **Baumé**.

bead. *Noun.* (1) An enlarged, rounded edge of a glass tumbler or other glass article. (2) An excess of porcelain-enamel slip or powder along the edge of a coated ware. (3) An application of porcelain enamel, usually of a contrasting colour to the edge or rim of a porcelain-enamelled article. (4) A small piece of glass tubing used to enclose a lead wire. (5) A ceramic insulator through which passes the inner conductor of a coaxial transmission line and by means of which the inner conductor is supported in a position coaxial with the outer conductor. (6) A spherical glass or pottery sample through the centre of which a hole has been drilled to allow it to be strung for decorative use.

beader. *Noun.* An operator who applies a beading enamel to a porcelain-enamelled article.

beader-off. *Noun.* An operator who removes a bead of excess porcelain-enamel or smoothes the edges of the coating on porcelain-enamelled ware.

beading. *Verb.* (1) To apply porcelain-enamel, usually of a contrasting colour, to the edges of rims of porcelain-enamelled articles. (2) To remove excess slip from the edge of dipped ware.

beading enamel. *Noun.* Any of the special porcelain-enamels applied as a beading on ware for purposes of decoration and protection of exposed edges of the ware.

bead test. *Noun.* A test of the softening and flow characteristics of glaze, glass, and porcelain-enamel compositions in which a bead or button-like specimen of specified size and shape is compared with standard compositions at elevated temperatures.

bead thermistor. *Noun.* A **thermistor** consisting of two wire leads cemented together by a molten droplet of a semiconducting material, such as **nickel oxide**, NiO.

beam, reinforced. *Noun.* See **reinforced beam**.

bearer arch. *Noun.* One of a series of arches that supports the **checkerwork** in a **regenerator** or heat exchanger that heats air or gas before combustion.

bearing zone. *Noun.* The middle region of a fibre or wire drawing die where the final diameter and surface finish of the wire or fibre are determined. See **die zones**.

Becke lines. *Plural noun.* Lines that appear at the edges of a microscope image of a fibre caused by refraction at the fibre edge.

beckelite. *Noun.* $Ca_3(Ce,La,Y)_4(Si,Zr)_3O_{15}$. A yellow coloured mineral used as a source of cerium.

Becquerel. B_q. *Noun.* The **SI unit** of radioactive decay; one B_q is equal to one radioactive decay per second. Usually quoted as $B_q g^{-1}$ or $B_q cm^2$ to define the mass or area of contamination.

becquerelite. *Noun.* $UO_2 \cdot 2H_2O$. Small yellow crystals of hydrated **uranium dioxide** occurring on the surface of **pitchblende**.

bed. *Noun.* (1) The layer of mortar upon which brick and stone are laid. (2) The prepared base or foundation upon which ware is placed for processing, such as the floor of a kiln.

bedded tuff. *Noun.* A layered rock formed from volcanic ash. See **tuff**.

bed depth, critical. *Noun.* See **critical bed depth**.

bedder. *Noun.* A plaster-of-Paris shape for forming a bed of powdered **alumina** on which **bone china** is fired.

bedding. *Verb.* To place ceramic ware in a suitable refractory grain or powder as a support to prevent warpage during firing.

bedding course sand. *Noun.* Well-graded, free-draining, mechanically resistant sand placed below **clay pavers** in flexible pavements to provide a uniform support for the pavers and prevent stress concentrations that could cause damage.

bed, expanded. *Noun.* See **expanded bed**.

bed, fluidised. *Noun.* See **fluidised bed**.

bed, intermittent-moving. *Noun.* See **intermittent-moving bed**.

bedrock. *Noun.* The solid, unweathered rock that lies beneath the soil etc.

beehive kiln. *Noun.* A circular beehive-shaped kiln characterised by a domed roof and fired through chambers stationed around the circumference.

Beer-Lambert law. *Noun.* Layers of equal thickness of a homogeneous material absorb equal proportions of light. This is expressed as $I = I_o \exp(-ad)$, where I is the intensity of the transmitted light, d is the layer thickness, and a is a constant known as the absorption coefficient; a is dependent on the wavelength of light used and the structure and composition of the material.

Beevers-Ross site. *Noun.* Positions formed by hexagonally close-packed O^{2-} ions on the mirror planes of β-Al_2O_3; two types of site exist and are occupied by the M^{n+} ions, one is directly above an O^{2-} in the **spinel** layer and one above an **interstitial site** in the spinel layer. Movement of M^{n+} within these sites is responsible for fast ion conduction in β-Al_2O_3.

beidellite. *Noun.* $(Al_{1.53}Fe_{0.2}Mg_{0.25})(Si_{3.88}Al_{0.12})O_{10}(OH)_2$. A **montmorillonite** three-sheet 2:1 layer-lattice clay mineral in which magnesium substitutes for aluminium in octahedral sites and some silicon is substituted by aluminium in tetrahedral sites.

bel. b or B. *Noun.* A unit for comparing two power levels. If two power levels to be compared are P_1 and P_2 the power ratio is $\log_{10}(P_1/P_2)$ bel. Since the bel is particularly large it is more common to use a subunit, the **decibel**, which is one tenth of a bel.

belemnite. *Noun.* A fossil found in the Pee Dee formation in South Carolina that is used as the main standard for carbon isotope determination. See **mille**.

Belgian kiln. *Noun.* A longitudinal-arch, side-fired kiln in which the fire is directed to grates stationed at regular intervals along the bottom of the structure.

belite. *Noun.* One of the main constituents of **Portland cement** and is the colloquial name used to describe one of the four known **polymorphs** of the **orthosilicate** Ca_2SiO_4. It reacts with water to form a paste able to develop compressive strength. In **cement notation** it is C_2S.

bell. *Noun.* (1) The enlarged end of a concrete or other pipe that overlaps the end of an adjoining pipe. (2) A refractory funnel placed to receive molten steel from the nozzle of a ladle.

bellarmine. *Noun.* A fat, narrow-necked, **salt-glazed** bottle or jug usually having a bearded face stamped or engraved on the neck as a decoration.

bell damper. *Noun.* A bell-shaped, sand-seal type of damper frequently used in **annular kilns**.

bell dresser. *Noun.* A tool consisting of rotating metal cutters employed in the truing, shaping, and dressing of grinding wheels.

Belleek china. *Noun.* Thin, highly translucent chinaware having zero water absorption, which is composed of a body containing substantial amounts of frit, and which normally, is coated with a soft lustre glaze. Named after the town in Ireland where it was first made.

bell glass. *Noun.* See **bell jar**.

bell jar. *Noun.* A bell-shaped glass cover used to prevent gases escaping in experiments and to cover apparatus. Also called **bell glass**.

belly. *Noun.* (1) The side of a clay pot. (2) The section of a converter in which steel is collected before it is poured. (3) The widest section of a blast furnace.

Belshazzar. *Noun.* A wine bottle of approximately l6-quart capacity or 15.1 litres.

belt. *Noun.* An endless flexible band passing around two or more pulleys; used to convey materials or objects, or to transmit motion from one pulley to one or more other pulleys.

belt conveyer. *Noun.* An endless belt running between head and tail pulleys used to transport loose materials or products from one point to another.

belt drive. *Noun.* A mechanism actuating a **ball mill** or other item of equipment by means of a friction belt rotating around a pulley mounted on a rotating shaft.

belt feeder. *Noun.* A mechanical device that delivers raw materials from one point to a processing station by means of a moving belt.

belt grinding. *Verb.* To grind the surface of a material or product by means of a continuous abrasive-coated belt.

belting. *Verb.* A finishing operation for concrete pavement in which a wide belt is dragged back and forth across a fresh slab of concrete and advanced along the slab.

belt kiln. *Noun.* A kiln through which ware being fired is transported by means of an endless, high-temperature-resistant alloy belt.

belt marks. *Noun.* Marks made on the bottom of glass articles as they ride through the **lehr** on a slightly overheated chain belt.

belt, segmented. *Noun.* See **segmented belt**.

bench. *Noun.* The floor of a **pot furnace**, often called **siege**.

bench grinder. *Noun.* An offhand grinding machine supported on a bench, the grinding mechanism consisting of one or two grinding wheels mounted on a horizontal spindle.

bench marks. *Noun.* Striations on a fatigue fracture surface showing where the crack front was held between moves forward.

bench moulding. *Verb.* The hand tool production of small moulds at a bench.

bench scale. *Adjective.* A process, test, or other procedure carried out on a small scale as on a laboratory bench or worktable.

bend. *Noun.* A pane of glass that has been bent to fit an opening. See **bending**.

bending. *Verb.* To manipulate glass in a kiln, particularly flat glass, to form curved shapes or bends.

bend test. *Noun.* (1) A measure of the transverse or cross-bending strength. (2) A test in which **bisque** or fired porcelain-enamelled panels are distorted by bending to determine the resistance of the coating to cracking or fracture.

benefication, beneficiation. *Noun.* Any process of upgrading or improving the physical or chemical properties of a mineral to enhance its use, such as washing, **flotation**, etc.

benitoite. *Noun.* $BaTiSi_3O_9$. A **ring silicate** containing $[Si_3O_9]^{6-}$ discrete ions formed from three corner-sharing $[SiO_4]^{4-}$ tetrahedra.

bent glass. *Noun.* Flat glass that has been shaped into cylindrical, curved, or other shapes while hot.

bentonite. *Noun.* Clay derived from volcanic ash and characterised by an extremely fine grain size. Its main constituent is **montmorillonite**, plus 5–10 % of alkalies or alkaline earth oxides. One type, which absorbs large quantities of water, swells enormously. It is used to increase dry and fired strengths and reduce absorption in whiteware bodies; also used as a **suspension agent** in porcelain-enamel slips. See **montmorillonite**.

berlinite. *Noun.* $AlPO_4$. A phosphate with the quartz structure.

bernalite. *Noun.* $Fe(OH)_3$. A rare greenish coloured iron oxide with a **perovskite** structure.

Bernal-stacking. *Noun.* Carbon atoms in the second layer of **graphene** sheets are positioned above the centres of hexagons in the first layer. This is the structure of **bilayer** graphene. Also known as AB-stacking.

bertrandite. *Noun.* $BeSi_2O_5{\cdot}H_2O$. A major ore of beryllium in the form of hydrated beryllium disilicate.

beryl. *Noun.* $Be_3A1_2Si_6O_{18}$. A **ring silicate** inert to most reagents except hydrofluoric acid; employed as a **dielectric**, to reduce firing shrinkage, and to improve transverse strength, resistance to thermal shock, and improve electrical resistance in spark plug bodies; used in mat glazes for **talc** bodies, as a green colorant in other glazes, and in the production of glass windows for x-ray tubes. Gem varieties are **aquamarine** and **emerald**. Mp 1,410 °C; density 2,640–2,800 kg m^{-3}; hardness (Mohs) 7.5–8.

beryl-ceramics. *Plural noun.* Refractory compositions containing **beryllium oxide**.

beryllia. *Noun.* Ceramic nomenclature for beryllium oxide. See **beryllium oxide**.

beryllides. *Plural noun.* Refractory hard compounds in which one element is beryllium, the general formula being Me_xBe_y; characterised by high melting temperatures ranging from approximately 1,427 to 2,080 °C; excellent resistances to oxidation up to 1,260 °C and some to as high as 1,540 °C; high strength with strength retention at elevated temperatures, and excellent thermal-shock resistance; reported **specific heats** range from 796 to 1,600 J kg^{-1} K^{-1}; **thermal conductivities** range from 0.44 to 1.41 J s^{-1} K^{-1} between 371 and 1,483 °C; linear thermal expansions of about 2 % at 1,371 °C; bend strengths of about 173 MN m^{-2} between 21 and 1,231 °C; **Vickers hardness** values between 5 and 13 GN m^{-2} and Young's modulus around 258 GN m^{-2} at 21 °C; potential materials for use in structural applications and spark-resistant tools.

berylliosis. *Noun.* An incapacitating lung disease caused by the inhalation of beryllium containing dusts.

beryllium. *Noun.* Be. A metalloid ceramic with toxic properties. A component in a number of special ceramics. Density 1,848 kg m^{-3}; mp 1,289 °C.

beryllium aluminate. *Noun.* $BeAl_2O_4$. An **olivine** even though formula suggests a **spinel**; mp 1,870 °C; density 3,500–3,840 kg m^{-3}; hardness (Mohs) 8.5. Also known as **chrysoberyl**.

beryllium boride. *Noun.* Be_2B; BeB_2; BeB_6. See **borides**.

beryllium carbide. *Noun.* Be_2C. Employed as a neutron **moderator** in nuclear applications and in applications where hardness, toughness, elasticity, and corrosion resistance at moderately high temperatures are important. Decomposes above 2,950 °C; unstable in oxygen above 982 °C; density 1,900 kg m^{-3}; hardness (Mohs) approximately 9; modulus of rupture 0.11 GN m^{-2}; compressive strength 72.4 GN m^{-2}.

beryllium nitride. *Noun.* Be_3N_2. Used in incandescent mantles and in applications where hardness, elasticity, corrosion resistance and toughness at temperatures in the range 600–1,400 °C are required. Mp 2,200 °C; density 2,710 kg m^{-3}; oxidises in air above 600 °C.

beryllium oxide. *Noun.* BeO. A lightweight and rigid ceramic that exhibits excellent dielectric properties, good physical strength, resistance to wetting by metals and non-metals, and high thermal conductivity (ten times greater than **alumina**). Employed in rocket nozzles, crucibles, insulators, **radomes**, thermocouple protection tubes, microwave parts, solid-state devices, gyroscopes, as a **moderator**, reflector material, in some porcelain glazes and as a matrix for fuel elements in nuclear applications. Poisonous vapour. Mp 2,570 °C; density 3,016 kg m^{-3}; hardness (Mohs) 9. Also known as **beryllia**.

beryllium silicate. *Noun.* Be_2SiO_4. Mp 1,560 °C; density 2,990 kg m^{-3}. Also known as **phenacit**e.

beryllosilicates. *Plural noun.* Ceramics with three-dimensional structures made from corner sharing oxygen atoms in SiO_4 and BeO_4 tetrahedra. See **chkalovite**.

Bessemer converter. *Noun.* A refractory-lined vessel, in which, steel is produced by the **Bessemer process**.

Bessemer process. *Noun.* A process for making steel by blowing air through molten pig iron, whereby most of the carbon and impurities are removed by oxidation.

BET. *Acronym*. Stands for Brunauer-Emmett-Teller equation. See **Brunauer-Emmett-Teller equation**.

beta activity. *Noun.* A form of radioactivity in which the atomic nucleus emits an electron or positron accompanied by an uncharged anti-neutrino, or neutrino respectively.