



**absorption:** dissolving of a vapour phase in a liquid medium

**absorption/solid desorption:** exchange phenomena between gaseous phase and solid phase, resulting in bonds being set up/broken between the molecules making up the gas and the substrate

**adsorption:** fixing of a vapour phase in a solid medium

**aerodynamic stall:** drop in lift of a wing or a propeller blade airfoil by turbulent unsticking of the air streams when the angle of incidence exceeds a certain value

**air:** mixture of gases containing 78% nitrogen, 21% oxygen, about 1% argon and traces of neon, krypton, xenon and helium

**amino acid:** protein-building molecule containing an amino group ( $\text{NH}_2$ ) and a carboxylic group ( $\text{COOH}$ )

**amorphous:** state characterised by the absence of order in material particle distribution, as opposed to a crystalline state

**anaerobic:** total absence of oxygen

**anisotropic:** with properties that vary according to direction

**antenna: in microalgae,** set of **photosynthetic** pigments that trap solar energy

**ATP (adenosine-triphosphate):** compound formed of a base (adenine) and a sugar (ribose) and having a chain of three phosphate groups

**bacterium:** living microorganism less than a few micrometres in size, that is generally single cell, without a nucleus and able to multiply quickly

**band (direct or indirect electronic bandgap):** a **semiconductor's** structure is made up of **electronic bands** characterised by the presence of a bandgap between an allowed and full band (or almost full at non zero temperature) the **valence band**, and an empty or almost empty band, called the **conduction band**. Photons of energy higher than the bandgap generate **charge carriers** by transition of the electrons between the two allowed bands. Depending on the way the atoms are arranged and on the energies of the peripheral electrons, the photons are able to pass through the bandgap causing phonons to be emitted (network vibration quanta) – the band is then referred to as an **indirect bandgap** (as in silicon) – or not – **direct bandgap**

**bio-gas:** gas resulting from the decomposition of organic matter

**biomass:** mass of living matter, both vegetable (over 99%) and animal, present on the Earth's surface

**biomimetic:** qualifies a compound or a process created by analogy with a biological substance or process

**breeding:** from *fertile* nuclear materials, production of *fissionable* materials similar to that consumed by nuclear chain reaction. The term is used when the regeneration ratio is greater than 1

**capillary (effects):** forces developing on the surface of a liquid and affecting the form of its border with the ambient medium; the smaller the dimensions, the more sensitive the capillary effects

**carbon dioxide ( $\text{CO}_2$ ):** gas heavier than **air** which is produced when materials containing carbon are burnt

**carburant:** hydrocarbon-based **fuel**

**carriers (charge): conduction** electrons; electrical current is the movement of charge carriers. In **photovoltaic** energy, they are the electrons and holes generated by photons

**catalysis:** process involving a substance, or **catalyst**, capable of accelerating a chemical reaction without being modified, or just temporarily

**cathode sputtering:** formation of thin layers by ejection of atoms from a target material during sputtering by rare gas ions accelerated under high voltage

**chemical grafting:** immobilisation of a molecule by another *via* a covalent bond

**chlorophyll:** light-absorbing pigment that plays an essential role in **photosynthesis**

**chloroplast:** organelle present in the **chlorophyll** cells of **photosynthetic** organisms, where light energy is transformed into chemical energy

**CIS:** for  $\text{CuInSe}_2$ , copper and indium diselenid belonging to the family of **chalcopyrites** made up of metalloid atoms (sulphur, selenium) and metals

**cogeneration:** simultaneous production of electricity and heat

**conduction (electronic or ionic):** phenomenon by which an electron or an ion moves in a material

**conduction (thermal):** phenomenon by which, in a given medium, heat flows from a high temperature region to a lower temperature region, or between two media in contact with each other

**conductivity (ionic or protonic):** quantifies the easiness with which an ion or a proton moves in a material

**conductivity:** characterises the **conduction** capacity (electrical and thermal) of a substance. **Electrical conductivity** is expressed in siemens per unit of length

**convection:** movement of a fluid with heat transport under the influence of temperature differences

**cracking:** process by which **hydrocarbons** are refined by modification of the molecular structure using heat, pressure and, sometimes, a **catalyst**

**cyanobacterium (from Greek *kuanos*, dark blue): bacterium** capable of using light energy in the same way as plants

**diamine:** substance having two amino functions. The amino group is derived from ammoniac ( $\text{NH}_3$ ) in which one (or several) atom(s) of hydrogen is replaced by another atom

**diode:** electronic component formed by the junction of two **semiconductors**

**distillation:** operation consisting in partially vapourising a mixture in its liquid state and then selectively condensing the vapours to separate the different constituents

**dopant:** foreign atom introduced into the lattice of a **semiconductor** in order to modify its electrical properties and resulting in a discrete allowable energy level in the **bandgap** and close to the **valence band** or to the **conduction band**. This atom then gives an electron or a mobile hole to either of the allowed bands thus increasing the **electrical conductivity** of the material

**efficiency (conversion):** for a photovoltaic cell, ratio between the maximum **electric** output **power** and the product of the surface of the generator by the incident lighting measured

**efficiency (gross):** in a fuel cell, ratio between the **electric power** supplied and the calorific value of the hydrogen injected, excluding consumption by the auxiliaries

**electric power:** product of the output voltage by the intensity of current supplied. For a power station, power supplied to the grid (about 35% of the **thermal power** for a pressurised water nuclear reactor)



**electrode:** conductive element that, *via* an electric field, emits, captures or controls electrons or ions (**anode** and **cathode**)

**electrolysis:** movement of ions, under the influence of a difference in potential, towards the **electrodes**, followed by the deposition or gaseous emission of oxidised or reduced species on these electrodes

**electrolyte (solid):** in an SOFC fuel cell, material (often a ceramic) that acts as an **ionic conductor** in the solid state and at high temperatures (several hundred degrees) but not as an **electronic conductor**

**electrolyte:** liquid or solid compound enabling **ionic conduction**

**electron-hole pair:** pair of **carriers** unlinked to an atom and therefore able to move in the entire crystal where they have appeared and one of which is negative (electron in the **conduction band**) and the other positive (absence of electron in the **valence band**)

**electronic bands:** ranges of energy available for the electrons in the matter, linked to the periodic nature of the atomic structure in the crystal and to the wave-like nature of the electrons

**electrostatic:** based on balanced electrical charges that do not move (zero electric field)

**endothermic/exothermic:** accompanied by absorption/emission of heat

**enthalpy:** function defined by the sum of internal energy of a system and product of its pressure by its volume

**enzyme:** protein which **catalyses** a biochemical reaction

**ethanol:** C<sub>2</sub>H<sub>5</sub>OH alcohol derived from C<sub>2</sub>H<sub>6</sub> ethane

**ferredoxin:** electron transfer protein with a polyhedral iron-sulphur **redox centre**

**flow density:** power going through a surface unit (in W/m<sup>2</sup> or W/cm<sup>2</sup>)

**fluidised bed:** technique in which an ascending current of a fluid counterbalances the apparent weight of the particles of a sputtered product which then flows like a fluid

**formulation:** composition set-up

**fossil (energy):** produced from **fuels** from the Earth such as coal, oil and **natural gas**

**fuel:** the combustion of fuel, i.e. reaction with a **comburent** or **combustive** (often oxygen), produces usable energy

**hybrid vehicle:** which combines two energy generation modes. The currently popular formula combines an internal combustion engine and a battery supplying an electrical traction system; in steady-state conditions, and thus optimum efficiency, the first recharges the battery which absorbs the current peaks and recovers the braking energy

**hydride:** compound able to absorb hydrogen. Ionic, covalent and metallic hydrides differ through the nature of the bond between the hydrogen and the element considered, as well as through their properties

**hydrocarbon:** molecule only formed of carbon and hydrogen

**hydrogenase: enzyme** (small **bacterial** protein), highly sensitive to the presence of oxygen, capable of causing a reversible **catalytic** reaction to produce hydrogen from protons and electrons

**hyperbaric (storage):** at a pressure far greater than the atmospheric pressure

**isomeric (state):** in which an atomic nucleus is "blocked" in an excited state (at an energy level above its fundamental state) for a given time, ranging from several billionths of a second to several billion years. A single nucleus can have several isomers

**kWh:** a kilowatt-hour = 3.6 million joules. Principal multiple of the **watt-hour**, unit of work and energy, product of the power by the time

**laminary (state):** the movement of a fluid is laminary or turbulent. In a laminary flow, the fluid flows in layers, each particle following a single and continuous line. In a turbulent flow, the particle movement is irregular, but on a statistical basis the overall movement is regular

**laser diode:** coherent light source whose beam intensity can vary when a variable voltage is applied

**ligand:** molecule or ion connected to the central atom of a complex *via* a coordinating bond

**metastable:** whose transformation speed is so low that it appears stable

**methane:** gas (CH<sub>4</sub>), essential component of **natural gas** or fire-damp. It is given off by putrefying matter

**methanol:** CH<sub>3</sub>OH alcohol derived from **methane**. Its calorific value is half that of gasoline

**microalga:** single cell organism possessing **chloroplasts** that is therefore able to transform light energy into chemical energy for growth

**monocrystal:** solid whose atoms are ordered according to a periodic lattice in the three directions. It is formed of a single block, as opposed to **polycrystal** which is formed of several monocrystals (grains) whose lattices are disoriented in relation to each other

**monolithic (device):** whose set of elements are assembled on the same substrate

**Mtep:** million tonnes oil equivalent. 1 tep = 42 billion joules

**mutation:** transmissible alteration of the genetic message by modification of a sequence of DNA nucleotides. The nucleotide is a basic component of DNA and RNA and is made up of a base, a sugar and a phosphate group

**NADP<sup>+</sup>** (nicotinamide adenine dinucleotide phosphate in its oxidised state); **NADPH** (in its reduced state): small organic molecule enabling the transfer of reducing power necessary for various enzyme-based reactions

**natural gas:** mixture of gaseous saturated **hydrocarbons** (principally **methane**) and other components (sulphurous hydrogen, nitrogen dioxide, **carbon dioxide**, etc.) used as a **fuel**

**noble metals:** precious metals that cannot be altered by air or water (silver, gold, platinum)

**ohmic drop:** in a fuel cell, drop in voltage owing to the internal resistance of the cells; directly proportional to the current

**osmosis:** transfer of a solvent from a diluted solution to a concentrated solution through a membrane; **reverse osmosis:** separation process with transfer in the opposite direction

**oxidation:** reaction during which an atom or an ion loses electrons

**oxo-species:** atom of oxygen with a double negative charge which generally bridges a bimetallic centre

**peak-watt (Wp):** unit of power corresponding to the maximum amount of sun absorbed by a photovoltaic cell



**perfluorinated:** organic structure where all the hydrogen associated with the carbon are replaced by fluorine

**photodissociation:** dissociation of a molecule from the energy of a photon

**photolysis:** breaking of a chemical bond from the energy of a photon

**photooxidise:** oxidising of a molecule from the energy of a photon

**photosynthesis:** process by which plants and certain **bacteria** use solar energy to synthesise organic molecules from **carbon dioxide** and water

**photovoltaic:** effect by which light energy is directly transformed into electrical energy in a **semiconductor**

**plasma projection:** technology for forming thick layers and bulky parts by introduction of a sputtering material in a heat plasma generated by an electric arc inside a torch

**plastocyanin:** electron transfer protein whose **redox centre** is a copper atom

**(plasto)quinone:** small liposoluble organic molecule enabling the transfer of two electrons and two protons

**polymer-gel:** material made up of a liquid encapsulated in a **polymer** matrix that is insoluble in the liquid

**polymerisation:** progressive addition of monomer molecules one with the other. A **polymer** is a macromolecule repeating the same pattern

**power density:** power supplied in a fuel cell by **electrode** surface unit ( $W/cm^2$ )

**promoter:** DNA sequence required to start transcription of a gene (synthesis of a RNA strand)

**pyrolysis:** decomposition of a substance under the effect of heat

**redox centre:** group of molecules participating in the transfer of electrons by electron exchange between its molecules

**reduction:** reaction during which an atom or an ion gains electrons given off by a **reducing agent**

**reforming:** chemical **cracking** operation of a **hydrocarbon** or alcohol molecule so that it can be transformed into its major components

**resistance (internal):** linked to the **ionic conductivity** and thickness of the **electrolytic** membrane, it must be kept to a minimum in order to deliver high current while maintaining a satisfactory voltage

**saline or alkaline cells (or storage batteries):** in a **saline battery**, the **electrolyte** is a saline compound (ammonium chloride, zinc chloride, etc.), while in an **alkaline battery** the electrolyte is a basic solution containing an alkaline metal (lithium, sodium, potassium, etc.)

**selenisation:** hot chemical reaction between a selenium vapour (Se) and an A solid compound to form  $ASe_x$  selenide

**semiconductor:** material with a **bandgap**, which is neither totally insulating nor totally conductive at non zero temperatures. Some of its electrons that have a weak link to their atoms can become **conduction** electrons. **Silicon** is the most widely used semiconductor. A semiconductor is said to be of the n type (mainly **charge carrying** electrons) or of the p type (mainly charge carrying holes) depending on the **dopants** used

**silicon (amorphous):** in the non crystalline state. When deposited on a substrate with a thickness of around  $1 \mu m$ , it is used to manufacture **photovoltaic** cells and modules

**silicon (crystalline) (c-Si):** name under which different crystalline forms are grouped. **Microcrystalline silicon ( $\mu c-Si$ )** is a material, whose thickness is around one  $\mu m$ , used to manufacture photovoltaic modules and cells (grain size  $< 1 \mu m$ ). **Monocrystalline (sc-Si)** is used to manufacture ingots and wafers or cells obtained by the Czochralski pulling method or by zone fusion. A wafer is composed of a single grain. **Multicrystalline (mc-Si)** is obtained by directional solidification in a crucible to manufacture ingots, wafers or cells (grain size:  $0.1 - 10 cm$ ). **Poly-crystalline (pc-Si)**, with a thickness of 10 to  $30 \mu m$ , is deposited on a substrate for the manufacture of ingots, wafers or cells (grain size:  $1 \mu m - 1 mm$ )

**site (active):** region of an **enzyme** enabling the **catalysis** of a specific reaction

**site-specific mutagenesis:** introduction of **mutations** in DNA in order to induce the targeted modification of **amino acids** in the sequence of a protein

**specific energy:** in a fuel cell, ratio (in  $Wh/kg$ ) between the electric power supplied by time unit and the converter mass, including the **fuel** tank

**spinel:** crystalline structure of oxides in which the oxygen ions roughly form a compact face-centred cubic assembly and where the cations occupy octahedral and tetrahedral sites of these assemblies

**sulphonic:**  $SO_3H$  group covalently bonded with carbon

**thermal power:** for a fuel cell, quantity of heat supplied by time unit; approximately the product of the cooling fluid flow rate by the difference in temperature endured. In a thermal power plant, boiler power

**thermohydraulics:** science relating to the behaviour and movement of fluids in relation to the temperature

**thermophoresis:** phenomenon based on the attraction of particles moving under the effect of a thermal gradient to a cold wall

**thermosets and thermoplastics:** the two major families of plastic materials. During hot forming, covalent bonds are created in thermosets thus irreversibly uniting the chains (reticulation). Thermoplastics can undergo hot "remodelling" during which the temperature only softens them

**thylakoid (from Greek *thulakos*, bag):** internal membrane in a **chloroplast** containing all the membrane proteins of electron transfers induced by photons

**transgenesis:** all operations for obtaining an organism that has incorporated, in a stable manner, one or several genes from another cell or organism and is able to transmit these to its offspring

**transition temperature:** at which a substance changes state or, in a given state, changes structure (crystalline or magnetic)

**vitrification:** acquisition of a vitreous structure by high temperature fusion

**VOC (volatile organic compounds):** organic compounds that easily change to vapour and notably include certain aldehydes, cetones and aromatic **hydrocarbons** such as benzene, toluene and xylene

**watt (W):** unit of power corresponding to consumption of 1 joule per second. Main multiples: the kilowatt ( $1 kW = 1\ 000$  watts), the megawatt ( $1 MW = 1$  million watts) and the terawatt ( $1\ 000$  billion watts)

**zeotropic mixture:** mixture of several fluids characterised by a vapourisation or condensation process at variable temperature