

## Glossary of terms

**AHSS** Advanced High Strength Steel: any steel with high levels of both strength and formability.

**Annealing** Heating to and holding at a suitable temperature and then cooling at a suitable rate to remove the effects of work hardening. This facilitates further cold working.

**Austenite** See 'Phase'.

**Bainite** See 'Phase'.

**Bake hardening** Steel grades that exhibit an increase in hardness (and therefore strength) when heated to a relatively low temperature, typically in an automotive paint-bake oven. For the bake-hardening mechanism to work the steel has to be work hardened.

**BIW** Body In White: the main structure of a vehicle, usually made of steel pressings welded together to make a strong and stiff frame.

**Boron steel** See PHS.

**BOS** Basic Oxygen Steelmaking: process for converting liquid pig iron into steel, excess carbon being removed by reaction with oxygen. 'Basic' here means that the reaction takes place under alkaline conditions.

**Carburising** Surface hardening by diffusion of carbon atoms.

**CMn** Carbon Manganese: steels with carbon and manganese as the principal alloying elements. Mn is the chemical symbol for manganese, not to be confused with Mg (magnesium).

**Chassis** Most cars built before the 1950s were constructed using a separate chassis frame and body. Nowadays, 'chassis' refers to the components (subframes, suspension, etc) that connect the BIW to the engine, steering and wheels.

**Closure** A panel attached to the Body In White, such as doors, bonnet and boot. Closures are usually hinged, although some vehicle manufacturers include bolted-on panels, such as front wings.

**Cold rolling** Reducing the thickness of strip steel by rolling at ambient temperature, mostly used in thinner gauges for automotive applications.

**Continuous casting** Non-stop manufacture of steel by pouring liquid steel into a mould, which is a water-cooled copper or ceramic jacket.

**Drawing** A method of forming steel into complex three-dimensional shapes in a press, the metal being pulled ('drawn') into the tool where it is stretched into shape.

**Dual Phase (DP)** Steel composed of ferrite and martensite phases. (See 'Phase').

**EAF** Electric Arc Furnace: uses electric current to melt scrap steel. The molten steel formulation can then be modified, with alloying elements added as required to produce a wide range of steel grades.

**Elastic limit** The maximum stress to which a material may be subjected and yet return to its original shape and dimensions upon removal of the stress. (See 'Yield strength').

**Elongation** The amount of permanent extension in a component under stress, usually described as a percentage of the initial length.

**ELVD** End of Life Vehicle Directive: a European law that requires an increasing percentage of a vehicle to be recyclable.

**Euro-NCAP** European New Car Assessment Program: the European automobile safety organisation providing motoring consumers with an independent assessment of vehicle safety performance. It awards stars for front and side impact performance, as well as pedestrian safety.

**Exothermic** A chemical reaction that gives off heat. For example, the conversion of iron to steel using oxygen generates a large amount of heat. The resultant molten steel is three or four hundred Celsius hotter than molten pig iron.

**Fracture splitting** A specialised manufacturing process in which the precision fracturing of a machined component results in matching, self-locating, surfaces.

**FEA** Finite Element Analysis: a computational method of stress calculation in which the component under load is considered as a large number of small pieces ('elements'). The FEA software is then able to calculate the stress level in each element, allowing a prediction of deflection or failure.

**Ferrite** See 'Phase'.

**Galvanise** Coat with zinc, either by electroplating, or (more commonly) by dipping into molten zinc. Since the 1980s, most automotive strip steel has been supplied galvanised for optimal corrosion protection.

**Grain** All steels are polycrystalline – made up of minute crystals known as grains. The size, shape and crystalline alignment of these grains are a key to the performance of steel.

**Hot rolling** Reducing the thickness of strip steel by rolling at elevated temperature, mostly used in thicker gauges for automotive applications.

**HSLA** High Strength Low Alloy: steels that generally contain small amounts of highly effective alloying elements such as titanium, vanadium or niobium in amounts of less than 0.1 per cent.

**HSS** High Strength Steel: steel with yield strength between 220 and 550MPa.

**Hydroforming** The use of pressurised fluid to change the shape of a metal sheet or tube.

**IF** Interstitial Free: steels without the strengthening effect of interstitial elements such as carbon and nitrogen, making them very formable with low strength. These are manufactured by the addition of titanium or niobium, which form compounds with carbon and nitrogen.

**Interstitial** The spaces between atoms are known as interstices. Atoms of carbon and nitrogen that are small enough to fit into these spaces are known as interstitial atoms. They strengthen the steel by preventing layers of atoms sliding past one another.

**IS** Isotropic Steel: strip steel with both chemistry and manufacturing processes specifically designed to give the same mechanical properties in any direction along the length or across the width of the strip.

**Martensite** See 'Phase'.

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**Mild steel** Low-strength steels containing low levels of carbon and insignificant amounts of alloying elements.

**Modulus** The 'stiffness' of a material. Calculated by measuring the stress on a test sample and dividing by the strain. Since strain is dimensionless, the unit of modulus is therefore the same as stress (N/m<sup>2</sup> or Pa). Some examples of moduli:

	GPa
Steel	207
Aluminium	69
Polyethylene	1
Diamond	1000

**n-value** A measurement of the work hardening (strengthening) of metal sheet during a forming process.

**OEM** Original Equipment Manufacturer: in the automotive industry, this refers to a manufacturer of vehicles that provides the original product design and materials for its assembly and manufacture.

**Pearlite** See 'Phase'.

**Pig iron** Iron direct from the blast furnace, containing high levels of carbon and other impurities. Originally sand-cast into a row of blocks, having the appearance of a sow feeding her piglets – hence 'pig' iron.

**Phase** Steel can exist in a number of crystalline forms and combinations of crystalline forms. These are known as 'phases'. Here are some of the most common:

- Austenite: A non-magnetic structure usually found in stainless steels and TWIP steel.
- Bainite: Ferrite containing needle shaped iron carbide (Fe<sub>3</sub>C) crystals – tough and hard.
- Ferrite: Iron containing a small amount of carbon in solid solution. The softest form of steel.
- Martensite: Excess carbon ('supersaturated') results in a distorted crystalline structure and the hardest form of steel.
- Pearlite: Alternating layers of ferrite and iron carbide. When viewed under a microscope it has the appearance of mother-of-pearl, hence 'pearl'ite.

**PHS** Press Hardening Steels (also: hot-formed steel, die-quenched steel, boron steel) a grade of steel that can be processed at high temperature by heating in a furnace and pressing while still hot using a cooled tool. The rapid cooling rate transforms the microstructure to 100 per cent martensite (see 'Phase'). PHS steels contain boron for optimum hardenability.

**Pickling** An acidic-dip process for removing oxide ('scale') from the surface of hot-rolled steel sheet.

**Rephos** Rephosphorised steel: steel that contains phosphor as the main alloying element. Known as Rephos since the high levels of phosphor in pig iron are removed along with other impurities in the BOS process, but phosphor is then added during secondary steelmaking.

**r-value** A measurement of the resistance to thinning of sheet metal during forming processes.

**Roll forming** A process for producing prismatic shapes in steel sheet, the sheet being progressively bent and folded by passing through a series of profiled rollers.

**Strain** The amount a component stretches when a stress is applied. Strain is dimensionless: 100 per cent elongation equals a strain of one.

**Stress** The applied force divided by the cross section of a component, measured in N/m<sup>2</sup> (= Pascal, Pa). Note: these units are the same as the units for pressure. Indeed, stress may be considered as the pressure applied to a component.

**Substitutional** Large alloying atoms (eg. phosphorus and manganese) take the place of, or substitute, an iron atom – unlike small alloying atoms, which are positioned between the larger iron atoms (see 'Interstitial').

**Tensile strength** Also called the ultimate tensile strength (UTS). The stress at which a material breaks.

**Temper rolling** After annealing, strip steel is given enough cold rolling to take it beyond the yield point, resulting in more controllable stretching during subsequent forming processes and a better surface finish.

**TRB** Tailor Rolled Blank: steel sheet cut to a size ready for pressing (i.e. 'blanked') where the blank has been rolled to give varying thicknesses along its length.

**TRIP** Transformation Induced Plasticity: steel that contains a small percentage of phases (see 'Phase') that change to a harder phase (usually austenite transforming to martensite) during the forming process. The formed steel therefore has a much higher strength.

**TWB** Tailor Welded Blank: steel sheet cut to a size ready for pressing (i.e. 'blanked') where the sheet has been welded together from smaller pieces of steel of varying gauge and/or grade.

**TWIP** Twinning Induced Plasticity: steel that has high levels of manganese is austenitic (see 'Phase') at ambient temperature. The crystalline structure of austenite results in the occurrence of millions of pairs of crystalline faults known as twins. These twins allow for unusual levels of formability in Ultra High Strength Steel.

**UHSS** Ultra High Strength Steel: any steel grade with a yield strength of 550MPa or greater.

**Work hardening** The increase in the strength of a metal as it is stretched or otherwise formed.

**Yield strength** The stress at which a material will permanently stretch or deform. Below this stress the material will return to its original shape and size once the stress is removed (see 'Elastic limit').

**Yield point** The start of yielding in steel may be accompanied by a sudden drop in strength. This is known as the yield point and is undesirable in steel for automotive pressings (see 'Temper rolling').