Alloys, Coatings, Material Compositions, and Related Terminology

aging
A change in the properties of certain metals and alloys that occurs at ambient or moderately elevated temperatures after a hot-working operation or a heat-treatment (quench aging in ferrous alloys, natural or artificial aging in ferrous and nonferrous alloys) or after a cold-working operation (strain aging). The change in properties is often, but not always, due to a phase change (precipitation), but never involves a change in chemical composition of the metal or alloy.

Al₂O₃, aluminum oxide
Abrasive material for grinding tools. Al₂O₃ also is the base for ceramics and is used to coat tools. See ceramic; coated tools; Category IV: Cutting Tools and Related Terminology: abrasive.

alclad
Composite wrought product comprised of an aluminum-alloy core having on one or both surfaces a metallurgically bonded aluminum or aluminum-alloy coating that is anodic to the core and thus electrochemically protects the core against corrosion.

alloy
A substance having metallic properties and being composed of two or more chemical elements of which at least one is a metal.

alloy steel
Steel containing specified quantities of alloying elements (other than carbon and the commonly accepted amounts of manganese, copper, silicon, sulfur and phosphorus) within the limits recognized for constructional alloy steels, added to effect changes in mechanical or physical properties.

alloying element
An element that is added to a metal to change the metal’s properties.

alpha iron
The body-centered cubic form of pure iron, stable below 910° C.

Alumel
A nickel-base alloy containing about 2.5 manganese, 2 aluminum, and 1 silicon used chiefly as a component of pyrometric thermocouples.

aluminizing
Formation of an aluminum or aluminum-alloy coating on a metal by hot dipping, hot spraying, or diffusion.

amorphous
Not having a crystal structure; noncrystalline.

atmospheric corrosion
The gradual degradation or alteration of a material by contact with substances present in the atmosphere, such as oxygen, carbon dioxide, water vapor, and sulfur and chlorine compounds.

austenite
Metallurgical term for a material that forms when carbon steel is heated above 735° C and the iron-carbide compounds within the steel dissolve. Quenching the carbon steel at this point replaces the austenite with martensite, which has an angular molecular structure and high hardness. See Category VIII: Heat-Treating and Special Processes: austenitizing; martensiting.

bainite
A metastable aggregate of ferrite and cementite resulting from the transformation of austenite at temperatures below the pearlite range but above M. Its appearance is feathery if formed in the upper part of the bainite transformation range; acicular, resembling tempered martensite, if formed in the lower part. See martensite.
**banded structure**  
A segregated structure consisting of alternating, nearly parallel bands of different composition, typically aligned in the direction of primary hot working.

**Bhn, Brinell hardness**  
Hardness scale used to indicate relative hardness of metals.

**black oxide**  
A black finish on a metal produced by immersing it in hot oxidizing salts or salt solutions.

**blue brittleness**  
Brittleness exhibited by some steels after being heated to a temperature within the range of about 200° C to 370° C, particularly if the steel is worked at the elevated temperature.

**brittle fracture**  
Separation of a solid accompanied by little or no macroscopic plastic deformation. Typically, brittle fracture occurs by rapid crack propagation with the less expenditure of energy than for ductile fracture.

**burning**  
1. Permanently damaging a metal or alloy by heating to cause either incipient melting or intergranular oxidation. 2. In grinding, getting the work hot enough to cause discoloration or to change the microstructure by tempering or hardening.

**carbide**  
Compound of carbon and one or more metallic elements. For cutting tools, tungsten carbide, titanium carbide, tantalum carbide, or a combination of these in a cobalt or nickel matrix provides hardness, wear resistance, and heat resistance. Other elements added to carbide include vanadium, niobium, columbium, and hafnium.

**carbon steel**  
Steel combined with varying amounts of carbon. Has no specified minimum quantity for any alloying element (other than the commonly accepted amounts of manganese, silicon, and copper) and contains only an incidental amount of any element other than carbon, silicon, manganese, copper, sulfur, and phosphorus.

**cast alloy**  
Alloy cast from the molten state; most high-speed steel is melted in an electric-arc furnace and cast into ingots.

**cast cobalt-base alloy**  
Used to make turning tools for interrupted cuts; more heat-resistant than high-speed steel and tougher (less brittle) than carbide.

**cast iron**  
A generic term for a large family of cast ferrous alloys in which the carbon content exceeds the solubility of carbon in austenite at the eutectic temperature. Most cast irons contain at least 2% carbon, plus silicon and sulfur, and may or may not contain other alloying elements. For the various forms—gray cast iron, white cast iron, malleable cast iron and ductile cast iron—the word "cast" is often left out.

**CBN, cubic boron nitride**  
Crystal manufactured from boron nitride under high pressure and temperature. Used to cut hard-to-machine ferrous and nickel-base materials up to RC 70. Second in hardness only to diamond. See Category IV: Cutting Tools and Related Terminology: superabrasive tools.

**cemented carbide**  
Carbide manufactured using powder-metallurgy processes. See PM, powder metallurgy.

**cementite**  
A compound of iron and carbon, known chemically as iron carbide and having the approximate chemical formula Fe₃C. It is characterized by an orthorhombic crystal structure.
ceramic
Made from finely powdered aluminum oxide sintered into the desired form. Ceramics operate at higher speeds than carbides, plus they wear longer, provide smoother finishes, and can machine harder materials. They are, however, less shock-resistant. Typically used for high-speed turning.

cermet
Material consisting of ceramic particles bonded with a metal. Cermets are more shock-resistant than ceramics. In general, cermet tools, like ceramic ones, are used for high-speed turning.

chevron pattern
A fractographic pattern of radial marks (shear ledges) that look like nested letters “V”; sometimes called a herringbone pattern. Chevron patterns are typically found on brittle fracture surfaces in parts whose widths are considerably greater than their thicknesses. The points of the chevrons can be traced back to the fracture origin.

Chromel
1. A 90Ni-10Cr alloy used in thermocouples. 2. A series of nickel-chromium alloys, some with iron, used for heat-resistant applications.

coated tools
Carbide and high-speed-steel tools coated with thin layers of aluminum oxide, titanium carbide, titanium nitride, hafnium nitride, or some combination of these elements. Coating improves a tool's resistance to wear, allows higher machining speeds, and provides better finishes. See CVD, chemical vapor deposition; PVD, physical vapor deposition.

cold shut
1. A discontinuity that appears on the surface of cast metal as a result of two streams of liquid meeting and failing to unite. 2. A lap on the surface of a forging or billet that was closed without fusion during deformation. 3. Freezing of the top surface of an ingot before the mold is full.

cold working
Deforming metal plastically under conditions of temperature and strain rate that induce strain hardening. Working below the recrystallization temperature, which is usually, but not necessarily, above room temperature.

commercial-grade tool steel
Low-grade tool steel; not controlled for hardenability.

compacted graphite cast iron
Cast iron having a graphite shape intermediate between the flake form typical of gray cast iron and the spherical form of fully spherulitic ductile cast iron. Also known as CG iron or vermicular iron, compacted graphite cast iron is produced in a manner similar to that for ductile cast iron, but using a technique that inhibits the formation of fully spherulitic graphite nodules.

composites
Materials composed of different elements, with one element normally embedded in another, held together by a compatible binder.

continuous casting
A casting technique in which a cast shape is continuously withdrawn through the bottom of the mold as it solidifies, so that its length is not determined by mold dimensions. Used chiefly to produce semifinished mill products such as billets, blooms, ingots, slabs and tubes.

corrosion
The chemical or electrochemical reaction between a material, usually a metal, and its environment that produces a deterioration of the material and its properties.

corrosion fatigue
The process in which a metal fractures prematurely under conditions of simultaneous corrosion and repeated cyclic loading at lower stress levels or fewer cycles than would be required in the absence of the corrosive environment.

corrosion resistance
Ability of an alloy or material to withstand rust and corrosion; properties fostered by nickel and chromium in alloys such as stainless steel.
cutting tool materials
Include cast cobalt-base alloys, ceramics, cemented carbides, cubic boron nitride, diamond, high-speed steels, and carbon steels.

CVD, chemical vapor deposition
High-temperature (1000° C or higher), atmosphere-controlled process in which a chemical reaction is induced for the purpose of depositing a coating 2µm to 12µm thick on a tool’s surface. See coated tools; PVD, physical vapor deposition.

dendrite
A crystal that has a treelike branching pattern, being most evident in cast metals slowly cooled through the solidification range.

diamond
Cubic crystalline form of carbon produced under extreme pressures at elevated temperatures. The hardest natural substance, it has approximately five times the indentation hardness of carbide. Its extreme hardness, though, makes it susceptible to fracturing. See Category IV: Cutting Tools and Related Terminology: superabrasive tools.

die casting
1. A casting made in a die. 2. A casting process wherein molten metal is forced under high pressure into the cavity of a metal mold.

diffusion
1. Spreading of a constituent in a gas, liquid, or solid, tending to make the composition of all parts uniform. 2. The spontaneous movement of atoms or molecules to new sites within a material.

diffusion coating
Any process whereby a basis metal or alloy is either: 1. coated with another metal or alloy and heated to a sufficient temperature in a suitable environment or 2. exposed to a gaseous or liquid medium containing another metal or alloy, thus causing diffusion of the coating or of the other metal or alloy into the basis metal or alloy with resultant changes in the composition and properties of its surface.

ductile cast iron
A cast iron that has been treated while molten with an element such as magnesium or cerium to induce the formation of free graphite as nodules or spherulites, which imparts a measurable degree of ductility to the cast metal. Also known as nodular cast iron, spherulitic graphite cast iron, or SG iron.

ductile fracture
Fracture characterized by tearing of metal accompanied by appreciable gross plastic deformation and expenditure of considerable energy.

ductility
The ability of a material to be bent, formed, or stretched without rupturing. Measured by elongation or reduction of area in a tensile test or by other means.

elastic limit
The maximum stress that a material can sustain without deforming.

elasticity
The property of a material to deform under stress and recover its original shape and dimensions after release of stress.

elongation
In tensile testing, the increase in the gage length, measured after fracture of the specimen within the gage length, usually expressed as a percentage of the original gage length.

embrittlement
Reduction in the normal ductility of a metal due to a physical or chemical change. Examples include blue brittleness, hydrogen embrittlement, and temper brittleness.

endurance limit
The maximum stress below which a material can presumably endure an infinite number of stress cycles.
eutectic
1. An isothermal reversible reaction in which a liquid solution is converted into two or more intimately mixed solids on cooling, the number of solids formed being the same as the number of components in the system. 2. An alloy having the composition indicated by the eutectic point on an equilibrium diagram. 3. An alloy structure of intermixed solid constituents formed by the eutectic reaction.

eutrication
Conversion of an ingot or billet into lengths of uniform cross section by forcing metal to flow plastically through a die orifice.

fatigue
The phenomenon leading to fracture under repeated or fluctuating stresses having a maximum value less than the tensile strength of the material. Fatigue fractures are progressive, beginning as minute cracks that grow under the action of the fluctuating stress.

fatigue life
The number of cycles of stress that can be sustained prior to failure under a stated test condition.

fatigue resistance
Ability of a tool or component to be flexed repeatedly without cracking; important for bandsaw-blade backing.

fatigue strength
The maximum stress that can be sustained for a specified number of cycles without failure, the stress being completely reversed within each cycle unless otherwise stated.

fatigue striations
Parallel lines frequently observed in electron-microscope fractographs of fatigue fracture surfaces. The lines are transverse to the direction of local crack propagation; the distance between successive lines represents the advance of the crack front during one cycle of stress variation.

ferrite
A solid solution of one or more elements in body-centered cubic iron. Unless otherwise designated (for instance, as chromium ferrite), the solute is generally assumed to be carbon. On some equilibrium diagrams, there are two ferrite regions separated by an austenite area. The lower area is alpha ferrite; the upper, delta ferrite. If there is no designation, alpha ferrite is assumed.

flash
A thin web or film of metal on a casting that occurs at die partings, around air vents, and around movable cores. This excess metal is due to necessary working and operating clearances in a die. Flash also is the excess material squeezed out of the cavity as a compression mold closes or as pressure is applied to the cavity.

flow stress
The uniaxial true stress at the onset of plastic deformation in a metal.

fracture stress
1. The maximum principal true stress at fracture. Usually refers to unnotched tensile specimens. 2. The (hypothetical) true stress that will cause fracture without further deformation at any given strain.

fracture toughness

free-machining steels
Carbon and alloy steels that contain lead, sulfur, or other elements that improve machinability.

galling
A condition whereby excessive friction between high spots results in localized welding with subsequent spalling and further roughening of the rubbing surface(s) of one or both of two mating parts.

gamma iron
The face-centered cubic form of pure iron, stable from 910° C to 1400° C.
graphitic corrosion
Deterioration of gray cast iron in which the metallic constituents are selectively leached or converted to corrosion products leaving the graphite intact. The term graphitization is commonly used to identify this form of corrosion, but is not recommended because of its use in metallurgy for the decomposition of carbide to graphite.

graphitization
A metallurgical term describing the formation of graphite in iron or steel, usually from decomposition of iron carbide at elevated temperatures. Not recommended as a term to describe graphitic corrosion.

gray cast iron
A cast iron that gives a gray fracture due to the presence of flake graphite. Often called gray iron.

growth
In cast iron, a permanent increase in dimensions resulting from repeated or prolonged heating at temperatures above 480°C due either to graphitizing of carbides or to oxidation.

hard chromium
Chromium electrodeposited for engineering purposes (such as to increase the wear resistance of sliding metal surfaces) rather than as a decorative coating. It is usually applied directly to basis metal and is customarily thicker than a decorative deposit, but not necessarily harder.

hardenability
The relative ability of a ferrous alloy to form martensite when quenched from a temperature above the upper critical temperature. Hardenability is commonly measured as the distance below a quenched surface at which the metal exhibits a specific hardness (RC 50, for example) or a specific percentage of martensite in the microstructure.

hardness
Resistance of metal to plastic deformation, usually by indentation. However, the term may also refer to stiffness or temper, or to resistance to scratching, abrasion, or cutting. Indentation hardness may be measured by various hardness tests, such as Brinell, Rockwell, and Vickers.

H-band steel
Alloy steel produced to specified limits of hardenability; the chemical-composition range may be slightly different from that of the corresponding grade of ordinary alloy steel.

heat-affected zone
That portion of the base metal that was not melted during brazing, cutting, or welding, but whose microstructure and mechanical properties were altered by the heat.

hot isostatic pressing, hipping
A process for simultaneously heating and forming a powder-metallurgy compact in which metal powder, contained in a sealed flexible mold, is subjected to equal pressure from all directions at a temperature high enough for sintering to take place.

hot working
Deforming a metal plastically at a temperature and strain rate such that the recrystallization temperature is exceeded and recrystallization takes place simultaneously with the deformation, thus avoiding any strain hardening.

HSS, high-speed steel
Tool steel alloyed with tungsten and molybdenum. Permits cutting at higher speeds and feeds than carbon-steel tools because an HSS tool’s cutting edges don’t soften at temperatures that soften carbon steel.

induction hardening
A surface-hardening process in which only the surface layer of a suitable ferrous workpiece is heated by electromagnetic induction to above the upper critical temperature and immediately quenched.
inhibitor
A chemical substance or combination of substances that, when present in the environment, prevents or reduces corrosion without significant reaction with the components of the environment.

investment casting
1. Casting metal into a mold produced by surrounding (investing) an expandable pattern with a refractory slurry that sets at room temperature, after which the wax, plastic, or frozen-mercury pattern is removed through the use of heat. Also called precision casting or lost-wax process. 2. A part made by the investment-casting process.

ion nitriding
A surface-hardening process in which nitrogen ions are accelerated under an electric potential in a closed chamber and become embedded in the surface of the parts being treated, where they interact with minor constituents of the treated metal to form nitrogen compounds.

isothermal transformation
A change in phase that takes place at a constant temperature. The time required for transformation to be completed, and in some instances the time delay before transformation begins, depends on the amount of supercooling below (or superheating above) the equilibrium temperature for the same transformation.

killed steel
Steel treated with a strong deoxidizing agent such as silicon or aluminum to reduce the oxygen content so that no reaction occurs between carbon and oxygen during solidification.

Knoop hardness
Hardness rating for very thin materials and plated surfaces.

lost-wax process
An investment-casting process in which a wax pattern is used.

machinability, machinability rating
Determines acceptability of a tool for the workpiece to be machined. Indicates workpiece’s hardness, chemical composition and qualities, microstructure, propensity to workharden, elasticity, and propensity to be worked cold. In general, the harder a material, the higher its machinability rating. A material’s machinability also is impacted by the type and age of machine, its power and rigidity, and the cutting tool used.

malleable cast iron
A cast iron made by prolonged annealing of white cast iron in which decarburization or graphitization, or both, take place to eliminate some or all of the cementite. The graphite is in the form of temper carbon.

martensite
A generic term for microstructures formed by diffusion phase transformation in which the parent and product phases have a specific crystallographic relationship. Martensite is characterized by an acicular pattern in the microstructure in both ferrous and nonferrous alloys. In alloys where the solute atoms occupy interstitial positions in the martensitic lattice (such as carbon in iron), the structure is hard and highly strained; but where the solute atoms occupy substitutional positions (such as nickel in iron), the martensite is soft and ductile. The amount of high-temperature phase that transforms to martensite on cooling depends to a large extent on the lowest temperature attained, there being a rather distinct beginning temperature (Ms) and a temperature at which the transformation is essentially complete (Mf).

mechanical properties
The properties of a material that reveal its elastic and inelastic behavior when force is applied, thereby indicating its suitability for mechanical applications; for example, modulus of elasticity, tensile strength, elongation, hardness, and fatigue limit. Compare with physical properties.

microhardness
The hardness of a material as determined by forcing an indenter such as a Vickers or Knoop indenter into the surface of the material under very light load; usually, the indentations are so small that they must be measured with a microscope. Capable of determining hardness of different microconstituents within a structure, or measuring steep hardness gradients such as those encountered in casehardening.
microstructure
The structure of a metal as revealed by microscopic examination of the etched surface of a polished specimen.

mild steel
Carbon steel with a maximum of about 0.25% carbon.

modulus of elasticity
Measure of the relative elasticity or rigidity of a metal or material; established by stress/strain tests.

oxidation
1. A reaction in which there is an increase in valence resulting from a loss of electrons. Contrast with reduction. 2. A corrosion reaction in which the corroded metal forms an oxide; usually applied to a reaction with a gas containing elemental oxygen, such as air.

PCD, polycrystalline diamond
Natural or manufactured diamond crystals bonded together under high pressure at elevated temperatures; used for cutting nonferrous metals and nonmetallics. See diamond; Category IV: Cutting Tools and Related Terminology: superabrasive tools.

pearlite
A metastable lamellar aggregate of ferrite and cementite resulting from the transformation of austenite at temperatures above the bainite range.

peening
Mechanical working of a metal by hammer blows or shot impingement.

physical properties
Properties of a metal or alloy that are relatively insensitive to structure and can be measured without the application of force; for example, density, electrical conductivity, coefficient of thermal expansion, magnetic permeability, and lattice parameter. Does not include chemical reactivity. Compare with mechanical properties.

pitting
Localized corrosion of a metal surface, confined to a point or small area, that takes the form of cavities.

plastic deformation
The permanent (inelastic) distortion of metals under applied stresses that strain the material beyond its elastic limit.

PM, powder metallurgy
Processes in which metallic particles are fused under various combinations of heat and pressure to create solid metals.

PVD, physical vapor deposition
Tool-coating process performed at low temperature (500° C), compared to chemical vapor deposition (1000° C). Employs electric field to generate necessary heat for depositing coating 2µm to 7µm thick on a tool’s surface. See CVD, chemical vapor deposition.

recrystallization
1. The formation of a new, strain-free grain structure from that existing in cold-worked metal, usually accomplished by heating. 2. The change from one crystal structure to another, as occurs on heating or cooling through a critical temperature.

recrystallization temperature
The approximate minimum temperature at which complete recrystallization of a cold-worked metal occurs within a specified time.

red hardness
Ability of a cutting tool material to withstand high temperatures at the point of cut without softening and degrading.

refractory metal
A metal having an extremely high melting point; for example, tungsten, molybdenum, tantalum, niobium (columbium), chromium, vanadium, and rhenium. In the broad sense, this term refers to metals having melting points above the range of iron.
residual stress
Stress present in a body that is free of external forces or thermal gradients.

Rockwell hardness
Various scales for determining material hardness. Rockwell C, A, and D scales measure metal hardness. The Rockwell C, or RC, scale, and the Brinell hardness (Bhn) scale are used most often in connection with cutting tools and machining.

shear lip
A narrow, slanting ridge along the edge of a fracture surface. The term sometimes also denotes a narrow, often crescent-shaped, fibrous region at the edge of a fracture that is otherwise of the cleavage type, even though this fibrous region is in the same plane as the rest of the fracture surface.

shear strength
The stress required to produce fracture in the plane of cross section, the conditions of loading being such that the directions of force and of resistance are parallel and opposite although their paths are offset a specified minimum amount. The maximum load divided by the original cross-sectional area of a section separated by shear.

shot peening
Cold working the surface of a metal by metal-shot impingement.

single-crystal diamond
Industrial-grade, natural diamond. Not recommended for cutting ferrous materials because it tends to react chemically with them and break down. Also not recommended for interrupted cuts in hard materials. Replaced by polycrystalline diamond in many applications. See diamond; PCD, polycrystalline diamond; Category IV: Cutting Tools and Related Terminology: superabrasive tools.

sintering
The bonding of adjacent surfaces in a mass of particles by molecular or atomic attraction on heating at high temperatures below the melting temperature of any constituent in the material. Sintering strengthens and increases the density of a powder mass and recrystallizes powder metals.

sponge
A form of metal characterized by a porous condition that is the result of the decomposition or reduction of a compound without fusion. The term is applied to forms of iron, titanium, zirconium, uranium, plutonium, and the platinum-group metals.

steel
Basically pure iron in combination with carbon and other elements. There are two types of steel: carbon steel, or a combination of iron and carbon; and alloy steel, which is carbon steel plus manganese, molybdenum, chromium, nickel, or other alloying elements. A steel's quality depends on how it is refined and produced. See alloy; alloy steel; alloying element; carbon steel.

steel-specification number
A system of numbers developed by the AISI (American Iron and Steel Institute) and SAE (Society of Automotive Engineers) to identify steel. The first two digits in the code indicate the family and basic alloying elements. The final two digits indicate the approximate carbon content in hundredths of a percent. For steels with a carbon content above 1.00%, five digits are used. Numbers with L or S added indicate alloys incorporating lead or sulfur for improved machinability. A number of steels and alloys are identified under different codes, including tool steel, carbon tool steel, high-speed steel, die steel, stainless steel, strain-hardenable or workhardening steel, and nickel-base superalloys.

strain hardening
An increase in hardness and strength caused by plastic deformation at temperatures below the recrystallization range.

stress
Force per unit area, often thought of as force acting through a small area within a plane. It can be divided into components, normal and parallel to the plane, called normal stress and shear stress, respectively. True stress denotes the stress where force and area are measured at the same time. Conventional stress, as applied to tension and compression tests, is force divided by original area. Nominal stress is the stress computed by simple elasticity formulas, ignoring stress raisers and disregarding plastic flow; in a notch bend test, for example, it is bending moment divided by minimum section modulus.
striation
A fatigue fracture feature, often observed in electron micrographs, that indicates the position of the crack front after each succeeding cycle of stress. The distance between striations indicates the advance of the crack front across that crystal during one stress cycle, and a line normal to the striations indicates the direction of local crack propagation.

superalloys
Tough, hard-to-machine alloys; includes Hastelloy, Inconel, and Monel.

superplasticity
The ability of certain metals to undergo unusually large amounts of plastic deformation before local necking occurs.

tensile strength
In tensile testing, the ratio of maximum load to original cross-sectional area. Also called ultimate strength. Compare with yield strength.

TiC, titanium carbide
Extremely hard material added to tungsten carbide to reduce cratering and built-up edge. Also used as a tool coating. See coated tools.

TiN, titanium nitride
Added to titanium-carbide tooling to permit machining of hard metals at high speeds. Also used as a tool coating. See coated tools; TiC, titanium carbide.

tool steel
Any of a class of carbon and alloy steels commonly used to make tools. Tool steels are characterized by high hardness and resistance to abrasion, often accompanied by high toughness and resistance to softening at elevated temperatures. These attributes are generally attained with high carbon and alloy contents.

ultrasonic cleaning
A method of cleaning metal or plastic parts by immersing them in an aqueous or solvent-based cleaning solution and imposing ultrasound energy on the bath to enhance cleaning by creating cavitation conditions at the part surface, which imparts a strong scouring action to remove tenacious soils.

wear resistance
Ability of the tool to withstand stresses that cause it to wear during cutting; an attribute linked to alloy composition, base material, thermal conditions, type of tooling and operation, and other variables.

white cast iron
Cast iron that shows a white fracture because the carbon is in combined form.

yield point
The first stress in a material, usually less than the maximum attainable stress, at which an increase in strain occurs without an increase in stress. Only certain metals exhibit a yield point. If there is a decrease in stress after yielding, a distinction may be made between upper and lower yield points.

yield strength
The stress at which a material exhibits a specified deviation from proportionality of stress and strain. An offset of 0.2% is used for many metals. Compare with tensile strength.