~~Designation:A 941–06a~~ Designation: A941 – 09

Standard Terminology Relating to Steel, Stainless Steel, Related Alloys, and Ferroalloys[1]

This standard is issued under the fixed designation A941; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope*

1.1 This standard is a compilation of definitions of terms related to steel, stainless steel, related alloys, and ferroalloys.

1.2 When a term is used in an ASTM document for which Committee A01 is responsible, it is included herein only when judged, after review by Subcommittee A01.92, to be a generally usable term.

1.3 Some definitions include a discussion section, which is a mandatory part of the definition and contains additional information that is relevant to the meaning of the defined term.

1.4 Definitions of terms specific to a particular standard will appear in that standard and will supersede any definitions of identical terms in this standard.

2. Referenced Documents

2.1 *ASTM Standards:*[2]

E112 Test Methods for Determining Average Grain Size

3. Terminology

3.1 *Definitions of General Terms:*

age hardening, *n*—see **precipitation hardening**.

alloy steel, *n*—a **steel**, other than a **stainless steel**, that conforms to a specification that requires one or more of the following elements, by mass percent, to have a minimum content equal to or greater than: 0.30 for aluminum; 0.0008 for boron; 0.30 for chromium; 0.30 for cobalt; 0.40 for copper; 0.40 for lead; 1.65 for manganese; 0.08 for molybdenum; 0.30 for nickel; 0.06 for niobium (columbium); 0.60 for silicon; 0.05 for titanium; 0.30 for tungsten (wolfram); 0.10 for vanadium; 0.05 for zirconium; or 0.10 for any other alloying element, except sulphur, phosphorus, carbon, and nitrogen.

capped steel, *n*—a **rimmed steel** in which, during ingot solidification, the rimming action was limited by mechanical or chemical means.

carbon steel, *n*—a **steel** that conforms to a specification that prescribes a maximum limit, by **heat analysis** in mass percent, of not more than: 2.00 for carbon and 1.65 for manganese, but does not prescribe a minimum limit for chromium, cobalt, molybdenum, nickel, niobium (columbium), tungsten (wolfram), vanadium, or zirconium.

DISCUSSION—Except as required above, it is permissible for carbon steel specifications to prescribe limits (minimum or maximum, or both) for each specified alloying element, subject to the following restrictions for the heat analysis limits in mass percent:
(a) for wrought carbon steel products, the specified maximum limit is not to exceed: 0.10 for aluminum, 0.60 for silicon, and 0.050 for titanium;
(b) for carbon steel castings, the specified maximum limit is not to exceed: 0.10 for aluminum, 1.00 for silicon, and 0.050 for titanium.
(c) for **carbon steels** that are required to be rephosphorized, the specified minimum limit for phosphorus is not to be less than 0.040;
(d) for **carbon steels** that are required to be resulfurized, the specified minimum limit for sulfur is not to be less than 0.060;
(e) for **carbon steels** that are not required to be rephosphorized or resulfurized, the specified maximum limit is not to exceed: 0.60 for copper, 0.050 for phosphorus, and 0.060 for sulfur; and
(f) for **carbon steels** that are required to contain boron, copper, or lead, the specified minimum limit is not to exceed: 0.0005 for boron, 0.35 for copper, and 0.25 for lead.

cast analysis—Deprecated term. Use the preferred term **heat analysis**.

certificate of compliance, *n—in manufactured products*, a document that states that the product was manufactured, sampled, tested, and inspected in accordance with the requirements of the specification (including year of issue) and any other

[1] This terminology is under the jurisdiction of ASTM Committee A01 on Steel, Stainless Steel and Related Alloys and is the direct responsibility of Subcommittee A01.92 on Terminology.

~~Current edition approved June 15, 2006. Published July 2006. Originally approved in 1995. Last previous edition approved in 2006 as A 941–06.~~
Current edition approved April 1, 2009. Published May 2009. Originally approved in 1995. Last previous edition approved in 2006 as A941 – 06a. DOI: 10.1520/A0941-09.

[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

***A Summary of Changes section appears at the end of this standard.**

requirements specified in the purchase order or contract, and has been found to meet such requirements.

DISCUSSION—A single document, containing test report information and certificate of compliance information, may be used.

certifying organization, *n—in product specifications*, the entity responsible for the conformance and certification of the product to the specification requirements.

check analysis—Deprecated term. Use the preferred term **product analysis**.

coarse grain practice, *n*—a steelmaking practice for other than **stainless steel** that is intended to produce a **killed steel** in which aluminum, niobium (columbium), titanium, and vanadium are **residual elements**.

cold working, *n*—mechanical deformation of a metal at temperatures below its **recrystallization temperature**.

defect, *n*—an imperfection of sufficient magnitude to warrant rejection based on the specified requirements.

direct quenching, *n—in thermomechanical processing*, **quenching** immediately following the final hot deformation.

document, *n*—a written, printed, or electronic record that provides information, evidence, or official statements.

electronic data interchange, *n*—the computer to computer exchange of business information in a standardized format.

ellipsis, *n—in a tabular entry*, three periods (...) that indicate that there is no requirement.

ferroalloy, *n*—an alloy of iron and one or more other metals, for use as an addition to the molten metal during the manufacture of **steels**, nickel alloys, or cobalt alloys.

fine grain practice, *n*—a steelmaking practice for other than **stainless steel** that is intended to produce a **killed steel** that is capable of meeting the requirements specified for fine austenitic grain size.

DISCUSSION—It normally involves the addition of one or more austenitic grain refining elements in amounts that have been established by the steel producer as being sufficient. Austenitic grain refining elements include, but are not limited to, aluminum, niobium (columbium), titanium, and vanadium.

grain size, *n*—the dimensions of the grains or crystals in a polycrystalline metal, exclusive of twinned regions and subgrains when present.

DISCUSSION—**Grain size** is usually estimated or measured on the cross section of an aggregate of grains, and designated by an ASTM grain size number. (See Test Methods ~~E 112~~E112.)

heat, *n*—a generic term denoting a specific **lot** of **steel**, based upon steelmaking and casting considerations.

DISCUSSION—Where it is necessary to be more definitive, the following more specific terms are used: **primary heat**, **multiple heat**, and **remelted heat**. In product specifications, the term **heat** generally is used, without qualification, to mean the **primary**, **multiple**, or **remelted heat**, whichever is applicable.

heat analysis, *n*—the chemical analysis determined by the steel producer as being representative of a specific **heat** of **steel**.

DISCUSSION—Where the analysis reported by the steel producer is not sufficiently complete for conformance with the heat analysis requirements of the applicable product specification to be fully assessed, the **manufacturer** may complete the assessment of conformance with such heat analysis requirements by using a product analysis for the **specified elements** that were not reported by the steel producer, provided that product analysis tolerances are not applied and the **heat analysis** is not altered.

heat number, *n*—the alpha, numeric, or alphanumeric designator used to identify a specific **heat** of **steel**.

high-strength low-alloy steel, *n*—a **steel**, other than a **carbon steel** or an **interstitial-free steel**, that conforms to a specification that requires the minimum content for each specified alloying element to be lower than the applicable limit in the definition for **alloy steel**, and the yield point or yield strength of the product to be at least 36 ksi or 250 MPa.

hot-cold working, *n*—the mechanical deformation of austenitic and precipitation hardening steels at a temperature just below the **recrystallization temperature** to increase the yield strength and hardness by plastic deformation or precipitation hardening effects induced by plastic deformation, or both.

hot working, *n*—mechanical deformation of a metal at temperatures above its **recrystallization temperature**.

imperfection, *n*—a material discontinuity or irregularity that is detectable by **inspection**.

inclusion shape control, *n*—the addition of elements during steel making in order to affect the inclusion morphology.

inspection, *n*—the process of measuring, examining, testing, gaging, or otherwise comparing the unit of product with the applicable requirements.

interstitial-free steel, *n*—a **steel** that has essentially all of its carbon and nitrogen chemically combined with stabilization elements rather than being present interstitially.

DISCUSSION—The heat analysis limits (minimum or maximum, or both) that are permitted to be prescribed in interstitial-free steel specifications are as given in the definition for **carbon steel**, except that the 0.050 % maximum limit for titanium does not apply.

killed steel, *n*—a **steel** deoxidized to such a level that essentially no reaction occurred between carbon and oxygen during solidification.

laser beam welding, *n*—a welding process that uses a laser beam as the heat source.

lot, *n*—a definite quantity of product manufactured under conditions that are considered uniform.

low-alloy steel, *n*—a **steel**, other than a **carbon steel** or an **interstitial-free steel**, that conforms to a specification that requires the

minimum content for each specified alloying element to be lower than the applicable limit in the definition for **alloy steel**.

manufacturer, *n*—the organization responsible for the conversion of materials into products meeting the requirements of a product specification.

microalloyed steel, *n*—a **low-alloy steel** that conforms to a specification that requires the presence of one or more carbide-, nitride-, or carbonitride-forming elements, generally in individual concentrations less than 0.15 mass percent, to enhance strength.

DISCUSSION—The most common microalloying elements are niobium (columbium), titanium, and vanadium.

multiple heat, *n*—two or more molten **primary heats**, in whole or in part, combined in a common ladle or in a common non-oscillating mold.

DISCUSSION—A **multiple heat** is identified by a single **heat number** representative of the **multiple heat**, or by the individual **heat numbers** of the **primary heats** contained in the **multiple heat**. The **heat analysis** of a **multiple heat** identified by a single **heat number** is the weighted average analysis of the individual **primary heats** contained in the **multiple heat**. Two or more molten **primary heats** sequentially strand cast (poured into an oscillating mold) constitute a series of individual **heats**, not a **multiple heat**.

nickel alloy, *n*—a material that conforms to a specification that requires by mass percent more nickel than any other element.

DISCUSSION—In castings, the nickel content requirement is not normally stated in the specification and is not normally determined by chemical analysis, but is taken to be 100 % minus the sum of the mean values permitted by the specification for all other elements having a specified range or a specified maximum.

plate-as-rolled, *n*—the quantity of plate product rolled at one time, either from an individual slab or directly from an ingot.

DISCUSSION—This term does not refer to the surface condition or the heat-treatment state of the material; a **plate-as-rolled** may be in the as-rolled condition, or may have received one or more surface treatments or **heat treatments**, or both.

primary heat, *n*—the product of a single cycle of a batch melting process.

DISCUSSION—In the investment casting industry, the term *master heat* is used.

product analysis, *n*—a chemical analysis of a specimen taken from the semi-finished product or the finished product.

remelted heat, *n*—the product of the remelting of a **primary heat**, in whole or in part.

DISCUSSION—In the investment casting industry, the term *sub-heat* is used.

residual element, *n*—*in* ***steel***, a specified or unspecified element, not intentionally added, originating in the raw materials, refractories, or surrounding atmospheres used in steel making.

rimmed steel, *n*—a **steel** that contained sufficient oxygen to generate carbon monoxide at the boundary between the solid metal and the remaining molten metal during solidification, resulting in an outer layer low in carbon.

semikilled steel, *n*—an incompletely deoxidized **steel** that contained sufficient oxygen to form enough entrapped carbon monoxide during solidification to offset solidification shrinkage.

specified element, *n*—*in* ***steel***, an element controlled to a specified minimum, maximum, or range, in accordance with the requirements of the applicable product specification.

stabilized stainless steel, *n*—a **stainless steel** that conforms to a specification that prescribes limits (minimum or range) for niobium (columbium), tantalum, titanium, or a combination thereof.

DISCUSSION—Such limits are sometimes expressed as a function of the carbon and nitrogen contents. In an appropriately annealed condition, a **stabilized stainless steel** will resist sensitization to intergranular corrosion associated with the precipitation of chromium carbide at grain boundaries as a result of thermal exposure, such as **annealing, stress relieving**, welding, or high temperature service. Resistance to sensitization to intergranular corrosion is dependent upon the corrosivity of the environment. The condition of being stabilized with respect to sensitization is frequently demonstrated by passing one or more standard corrosion tests for sensitization.

stainless steel, *n*—a **steel** that conforms to a specification that requires, by mass percent, a minimum chromium content of 10.5 or more, and a maximum carbon content of less than 1.20.

steel, *n*—a material that conforms to a specification that requires, by mass percent, more iron than any other element and a maximum carbon content of generally less than 2.

DISCUSSION—The iron content requirement is not normally stated in the specification and is not normally determined by chemical analysis, but is taken to be 100 % minus the sum of the mean values permitted by the specification for all other elements having a specified range or a specified maximum. For conformance purposes, this calculated value for iron is compared on an individual basis to the mean values permitted by the specification for each of the other elements having a specified range or a specified maximum. Some chromium-containing steels may contain more than 2 % carbon; however, 2 % carbon is generally considered to be the demarcation between **steel** and cast iron.

strain hardening, *n*—an increase in hardness and strength of a metal caused by plastic deformation at temperatures below its **recrystallization temperature**. (Syn. *work hardening*)

test record, *n*—a document or electronic record that contains the observations and derived data obtained by applying a given test method.

test report, *n*—a document that presents the applicable qualitative or quantitative results obtained by applying one or more given test methods.

DISCUSSION—A single document, containing test report information and certificate of compliance information, may be used.

unspecified element, *n*—*in* ***steel***, an element not controlled to a specified minimum, maximum, or range, in accordance with the requirements of the applicable product specification.

3.2 *Definitions of Terms Relating to Heat Treatment of Steels:*

Ac_{cm}, Ac_1, Ac_3, Ac_4—See **transformation temperature**.

Ae_{cm}, Ae_1, Ae_3, Ae_4—See **transformation temperature**.

age hardening, *n*—hardening by **aging**, usually after rapid cooling or **cold working**.

aging, *n*—a change in the properties of certain **steels** that occurs at ambient or moderately elevated temperatures after hot working or a heat treatment (**quench aging, natural aging,** or **artificial aging**) or after a cold-working operation (**strain aging**).

DISCUSSION—The change in properties is often, but not always, due to **precipitation hardening**, but never involves a change in the chemical composition of the **steel**.

annealing, *n*—a generic term covering any of several **heat treatments**.

DISCUSSION—This treatment is used for purposes such as reducing hardness, improving machinability, facilitating **cold working**, producing a desired microstructure, or obtaining desired mechanical, physical, or other properties. Where applicable, it is preferred that the following more specific terms be used: **box annealing, bright annealing, flame annealing, full annealing, graphitization annealing, intermediate annealing, isothermal annealing, process annealing, recrystallization annealing, spheroidizing**, and **subcritical annealing**. The term "**annealing**," without qualification, implies **full annealing**. Any process of **annealing** will usually reduce stresses; however, if the treatment is applied for the sole purpose of stress reduction, it should be designated **stress relieving**.

Ar_{cm}, Ar_1, Ar_3, Ar_4—See **transformation temperature**.

artificial aging, *n*—**aging** above room temperature.

austempering, *n*—**heat treatment** involving **quenching** a steel object from a temperature above the **transformation range** in a medium maintained at a temperature above the **martensite range** sufficiently fast to avoid the formation of high temperature transformation products, and then holding it at that temperature until transformation is complete.

austenitizing, *n*—forming austenite by heating a steel object above the **transformation range**.

baking, *n*—heating to a low temperature in order to remove gases.

batch furnace, *n*—a heating device within which steel objects are held stationary or oscillated during the thermal processing cycle.

blank carburizing, *n*—simulating the **carburizing** operation without introducing carbon.

DISCUSSION—This is usually accomplished by using an inert material in place of the carburizing agent, or by applying a suitable protective coating on the object being heat treated.

blank nitriding, *n*—simulating the nitriding operation without introducing nitrogen.

DISCUSSION—This is usually accomplished by using an inert material in place of the nitriding agent, or by applying a suitable protective coating on the object being heat treated.

bluing, *n*—subjecting the scale-free surface of a steel object to the action of air, steam, or other agents at a suitable temperature, thereby forming a thin blue film of oxide and improving the object's appearance and corrosion resistance.

DISCUSSION—This term is ordinarily applied to sheet, strip, or finished parts. It is used also to denote the heating of springs after fabrication in order to improve their properties.

box annealing, *n*—**annealing** in a sealed container under conditions that minimize oxidation.

DISCUSSION—The charge is usually heated slowly to a temperature below the **transformation range**, but sometimes above or within it, and is then cooled slowly.

bright annealing, *n*—**annealing** in a protective medium to prevent discoloration of the bright surface.

carbon potential, *n*—the carbon content at the surface of a specimen of pure iron in equilibrium with the carburizing medium considered, and under the conditions specified.

carbon restoration, *n*—replacing the carbon lost from the surface layer in previous processing by carburizing this layer to substantially the original carbon level.

carbonitriding, *n*—**case hardening** in which a suitable steel object is heated above Ac_1 in a gaseous atmosphere of such composition as to cause simultaneous absorption of carbon and nitrogen by the surface and, by diffusion, to create a concentration gradient.

carburizing, *n*—a process in which an austenitized steel object is brought into contact with a carbonaceous environment of sufficient carbon potential to cause absorption of carbon at the surface and, by diffusion, to create a concentration gradient.

case, *n*—*in case hardening*, the outer portion that has been made harder than the **core** as a result of altered composition or microstructure, or both, from treatments such as **carburizing, nitriding**, and **induction hardening**.