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## Standard Terminology of Powder Metallurgy<sup>1</sup>

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### 1. Scope

1.1 This terminology standard includes definitions that are helpful in the interpretation and application of powder metallurgy terms.

### 2. Referenced Documents

#### 2.1 ASTM Standards:

B 331 Test Method for Compressibility of Metal Powders in Uniaxial Compaction<sup>2</sup>

### 3. Terminology

3.1 *Powder*—Terms associated with production, characterization, use, and testing of metal powders.

#### 3.1.1 Table of Contents

##### 1. Powders:

- 1.0 General, 3.1.2
- 1.1 Processes to Produce Powder, 3.1.3
- 1.2 Types of Powder, 3.1.4
- 1.3 Shapes of Powder Particles, 3.1.5
- 1.4 Additives to Powder, 3.1.6
- 1.5 Treatment of Powder, 3.1.7
- 1.6 Properties of Powder, 3.1.8
- 1.7 Procedures to Evaluate Powder, 3.1.9
- 1.8 Equipment to Evaluate Powder, 3.1.10

##### 2. Forming:

- 2.0 General, 3.2.1
- 2.1 Processes for Compacting, 3.2.2
- 2.2 Conditions of Compacting, 3.2.3
- 2.3 Tools Used for Compacting, 3.2.4
- 2.4 Phenomena Resulting from Compaction, 3.2.5
- 2.5 Properties of Compacts, 3.2.6
- 2.6 Forging, 3.2.7

2.7 Metal Injection Molding, 3.2.8

#### 3. Sintering:

- 3.1 Process for Sintering, 3.3.1
- 3.2 Conditions During Sintering, 3.3.2
- 3.3 Phenomena Resulting from Sintering, 3.3.3
- 3.4 Properties of Sintered Parts, 3.3.4
- 3.5 Procedure to Evaluate Sintered Parts, 3.3.5
- 3.6 Removal of Binders, 3.3.6

#### 4. Postsinter Treatments:

- 4.1 Processes, 3.4.1

#### 5. Miscellaneous:

- 5.1 Definitions, 3.5.1
- 5.2 Processes, 3.5.2
- 5.3 Materials, 3.5.3

##### 3.1.2 General:

**1001 agglomerate, n**—several particles adhering together.

**1002 particulate matter, n**—see **powder**.

**1003 P/M, n**—the acronym representing powder metallurgy. Used as **P/M Part**, **P/M Product**, **P/M Process**, and so forth.

**1004 powder metallurgy, n**—the production and utilization of metal powders.

**1005 powder, n**—particles that are usually less than 1000  $\mu\text{m}$  (1 mm) in size.

**1006 metal powder, n**—particles of elemental metals or alloys, normally less than 1000  $\mu\text{m}$  (1 mm) in size.

##### 3.1.3 Processes to Produce Powder:

**1101 atomization, n**—the dispersion of a molten metal into particles by a rapidly moving gas or liquid stream or by mechanical means.

**1102 granulation, n**—the production of coarse metal particles by pouring the molten metal through a screen into water (shotting) or by violent agitation of the molten metal while solidifying.

**1103 classification, n**—separation of a powder into fractions according to particle size.

**1104 air classification, n**—the separation of powder into particle size fractions by means of an air stream of controlled velocity.

<sup>1</sup> This terminology is under the jurisdiction of ASTM Committee B09 on Metal Powders and Metal Powder Products and is the direct responsibility of Subcommittee B09.01 on Nomenclature and Technical Data.

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<sup>2</sup> 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.

**1105 gas classification, n**—the separation of powder into particle size fractions by means of a gas stream of controlled velocity.

**1106 chemical deposition, n**—the precipitation of one metal from a solution of its salts by the addition of another metal or reagent to the solution.

**1107 chemically precipitated metal powder, n**—powder produced by the reduction of a metal from a solution of its salts either by the addition of another metal higher in the electro-motive series or by other reducing agent.

**1108 reduced metal powder, n**—metal powder produced, without melting, by the chemical reduction of metal oxides or other compounds.

**1109 disintegration, n**—the reduction of massive material to powder.

**1110 milling, n**—the mechanical treatment of metal powder, or metal powder mixtures, as in a ball mill, to alter the size or shape of the individual particles or to coat one component of the mixture with another.

**1111 pulverization, n**—the reduction in particle size of metal powder by mechanical means, a specific type of disintegration.

#### 3.1.4 *Types of Powder:*

**1201 atomized metal powder, n**—metal powder produced by the dispersion of a molten metal by a rapidly moving gas, or liquid stream, or by mechanical dispersion.

**1202 electrolytic powder, n**—powder produced by electrolytic deposition or by the pulverization of an electrodeposit.

**1203 dendritic powder, n**—particles, usually of electrolytic origin, having the typical pine tree structure.

**1204 carbonyl powder, n**—a metal powder prepared by the thermal decomposition of a metal carbonyl.

**1205 master-alloy powder, n**—a powder with high alloy concentration, designed to be diluted when mixed with a base powder to produce the desired composition.

**1206 pre-alloyed powder, n**—powder composed of two or more elements that are alloyed in the powder manufacturing process in which the particles are of the same nominal composition throughout. Synonymous with **completely alloyed powder**.

**1207 completely alloyed powder, n**—see **pre-alloyed powder**.

**1208 partially alloyed powder, n**—a powder in which the alloy addition or additions are metallurgically bonded to an elemental or pre-alloyed powder.

**1209 diffusion-alloyed powder, n**—a partially alloyed powder produced by means of a diffusion anneal.

**1210 mechanically alloyed powder, n**—a composite powder produced by mechanically incorporating other constituents which are generally insoluble within the deformable particles of the matrix metal.

**1211 matrix metal, n**—the continuous phase of a polyphase alloy or mechanical mixture; the physically continuous metallic constituent in which separate particles of another constituent are embedded.

**1212 composite powder, n**—a powder in which each particle consists of two or more distinct constituents.

**1213 spongy, n**—a porous condition in metal powder particles usually observed in reduced oxides.

**1214 sponge iron, n**—a coherent, porous mass of substantially pure iron produced by solid-state reduction of iron oxide (for example, iron ore or mill scale).

**1215 sponge iron powder, n**—ground and sized sponge iron, which may have been purified or annealed or both.

**1216 mixed powder, n**—a powder made by mixing two or more powders as uniformly as possible. The constituent powders will differ in chemical composition or in particle size or shape, or a combination thereof.

**1217 premix, n**—a uniform mixture of ingredients to a prescribed analysis, prepared by the powder producer, for direct use in compacting powder metallurgy products.

#### 3.1.5 *Shapes of Powder Particles:*

**1301 acicular powder, n**—needle-shaped particles.

**1302 needles, n**—elongated rod-like particles.

**1303 granular powder, n**—particles having approximately equidimensional nonspherical shapes.

**1304 nodular powder, n**—irregular particles having knotted, rounded, or similar shapes.

**1305 irregular powder, n**—particles lacking symmetry.

**1306 spherical powder, n**—globular-shaped particles.

**1307 flake powder, n**—flat or scale-like particles whose thickness is small compared with the other dimensions.

**1308 plates, n**—flat particles of metal powder having considerable thickness.

#### 3.1.6 *Additives to Powder:*

**1401 binder, n**—a cementing medium; either a material added to the powder to increase the green strength of the compact, and which is expelled during sintering; or a material (usually of relatively lower melting point) added to a powder mixture for the specific purpose of cementing together powder particles which alone would not sinter into a strong body.

**1402 feedstock, n**—*in metal injection molding (MIM)*, a moldable mixture of metal powder and binder.

**1403 powder lubricant, n**—an agent mixed with or incorporated in a powder to facilitate the pressing and ejecting of the compact.

**1404 dispersion-strengthened material, n**—a material consisting of a metal and finely dispersed, substantially insoluble, metallic or nonmetallic phase.

**1405 pore-forming material, n**—a substance included in a powder mixture that volatilizes during sintering and thereby produces a desired kind and degree of porosity in the finished compact.

#### 3.1.7 *Treatment of Powder:*

**1501 blending, n**—the thorough intermingling of powders of the same nominal composition (not to be confused with mixing).

**1502 equalizing, n**—see **blending**.

**1503 mixing, n**—the thorough intermingling of powders of two or more materials.

**1504 cross-product contamination, n**—the unintentional mixing of powders with distinct differences in either physical characteristics or chemical composition or both.

**1505 lubricating, n**—mixing with, or incorporating in, a powder, some agent to facilitate pressing and ejecting the compact from the die body; applying a lubricant to the die walls and punch surfaces.

### 3.1.8 *Properties of Powder:*

**1601 apparent density, n**—the mass of a unit volume of powder, usually expressed as grams per cubic centimetre, determined by a specified method.

**1602 bulk density, n**—the mass per unit volume of a powder under nonstandard conditions, for example, in a shipping container (not to be confused with apparent density).

**1603 tap density, n**—the apparent density of the powder in a container that has been tapped under specified conditions.

**1604 flow rate, n**—the time required for a powder sample of standard weight to flow through an orifice in a standard instrument according to a specified procedure.

**1605 specific surface, n**—the surface area of one gram of powder, usually expressed in square centimetres.

**1606 compactibility, n**—a conceptual term, encompassing the powder characteristics of compressibility, green strength, edge retention, and lamination tendency, that relates to the ability of a powder to be consolidated into a usable green compact.

**1607 compressibility, n**—the capacity of a metal powder to be densified under a uniaxially applied pressure in a closed die.

*DISCUSSION*—Compressibility is measured in accordance with Test Method B 331 and may be expressed numerically as the pressure to reach a specified density, or alternatively the density at a given pressure.<sup>3</sup>

**1608 compression ratio, n**—the ratio of the volume of the loose powder to the volume of the compact made from it. Synonymous with **fill ratio**.

**1609 fill ratio, n**—see **compression ratio**.

**1610 oversize powder, n**—particles coarser than the maximum permitted by a given particle size specification.

**1611 plus sieve, n**—the portion of a powder sample retained on a standard sieve of specified number. (See **minus sieve**.)

**1612 minus sieve, n**—the portion of a powder sample which passes through a standard sieve of specified number. (See **plus sieve**.)

**1613 fines, n**—the portion of a powder composed of particles which are smaller than a specified size, currently less than 44  $\mu\text{m}$ . See also **superfines**.

**1614 superfines, n**—the portion of a powder composed of particles that are smaller than a specified size, currently less than 10  $\mu\text{m}$ .

**1615 fraction, n**—that portion of a powder sample that lies between two stated particle sizes. Synonymous with **cut**.

**1616 cut, n**—see **fraction**.

**1617 subsieve fraction, n**—particles all of which will pass through a 44- $\mu\text{m}$  (No. 325) standard sieve.

**1618 sieve fraction, n**—that portion of a powder sample that passes through a standard sieve of specified number and is retained by some finer sieve of specified number.

**1619 particle size, n**—the controlling linear dimension of an individual particle as determined by analysis with sieves or other suitable means.

**1620 particle size distribution, n**—the percentage by weight, or by number, of each fraction into which a powder sample has been classified with respect to sieve number or microns. (Preferred usage: “particle size distribution by frequency.”)

**1621 hydrogen loss, n**—the loss in weight of metal powder or of a compact caused by heating a representative sample for a specified time and temperature in a purified hydrogen atmosphere—broadly, a measure of the oxygen content of the sample when applied to materials containing only such oxides as are reducible with hydrogen and no hydride-forming element.

### 3.1.9 *Procedures to Evaluate Powder:*

**1701 sieve analysis, n**—particle size distribution; usually expressed as the weight percentage retained upon each of a series of standard sieves of decreasing size and the percentage passed by the sieve of finest size. Synonymous with **screen analysis**.

**1702 screen analysis, n**—see **sieve analysis**.

**1703 sieve classification, n**—the separation of powder into particle size ranges by the use of a series of graded sieves.

### 3.1.10 *Equipment to Evaluate Powder:*

**1801 powder flow meter, n**—an instrument for measuring the rate of flow of a powder according to a specified procedure.

**1802 mesh, n**—the number of openings per linear inch of screen.

**3.2 Forming**—Terms associated with consolidation of metal powders and mixes, including tooling, equipment, and characterization of sintered compacts.

#### 3.2.1 *General:*

**2001 green**—unsintered (not sintered); for example, green compact, green density, green strength.

**2002 preforming**—the initial pressing of a metal powder to form a compact that is subjected to a subsequent pressing operation other than coining or sizing. Also, the preliminary shaping of a refractory metal compact after presintering and before the final sintering.

**2003 blank, n**—a pressed, presintered, or fully sintered compact, usually in the unfinished condition, requiring cutting, machining, or some other operation to give it its final shape.

**2004 briquet, n**—see **compact**.

**2005 compact, n**—an object produced by the compression of metal powder, generally while confined in a die, with or without the inclusion of nonmetallic constituents. Synonymous with **briquet**.

**2006 pressed bar, n**—a compact in the form of a bar; a green compact.

<sup>3</sup> See Test Method B 331.

**2007 rolled compact, n**—a compact made by passing metal powder continuously through a rolling mill so as to form relatively long sheets of pressed material.

**2008 composite compact, n**—a metal powder compact consisting of two or more adhering layers, rings, or other shapes of different metals or alloys with each material retaining its original identity.

**2009 compound compact, n**—a metal powder compact consisting of mixed metals, the particles of which are joined by pressing or sintering or both, with each metal particle retaining substantially its original composition.

### 3.2.2 Processes for Compacting:

**2101 molding, v**—the pressing of powder to form a compact.

**2102 press, v**—to apply force to a mass of powder, generally while confined in a die or container, to form a compact.

**2103 double press-double sinter, n**—to repress and sinter a previously presintered or sintered compact.

DISCUSSION—Used to describe a four-step manufacturing process.

**2104 single-action pressing, n**—a method by which a powder is pressed in a stationary die between one moving and one fixed punch.

DISCUSSION—Only during ejection does either the stationary die or punch move.

**2105 double-action pressing, n**—a method by which a powder is pressed in a die between opposing moving punches.

**2106 withdrawal pressing, n**—a powder consolidation method in which the die moves downward in relation to the lower punch(es) during compaction. It further descends over the fixed lower punch(es) for ejection, so that the compact may then be pushed off the tooling at this point.

**2107 multiple pressing, n**—a method of pressing whereby two or more compacts are produced simultaneously in separate die cavities.

**2108 roll compacting, n**—the progressive compacting of metal powders by the use of a rolling mill. Synonymous with **powder rolling**.

**2109 powder rolling, n**—see **roll compacting**.

**2110 cold pressing, n**—the forming of a compact at room temperature.

### 3.2.3 Conditions for Compacting:

**2201 die lubricant, n**—a lubricant applied to the walls of the die and to the punches to facilitate the pressing and ejection of the compact.

DISCUSSION—Contrast with **powder lubricant**. Synonymous with **die-wall lubricant**.

**2202 die-wall lubricant, n**—synonymous with **die lubricant**.

### 3.2.4 Tools Used for Compacting:

**2301 mold, n**—in metal or powder injection molding, the member of the tooling into which the powder and binder mixture is forced, and the configuration of which forms the

surfaces of the green part. In isostatic compacting, a mold is also the confining form in which powder is isostatically compacted.

**2302 compacting tool set, n**—an assembly of tooling items in which powder is pressed.

DISCUSSION—May include a die, punches, and core rods.

**2303 die, n**—a member of the compacting tool set forming the cavity in which the powder is compacted or a P/M compact is repressed.

**2304 die body, n**—the stationary or fixed part of a die.

**2305 die set, n**—the parts of a press that hold and locate the die in proper relation to the punches.

**2306 core rod, n**—a member of the compacting tool set that forms internal features such as splines, diameters, keyways, or other profiles in a P/M compact.

**2307 punch, n**—a member of a compacting tool set used to close the die cavity and transmit the applied pressure to the powder or P/M compact.

DISCUSSION—Multiple upper or lower punches may be needed to compact multilevel parts.

**2308 stripper punch, n**—a punch that, in addition to forming the top or bottom of the die cavity, later moves further into the die to eject the compact.

**2309 split die, n**—a die made of parts that can be separated for ready removal of the compact.

**2310 die insert, n**—a removable liner or part of a die body.

**2311 segment die, n**—a die fabricated by the assembly of several die sections within a retaining bolster or shrinkage ring.

**2312 rotary press, n**—a machine fitted with a rotating table carrying multiple dies in which a material is pressed.

### 3.2.5 Phenomena Resulting from Compaction:

**2401 bridging, v**—the formation of arched cavities in a powder mass.

**2402 green, adj**—unsintered (not sintered); for example, green compact, green density, green strength.

**2403 springback, n**—see **green expansion**.

**2404 cold welding, n**—cohesion between two surfaces of metal, generally under the influence of externally applied pressure, at room temperature.

DISCUSSION—Often used to describe the mechanism by which powder particles develop initial bonds and a pressed compact develops green strength.

### 3.2.6 Properties of Compacts:

**2501 green density, n**—the mass per unit volume of an unsintered compact.

**2502 pressed density, n**—synonymous with **green density**.

**2503 green expansion, n**—the increase in dimensions of an ejected compact relative to the die dimensions, measured at right angles to the direction of pressing. Synonymous with **springback**.

### 3.2.7 Forging:

**2601 powder forging (P/F), n**—densification by forging of an unsintered, presintered, or sintered preform made from powder.

DISCUSSION—In the case in which the preform has been sintered, the process is often referred to as “sinter forging.”

**2602 P/F, v**—the acronym for powder forging. See **powder forging**.

**2603 P/M forging, v**—see **powder forging**.

**2604 P/M hot forming, v**—see **powder forging**.

**2605 preform, n**—a blank intended to be subject to deformation and densification involving a change of shape.

**2606 sinter forging, n**—powder forging using sintered preforms.

**2608 hot forging, v**—see **powder forging**.

**2610 hot upset powder forging, n**—hot densification of a P/M preform by forging where there is a significant amount of lateral material flow.

**2611 hot repressed powder forging, n**—hot densification of a P/M preform by forging where material flow is mainly in the direction of pressing.

### 3.2.8 Metal Injection Molding:

**2701 metal injection molding (MIM), n**—a process in which a mixture of metal powders and a binder system is forced under pressure into a mold. See also **powder injection molding**.

**2702 MIM**—see **metal injection molding**.

**2703 powder injection molding (PIM), n**—a process in which a mixture of powders and a binder system is forced under pressure into a mold. See also **metal injection molding**.

**2704 PIM**—see **powder injection molding**.

**3.3 Sintering**—Terms associated with forming a metallic bond among particles including processes, equipment, and characterization of sintered compacts.

### 3.3.1 Processes for Sintering:

**3101 sinter, v**—to increase the bonding in a mass of powder or a compact by heating below the melting point of the main constituent.

**3102 solid-state sintering, v**—sintering of a powder or compact without formation of a liquid phase.

**3103 presintering, v**—the heating of a compact at a temperature below the normal final sintering temperature, usually to increase the ease of handling or shaping the compact, or to remove a lubricant or binder before sintering.

**3104 activated sintering, v**—a sintering process during which the rate of sintering is increased, for example, by addition of a substance to the powder or by changing sintering conditions.

**3105 continuous sintering, v**—presintering, or sintering, in such manner that the objects are advanced through the furnace at a fixed rate by manual or mechanical means. Synonymous with **stoking**.

**3106 stoking, v**—see **continuous sintering**.

**3107 liquid phase sintering, v**—sintering of a compact, or loose powder aggregate, under conditions in which a liquid phase is present during part of the sintering cycle.

**3108 infiltration, n**—a process of filling the pores of a sintered, or unsintered, compact with a metal or alloy of lower melting point.

**3109 nitrogen alloying, n**—the transfer of nitrogen from a furnace atmosphere to powder or a P/M part, in such a way as to increase the nitrogen content of the material within controlled limits.

**3110 cored bar, n**—a compact of bar shape heated by its own electrical resistance to a temperature high enough to melt its interior.

### 3.3.2 Conditions During Sintering:

**3201 packing material, n**—any material in which compacts are embedded during the presintering or sintering operation.

**3202 sintering time, n**—the total elapsed time during which the P/M part/specimen is within ( $\pm$ ) a specified percentage of the stated sintering temperature.

**3203 dissociated ammonia, n**—a reducing gas produced by the thermal decomposition of anhydrous ammonia over a catalyst, resulting in a gas of 75 % hydrogen and 25 % nitrogen. Synonymous with cracked ammonia.

### 3.3.3 Phenomena Resulting from Sintering:

**3301 powder metallurgy part, n**—a shaped object that has been formed from metal powders and bonded by heating below the melting point of the major constituent. A structural or mechanical component, bearing, or bushing made by the powder metallurgy process. Synonymous with **P/M part**.

**3302 P/M part, n**—see **powder metallurgy part**.

**3303 fully dense material, n**—a material completely free of porosity and voids.

DISCUSSION—This is a conceptual term. In practice, complete densification is difficult to achieve and some microporosity will generally be present. The measured density of a material depends on its specific chemistry, thermomechanical condition, and microstructure.

**3304 cake, n**—a bonded mass of unpressed metal powder.

DISCUSSION—Often refers to the form of powder as it exits a furnace.

**3305 closed pore, n**—a pore not communicating or connected with an exterior surface.

**3306 open pore, n**—a pore communicating with an exterior surface.

**3307 communicating pores, n**—see **interconnected porosity**.

**3308 interconnected porosity, n**—a network of pores in and extending to the surface of a sintered compact. Usually applied to powder metallurgy materials in which the interconnected porosity is determined by impregnating the specimens with oil. Synonymous with **communicating pores**.

**3309 exudation, n**—the action by which all or a portion of the low melting constituent of a compact is forced to the surface during sintering. Sometimes referred to as “bleed out.” Synonymous with **sweating**.

**3310 sweating, n**—see **exudation**.

**3311 infiltration erosion, n**—the pitting, channeling, and coarsening of the surface porosity that results from the dissolution of the base metal by the liquid infiltrant, as the infiltrant flows into the matrix.

**3312 infiltration residue, n**—material that remains on the surface of the part after infiltration.

**3313 blistered compact, n**—a sintered object characterized by having blisters or eruptions on the surface.

DISCUSSION—In ferrous materials, this effect is often caused by in situ gas decomposition and soot formation that forces particles apart and causes the compact to blister.

**3315 neck formation, n**—during sintering, the development of a neck-like bond between particles.

**3316 slumping, n**—the lack of shape retention of a molded part, during subsequent processing, because of the effect of gravity.

**3317 warpage, n**—distortion that may occur in a compact during sintering.

**3318 oxide network, n**—continuous or discontinuous oxides that follow prior particle boundaries.

**3319 surface finger oxide, n**—the oxide that follows prior particle boundaries into a part from the surface and cannot be removed by physical means, such as rotary tumbling.

**3320 pore, n**—an inherent or induced cavity within a particle or within an object.

### 3.3.4 *Properties of Sintered Parts:*

**3401 dimensional change of a compact, n**—the difference, at room temperature, between the size of the sintered specimen and the die size.

DISCUSSION—The difference in dimensions is usually reported as a percentage of the die size. It should include a (+) when the sintered part is larger than the die size and a (–) when the sintered part is smaller than the die size.

**3402 growth, n**—an increase in dimensions of a compact which may occur during sintering. (Converse of **shrinkage**.)

**3403 shrinkage, n**—a decrease in dimensions of a compact which may occur during sintering. (Converse of **growth**.)

**3404 infiltrant efficiency, n**—the ratio of the mass of infiltrant absorbed by the part to the mass of infiltrant originally used, expressed as a percentage.

**3405 infiltration loading density, n**—infiltrant weight per unit area of contact between infiltrant and part.

**3406 metal filter, n**—a metal structure having controlled interconnected porosity produced to meet filtration or permeability requirements.

**3407 porosity, n**—the amount of pores (voids) expressed as a percentage of the total volume of the powder metallurgy part.

**3408 apparent porosity, n**—specific to cemented carbides, microstructural features that appear to be pores in a properly prepared, unetched surface; these features may result from uncombined carbon or nonmetallic inclusions as well as actual porosity.

**3409 density (dry), n**—the mass per unit volume of an unimpregnated powder metallurgy part.

**3410 density (wet), n**—the mass per unit volume of a powder metallurgy part impregnated with oil or other nonmetallic materials.

**3411 density ratio, n**—the ratio, often expressed as a percentage, of the density of a porous material to the density of the same material completely free of porosity. Synonymous with **relative density**.

**3412 relative density, n**—see **density ratio**.

**3413 K factor**—the strength constant in the formula for **radial crushing strength** of a plain sleeve specimen of sintered metal. See also **radial crushing strength**.

**3414 radial crushing strength, n**—the relative capacity of a plain sleeve specimen of sintered metal to resist fracture induced by a load applied between flat parallel plates in a direction perpendicular to the axis of the specimen.

**3415 transverse rupture strength, n**—the stress calculated from the flexure formula, required to break a specimen supported near the ends as a simple beam; the load is applied midway between the center lines of the supports.

**3416 permeability, n**—a property measured as the rate of passage of a liquid or gas through a compact; measured under specified condition.

**3417 oil content, n**—the measured amount of oil contained in an oil-impregnated object, for example, a self-lubricating bearing.

**3418 apparent hardness, n**—the hardness of a P/M material (including the effects of porosity), measured using macro-indentation hardness equipment.

DISCUSSION—See general description of production, properties, and uses of sintered metal powder bearings and structural parts, paragraph on density and mechanical properties, information on hardness measurement, Volume 02.05, gray pages.<sup>4</sup>

### 3.3.5 *Procedure to Evaluate Sintered Parts:*

**3501 rate-of-oil flow, n**—the rate at which a specified oil will pass through a sintered porous compact under specified test conditions.

### 3.3.6 *Removal of Binders:*

**3601 binder removal, n**—the chemical or thermal extraction of binder from a compact. Synonymous with **debinding**.

**3602 debinding, n**—see **binder removal**.

3.4 *Postsinter Treatments*—Terms associated with secondary operations including repressing, machining, and heat treatment that are performed on sintered compacts.

### 3.4.1 *Processes:*

**4101 impregnation, n**—a process of filling the pores of a sintered compact, with a nonmetallic material such as oil, wax, or resin.

**4102 repress, v**—to apply pressure to a previously pressed and either sintered or presintered compact. It includes **restrike**, **coin**, and **size**.

**4103 restrike, v**—to repress for the purpose of increasing the density of a sintered compact (not to be confused with **coin** or **size**).

**4104 coin, v**—to repress a sintered compact to obtain a definite surface configuration. Synonymous with **emboss** (not to be confused with **restrike** or **size**).

<sup>4</sup> For a discussion of apparent hardness, see the section on Density in General Description of Production, Properties, and Uses of Metal Powder Sintered Bearings, and Sintered Metal Powder Structural Parts, which appears in the *Annual Book of ASTM Standards*, Vol 02.05.

**4105 size, v**—to repress a sintered compact to decrease the dimensional variation (not to be confused with **coin** or **re-strike**).

**4106 steam blackening, n**—the superheated steam treatment of a ferrous P/M component to form a thin, dark, oxide layer, primarily Fe<sub>3</sub>O<sub>4</sub>, on the outside surfaces of the component, and extending into the surfaces of the interconnecting porosity.

**4107 steam treatment, n**—see **steam blackening**.

3.5 *Miscellaneous*—Terms that do not belong under any other category.

3.5.1 *Definitions:*

**5101 RSM**—Rapidly Solidified Materials.

**5102 RSP**—Rapid Solidification Processing or Rapidly Solidified Powders.

**5103 RST**—Rapid Solidification Technology.

3.5.2 *Processes:*

**5201 isostatic pressing, n**—the pressing of a powder, compact, or sintered object by subjecting it to a nominally equal pressure from every direction.

**5202 cold isostatic pressing, n**—the pressing of a powder, compact, or sintered object by subjecting it, at ambient temperature, to nominally equal pressure from every direction.

**5203 hot isostatic pressing, n**—the pressing of a powder, compact or sintered object by subjecting it, at elevated temperature, to nominally equal pressure from every direction.

**5204 hot densification, n**—the consolidation, at elevated temperature and pressure, of an unsintered, presintered, or sintered powder preform, or encapsulated or loose powder, to reduce porosity.

**5205 hot pressing, v**—pressure-assisted, low strain rate uniaxial densification of a powder preform, compact, or encapsulated or loose powder at a temperature sufficient to induce diffusion or creep.

3.5.3 *Materials:*

**5301 cemented carbide, n**—sintered material characterized by high strength and wear resistance and comprising one or more carbides of refractory metals as the main component bonded by metallic binder phase.

**5302 hardmetal, n**—see **cemented carbide**.

**5303 cermet, n**—sintered material containing at least one metallic phase and at least one nonmetallic phase that is generally of a ceramic nature.

## APPENDIX

### X1. ALPHABETICAL INDEX

**X1.1 Index Numbers correspond to numbers assigned to terms within the standard.**

**A**

acicular powder 1301  
 activated sintering 3104  
 agglomerate 1001  
 air classification 1104  
 apparent density 1601  
 apparent hardness 3418  
 apparent porosity 3408  
 atomization 1101  
 atomized metal powder 1201

**B**

binder 1401  
 binder removal 3601  
 blank 2003  
 blending 1501  
 blistered compact 3313  
 bridging 2401  
 briquet 2004  
 bulk density 1602

**C**

cake 3304  
 carbonyl powder 1204  
 cemented carbide 5301  
 cermet 5303  
 chemical deposition 1106

chemically precipitated metal powder 1107  
 classification 1103  
 closed pore 3305  
 coin 4104  
 cold isostatic pressing 5202  
 cold pressing 2110  
 cold welding 2404  
 communicating pores 3307  
 compact 2005  
 compatibility 1606  
 compacting tool set 2302  
 completely alloyed powder 1207  
 composite compact 2008  
 composite powder 1212  
 compound compact 2009  
 compressibility 1607  
 compression ratio 1608  
 continuous sintering 3105  
 core rod 2306  
 cored bar 3110  
 cross-product contamination 1504  
 cut 1616

**D**

debinding 3602  
 dendritic powder 1203  
 density (dry) 3409  
 density (wet) 3410  
 density ratio 3411

die 2303  
 die body 2304  
 die insert 2310  
 die lubricant 2201  
 die set 2305  
 die-wall lubricant 2202  
 diffusion—alloyed powder 1209  
 dimensional change of a compact 3401  
 disintegration 1109  
 dispersion-strengthened material 1404  
 dissociated ammonia 3203  
 double-action pressing 2105  
 double press-double sinter 2103

**E**

electrolytic powder 1202  
 equalizing 1502  
 exudation 3309

**F**

feedstock 1402  
 fill ratio 1609  
 fines 1613  
 flake powder 1307  
 flow rate 1604  
 forging preform 2605  
 fraction 1615  
 fully dense material 3303

**G**

gas classification 1105  
 granular powder 1303  
 granulation 1102  
 green 2402, 2001  
 green density 2501  
 green expansion 2503  
 growth 3402

**H**

hardmetal 5302  
 hot densification 5204  
 hot coining 2607  
 hot forging 2608  
 hot isostatic pressing 5203  
 hot pressing 5205  
 hot upset powder forging 2610  
 hot repressed powder forging 2611  
 hot restriking 2609  
 hydrogen loss 1621

**I**

impregnation 4101  
 infiltrant efficiency 3404  
 infiltration 3108  
 infiltration erosion 3311  
 infiltration loading density 3405  
 infiltration residue 3312  
 interconnected porosity 3308  
 irregular powder 1305  
 isostatic pressing 5201

**K**

*K* factor 3413

**L**

liquid phase sintering 3107  
 lubricating 1505

**M**

master-alloy powder 1205  
 matrix metal 1211  
 mechanically alloyed powder 1210  
 mesh 1802  
 metal filter 3406  
 metal injection molding (MIM) 2701  
 metal powder 1006  
 milling 1110  
 MIM 2702  
 minus sieve 1612  
 mixed powder 1216  
 mixing 1503  
 mold 2301  
 molding 2101  
 multiple pressing 2107

**N**

neck formation 3315  
 needles 1302  
 nitrogen alloying 3109  
 nodular powder 1304

**O**

oil content 3417  
 open pore 3306  
 oversize powder 1610  
 oxide network 3318

**P**

packing material 3201  
 partially alloyed powder 1208  
 particle size 1619  
 particle size distribution 1620  
 particulate matter 1002  
 permeability 3416  
 P/F 2602  
 PIM 2704  
 plates 1308  
 plus sieve 1611  
 P/M 1003  
 P/M forging 2603  
 P/M hot forming 2604  
 P/M part 3302  
 pore 3320  
 pore-forming material 1405  
 porosity 3407  
 powder 1005  
 powder flow meter 1801  
 powder forging 2601  
 powder injection molding (PIM) 2703  
 powder lubricant 1403  
 powder metallurgy 1004  
 powder metallurgy part 3301  
 powder rolling 2109  
 pre-alloyed powder 1206  
 preform 2605  
 preforming 2002  
 premix 1217



presintering 3103  
press 2102  
pressed bar 2006  
pressed density 2502  
pulverization 1111  
punch 2307

**R**

radial crushing strength 3414  
rate-of-oil flow 3501  
reduced metal powder 1108  
relative density 3412  
repress 4102  
restrike 4103  
roll compacting 2108  
rolled compact 2007  
rotary press 2312  
RSM 5101  
RSP 5102  
RST 5103

**S**

screen analysis 1702  
segment die 2311  
shrinkage 3403  
sieve analysis 1701  
sieve classification 1703  
sieve fraction 1618  
single-action pressing 2104

sinter 3101  
sinter forging 2606  
sintering time 3202  
size 4105  
slumping 3316  
solid-state sintering 3102  
specific surface 1605  
spherical powder 1306  
split die 2309  
sponge iron 1214  
sponge iron powder 1215  
spongy 1213  
springback 2403  
steam blackening 4106  
steam treatment 4107  
stoking 3106  
stripper punch 2308  
subsieve fraction 1617  
superfines 1614  
surface finger oxide 3319  
sweating 3310

**T**

tap density 1603  
transverse rupture strength 3415

**W**

warpage 3317  
withdrawal pressing 2106

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