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Standard Specification for Sintered Aluminum Structural Parts[1]

This standard is issued under the fixed designation B595; 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 specification covers sintered aluminum structural parts made primarily from aluminum powders to which controlled amounts of master alloys or elemental copper, magnesium, and silicon have been added by mixing.

1.2 This specification covers the following variables:

1.2.1 *Composition*—Depending upon levels of copper, magnesium, and silicon content, two grades, and

1.2.2 *Density*—Type.

1.3 Parts ordered to this specification will be in one of the following conditions:

1.3.1 As-sintered,

1.3.2 As-repressed for additional density, or

1.3.3 All other conditions plus heat treated.

1.4 With the exception of the values for density, for which the use of the gram per cubic centimeter unit is long-standing industry practice, the values stated in SI units are to be regarded as the standard.

2. Referenced Documents

2.1 *ASTM Standards:*[2]

B243 Terminology of Powder Metallurgy

B962 Test Methods for Density of Compacted or Sintered Powder Metallurgy (PM) Products Using Archimedes' Principle

B963 Test Methods for Oil Content, Oil-Impregnation Efficiency, and Surface-Connected Porosity of Sintered Powder Metallurgy (PM) Products Using Archimedes' Principle

E8 Test Methods for Tension Testing of Metallic Materials

3. Terminology

3.1 *Definitions*—Definitions of powder metallurgy terms can be found in Terminology B243. Additional descriptive information is available in the Related Material Section of Volume 02.05 of the *Annual Book of ASTM Standards.*

4. Ordering Information

4.1 Orders for material to this specification shall include the following information:

4.1.1 Dimensions (see 9.1),

4.1.2 Chemical composition (see 6.1),

4.1.3 Density (see 7.1),

4.1.4 State of heat treatment,

4.1.5 Mechanical property requirements (see 8.1), and

4.1.6 Certification (see 14.1).

5. Materials and Manufacture

5.1 Structural parts shall be made by compacting and sintering metal powders to produce finished parts conforming to the requirements of this specification.

6. Chemical Composition

6.1 The material shall conform to the requirements of Table 1.

6.2 The chemical analysis shall be made in accordance with the methods prescribed in the latest edition of the *Annual Book of ASTM Standards*, Vol 03.05, or any other approved method agreed upon between the manufacturer and the purchaser.

7. Density

7.1 The parts shall conform to the density range prescribed in Table 2.

7.2 The density shall be measured in accordance with Test Method B962.

7.3 If the density does not vary more than 0.1 g/cm^3 from one section of the structural part to any other section, the overall density shall fall within the limits prescribed in Table 2.

7.4 If the density varies more than 0.1 g/cm^3 from one section of the structural part to any other section, the manufacturer and the purchaser shall agree upon a critical section of the part where the stresses are the highest. The density of this critical section rather than the average density shall fall within the limits prescribed in Table 2.

[1] This specification is under the jurisdiction of ASTM Committee B09 on Metal Powders and Metal Powder Productsand is the direct responsibility of Subcommittee B09.05 on Structural Parts.

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[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.

TABLE 1 Chemical Requirements

Element	Composition, mass %	
	AXX-6061[A]	ACXX-2014[A]
Copper	0.5 max	3.5–5.0
Magnesium	0.4–1.2	0.2–0.8
Silicon	0.2–0.8	1.2 max
Aluminum, min	96.0	91.5
Total of other elements, determined by difference, max	1.5	1.5

[A] "XX" denotes thermal condition – see footnote to Table X1.1

TABLE 2 Density

Type	Dry Density, g/cm^3
I	2.30 to 2.45
II	2.45 to 2.60
III	2.60 min

8. Mechanical Properties

8.1 The manufacturer and the purchaser shall agree on qualification tests for the determination of mechanical properties.

8.2 These tests shall be performed on production parts.

8.3 These tests shall be determined after consideration of the function of the part.

8.4 The limits and sampling plan shall be agreed upon between the manufacturer and purchaser.

8.5 All shipments of parts subsequent to the establishment of testing conditions shall conform to the limits agreed upon.

NOTE 1—The mechanical properties in tension and compression that may be expected from standard specimens compacted to size are given in Appendix X1 of this specification.

9. Dimensions and Tolerances

9.1 Permissible variations in dimensions shall be within the limits specified on the drawings describing the structural parts accompanying the order or shall be within the limits specified in the order.

10. Workmanship, Finish, and Appearance

10.1 Structural parts shall be uniform in composition.

10.2 When parts are cut or fractured, the exposed surface shall be of uniform appearance.

11. Sampling

11.1 *Chemical Analysis*—If required by purchase agreement, at least one sample for chemical analysis shall be taken from each lot. A representative sample of chips may be obtained by dry milling, drilling or crushing at least two pieces with clean dry tools without lubrication. To obtain oil-free chips, the parts selected for test shall have the oil extracted in accordance with Test Method B963, if necessary.

11.2 *Mechanical Tests*—The manufacturer and purchaser shall agree on the number of specimens for mechanical tests.

12. Inspection

12.1 Unless otherwise specified, inspection of parts supplied on contract shall be made by the purchaser.

13. Rejection and Rehearing

13.1 Parts that fail to conform to the requirements of this specification may be rejected. Rejection should be reported to the producer or supplier promptly and in writing. In case of dissatisfaction with test results, the producer or supplier may make claim for rehearing.

14. Certification

14.1 When specified in the purchase order or contract, a producer's certification shall be furnished to the purchaser that the parts were manufactured, sampled, tested, and inspected in accordance with this specification and have been found to meet the requirements. When specified in the purchase order or contract, a report of the test results shall be furnished.

14.2 The purchase order shall specify whether or not the certification includes chemical composition.

14.3 Upon request of the purchaser in the contract or order, the certification of an independent third party indicating conformance to the requirements of this specification may be considered.

15. Keywords

15.1 as-repressed; as-sintered; density; interconnected porosity; oil-impregnated; powder metallurgy; sintered aluminum; structural parts; thermal condition

APPENDIX

(Nonmandatory Information)

X1. MECHANICAL PROPERTIES AND HARDNESS DATA

X1.1 Data for the mechanical properties of sintered aluminum specimens are given in Table X1.1 The data do not constitute a part of this specification. They merely indicate to the purchaser the mechanical properties that may be expected from special tension specimens conforming to the density and chemical requirements specified. It should be understood that the values represent specimens compacted to size and not specimens cut from commercial parts. See Fig. 20 of Test Methods E8.

TABLE X1.1 Typical Properties[A]

Material Designation Code[B]	Type	Ultimate Tensile Strength	Tensile Yield Strength (0.2 % offset)	Elongation in 25 mm	Apparent Rockwell Hardness
		MPa	MPa	%	
AT1-6061	I	83	62	4.0	60–65 HRH
AT4-6061	I	97	79	3.5	65–70 HRH
AT6-6061	I	138	131	0.5	80–85 HRH
AT1-6061	II	128	69	6.0	80–85 HRH
AT4-6061	II	159	103	5.0	50–55 HRE
AT6-6061	II	207	193	2.0	65–70 HRE
ACT1-2014	I	138	97	2.0	80–85 HRH
ACT4-2014	I	165	145	2.0	55–60 HRE
ACT6-2014	I	207	172	0.5	65–70 HRE
ACT1-2014	II	152	117	3.0	85–90 HRH
ACT4-2014	II	179	152	2.5	55–60 HRE
ACT6-2014	II	241	228	1.0	70–75 HRE
ACT1-2014	III	172	152	3.0	55–60 HRE
ACT4-2014	III	221	179	2.5	70–75 HRE
ACT6-2014	III	290	279	2.0	80–85 HRE

[A] Typical sintering atmosphere for the above grades may be nitrogen, dissociated ammonia, or vacuum.
[B] *Description of Thermal Conditions:*
T1 as-sintered.
T4 solution heat treated at 505 to 520°C, cold water quenched and aged minimum of 4 days at room temperature.
T6 solution heat treated at 505 to 520°C, cold water quenched and aged 18 h at 160 to 175°C.

X1.2 Hardness values are given as apparent values, as described in General Description of Production, Properties, and Uses of Metal Powder Sintered Bearings, and Sintered Metal Powder Structural Parts (see gray pages).