Designation: B221M − 21

Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric)[1]

This standard is issued under the fixed designation B221M; 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.

This standard has been approved for use by agencies of the U.S. Department of Defense.

1. Scope*

1.1 This specification covers aluminum and aluminum-alloy extruded bars, rods, wires, profiles, and tubes in the aluminum alloys (Note 1) and tempers shown in Table 2.

NOTE 1—Throughout this specification the use of the term *alloy* in the general sense includes aluminum as well as aluminum alloy.

NOTE 2—For rolled or cold-finished bars and rods refer to Specification B211/B211M, for drawn seamless tube used in pressure applications, Specification B210/B210M, for structural pipe and tube, Specification B429/B429M, and for seamless pipe and tube used in pressure applications, Specification B241/B241M.

NOTE 3— Pipe and tube products listed in this specification are intended for general purpose applications. This specification may not address the manufacturing processes, integrity testing, and verification required for fluid-carrying applications involving pressure. See Specification B210/B210M, B241/B241M, or both as appropriate for seamless pipe and tube used in fluid-carrying applications involving pressure. See Specification B234M, as appropriate, for use in surface condensers, evaporators, and heat exchangers.

1.2 Alloy and temper designations are in accordance with ANSI H35.1/H35.1M. The equivalent Unified Numbering System alloy designations are those of Table 1 preceded by A9, for example, A91100 for Aluminum 1100 in accordance with Practice E527.

1.3 For acceptance criteria for inclusion of new aluminum and aluminum alloys in this specification, see Annex A2.

1.4 This specification is the metric counterpart of Specification B221.

1.5 The values stated in SI are to be regarded as standard. No other units of measurement are included in this specification.

1.6 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 The following documents of the issue in effect on the date of material purchase form a part of this specification to the extent referenced herein:

2.2 *ASTM Standards:*[2]

B210/B210M Specification for Aluminum and Aluminum-Alloy Drawn Seamless Tubes
B211/B211M Specification for Aluminum and Aluminum-Alloy Rolled or Cold Finished Bar, Rod, and Wire
B234M Specification for Aluminum and Aluminum-Alloy Drawn Seamless Tubes for Surface Condensers, Evaporators, and Heat Exchangers (Metric)
B241/B241M Specification for Aluminum and Aluminum-Alloy Seamless Pipe and Seamless Extruded Tube
B429/B429M Specification for Aluminum-Alloy Extruded Structural Pipe and Tube
B557M Test Methods for Tension Testing Wrought and Cast Aluminum- and Magnesium-Alloy Products (Metric)
B594 Practice for Ultrasonic Inspection of Aluminum-Alloy Wrought Products
B660 Practices for Packaging/Packing of Aluminum and Magnesium Products
B666/B666M Practice for Identification Marking of Aluminum and Magnesium Products
B807/B807M Practice for Extrusion Press Solution Heat Treatment for Aluminum Alloys
B881 Terminology Relating to Aluminum- and Magnesium-Alloy Products
B918/B918M Practice for Heat Treatment of Wrought Aluminum Alloys
B945 Practice for Aluminum Alloy Extrusions Press Cooled from an Elevated Temperature Shaping Process for Production of T1, T2, T5 and T10–Type Tempers

[1] This specification is under the jurisdiction of ASTM Committee B07 on Light Metals and Alloys and is the direct responsibility of Subcommittee B07.03 on Aluminum Alloy Wrought Products.

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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.

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

TABLE 1 Chemical Composition Limits [A,B,C]

Alloy	Silicon	Iron	Copper	Manga-nese	Magne-sium	Chromium	Zinc	Titanium	Vanadium	Other Elements[D]		Aluminum
										Each	Total[E]	
1060	0.25	0.35	0.05	0.03	0.03	...	0.05	0.03	0.05	0.03	...	99.60 min[F]
1100[G]	0.95 Si + Fe		0.05–0.20	0.05	...	...	0.10	...	...	0.05	0.15	99.00 min[F]
2014[H]	0.50–1.2	0.7	3.9–5.0	0.40–1.2	0.20–0.8	0.10	0.25	0.15	...	0.05	0.15	rem
2024[H]	0.50	0.50	3.8–4.9	0.30–0.9	1.2–1.8	0.10	0.25	0.15	...	0.05	0.15	rem
2219[I]	0.20	0.30	5.8–6.8	0.20–0.40	0.02	...	0.10	0.02–0.10	0.05–0.15	0.05	0.15	rem
3003	0.6	0.7	0.05–0.20	1.0–1.5	...	...	0.10	...	...	0.05	0.15	rem
Alclad 3003	...	3003 Clad with 7072 Alloy			...	...	...	...	...	...	...	...
3004	0.30	0.7	0.25	1.0–1.5	0.8–1.3	...	0.25	...	...	0.05	0.15	rem
3102	0.40	0.7	0.10	0.05–0.40	...	...	0.30	0.10	...	0.05	0.15	rem
5052	0.25	0.40	0.10	0.10	2.2–2.8	0.15–0.35	0.10	...	...	0.05	0.15	rem
5083	0.40	0.40	0.10	0.40–1.0	4.0–4.9	0.05–0.25	0.25	0.15	...	0.05	0.15	rem
5086	0.40	0.50	0.10	0.20–0.7	3.5–4.5	0.05–0.25	0.25	0.15	...	0.05	0.15	rem
5154[G]	0.25	0.40	0.10	0.10	3.1–3.9	0.15–0.35	0.20	0.20	...	0.05	0.15	rem
5454	0.25	0.40	0.10	0.50–1.0	2.4–3.0	0.05–0.20	0.25	0.20	...	0.05	0.15	rem
5456	0.25	0.40	0.10	0.50–1.0	4.7–5.5	0.05–0.20	0.25	0.20	...	0.05	0.15	rem
6005	0.6–0.9	0.35	0.10	0.10	0.40–0.6	0.10	0.10	0.10	...	0.05	0.15	rem
6005A[J]	0.50–0.9	0.35	0.30	0.50	0.40–0.7	0.30	0.20	0.10	...	0.05	0.15	rem
6013	0.6-1.0	0.50	0.6-1.1	0.20-0.8	0.8-1.2	0.10	0.25	0.10	...	0.05	0.15	rem
6020[K]	0.40–0.9	0.50	0.30–0.9	0.35	0.6–1.2	0.15	0.20	0.15	...	0.05	0.15	rem
6026[L]	0.6–1.4	0.7	0.20–0.50	0.20–1.0	0.6–1.2	0.30	0.30	0.20	...	0.05	0.15	rem
6041[M]	0.50–0.9	0.15–0.7	0.15–0.6	0.05–0.20	0.8–1.2	0.05–0.15	0.25	0.15	...	0.05	0.15	rem
6042[N]	0.50–1.2	0.7	0.20–0.6	0.40	0.7–1.2	0.04–0.35	0.25	0.15	...	0.05	0.15	rem
6060	0.30–0.6	0.10–0.30	0.10	0.10	0.35–0.6	0.05	0.15	0.10	...	0.05	0.15	rem
6061[O]	0.40–0.8	0.7	0.15–0.40	0.15	0.8–1.2	0.04–0.35	0.25	0.15	...	0.05	0.15	rem
6063	0.20–0.6	0.35	0.10	0.10	0.45–0.9	0.10	0.10	0.10	...	0.05	0.15	rem
6064[P]	0.40–0.8	0.7	0.15–0.40	0.15	0.8–1.2	0.05–0.14	0.25	0.15	...	0.05	0.15	rem
6066	0.9–1.8	0.50	0.7–1.2	0.6–1.1	0.8–1.4	0.40	0.25	0.20	...	0.05	0.15	rem
6070	1.0–1.7	0.50	0.15–0.40	0.40–1.0	0.50–1.2	0.10	0.25	0.15	...	0.05	0.15	rem
6082	0.7–1.3	0.50	0.10	0.40–1.0	0.6–1.2	0.25	0.20	0.10	...	0.05	0.15	rem
6105	0.6–1.0	0.35	0.10	0.15	0.45–0.8	0.10	0.10	0.10	...	0.05	0.15	rem
6162	0.40–0.8	0.50	0.20	0.10	0.7–1.1	0.10	0.25	0.10	...	0.05	0.15	rem
6262[Q]	0.40–0.8	0.7	0.15–0.40	0.15	0.8–1.2	0.04–0.14	0.25	0.15	...	0.05	0.15	rem
6351	0.7–1.3	0.50	0.10	0.40–0.8	0.40–0.8	...	0.20	0.20	...	0.05	0.15	rem
6360	0.35–0.8	0.10–0.30	0.15	0.02–0.15	0.25–0.45	0.05	0.10	0.10	...	0.05	0.15	rem
6463	0.20–0.6	0.15	0.20	0.05	0.45–0.9	...	0.05	...	...	0.05	0.15	rem
6560	0.30–0.7	0.10–0.30	0.05–0.20	0.20	0.20–0.6	0.05	0.15	0.10	...	0.05	0.15	rem
7005[R]	0.35	0.40	0.10	0.20–0.7	1.0–1.8	0.06–0.20	4.0–5.0	0.01–0.06	...	0.05	0.15	rem
7072[S]	0.7 Si + Fe		0.10	0.10	0.10	...	0.8–1.3	...	...			rem
7075[T]	0.40	0.50	1.2–2.0	0.30	2.1–2.9	0.18–0.28	5.1–6.1	0.20	...	0.05	0.15	rem
7116[U]	0.15	0.30	0.50–1.1	0.05	0.8–1.4	...	4.2–5.2	0.05	0.05	0.05	0.15	rem
7129[U]	0.15	0.30	0.50–0.9	0.10	1.3–2.0	0.10	4.2–5.2	0.05	0.05	0.05	0.15	rem

[A] Limits are in weight percent maximum unless shown as a range, or stated otherwise.
[B] Analysis shall be made for the elements for which limits are shown in this table.
[C] For the purpose of determining conformance to these limits, an observed value or a calculated value obtained from analysis shall be rounded to the nearest unit in the last right-hand place of the figures used in expressing the specified limit, in accordance with the rounding-off method of Practice E29.
[D] *Others* includes listed elements for which no specific limit is shown as well as unlisted metallic elements. The producer may analyze samples for trace elements not specified in the specification. However, such analysis is not required and may not cover all metallic *Others* elements. Should any analysis by the producer or the purchaser establish that an *Others* element exceeds the limit of *Each* or that the aggregate of several *Others* elements exceeds the limit of *Total*, the material shall be considered nonconforming.
[E] *Other Elements*—Total shall be the sum of unspecified metallic elements 0.010 % or more, rounded to the second decimal before determining the sum.
[F] The aluminum content shall be calculated by subtracting from 100.00 % the sum of all metallic elements present in amounts of 0.010 % or more each, rounded to the second decimal before determining the sum.
[G] Be 0.0003 max for welding electrode, welding rod, and filler wire.
[H] Upon agreement between the purchaser and the producer or supplier, a Zr + Ti limit of 0.20 % max is permitted. Properties in Specification (Table 2) are not based on the Zirconium and Titanium algorithm.
[I] Zirconium, 0.10–0.25 %. The total for other elements does not include zirconium.
[J] Manganese plus chromium shall total 0.12–0.50.
[K] Lead 0.05 % max, Tin 0.9–1.5 %.
[L] Bismuth 0.50–1.5 %, Lead 0.4 % max, Tin 0.05 % max.
[M] Bismuth 0.30–0.9 %, Tin 0.35–1.2 %.
[N] Bismuth 0.20–0.8 % Lead 0.15–0.40 %.
[O] In 1965 the requirements for 6062 were combined with those for 6061 by revising the minimum chromium from "0.15 %" to"0.04 %." This action cancelled Alloy 6062.
[P] Bismuth 0.50–0.7 %, Lead 0.20–0.04 %,
[Q] Bismuth and lead shall be 0.40–0.7 % each.
[R] Zirconium 0.08–0.20 %. The total for other elements does not include zirconium.
[S] Composition of cladding alloy applied during the course of manufacture. Samples from finished tube shall not be required to conform to these limits.
[T] Upon agreement between the purchaser and the producer or supplier, a Zr + Ti limit of 0.25 % max is permitted. Properties in Specification (Table 2) are not based on the Zirconium and Titanium algorithm.
[U] Gallium 0.03 % max.

TABLE 2 Tensile Property Limits[A,B]

Temper	Product Type[C]	Specified Section or Wall Thickness, mm		Area, mm^2		Tensile Strength, MPa		Yield Strength (0.2 %)		Elongation,[D] %, min	
		over	incl	over	incl	min	max	min	max	in 50 mm	in 50 × Diameter (5.56$\sqrt{A}$)
				Aluminum 1060[E]							
O	Extruded Tube	all		all		60	95	15	. . .	25	22
H112	Extruded Tube	all		all		60	. . .	15	. . .	25	22
				Aluminum 1100[E]							
O	Extruded Tube	all		all		75	105	20	. . .	25	22
H112	Extruded Tube	all		all		75	. . .	20	. . .	25	22
				Alloy 2014[E]							
O	Extruded Wire, Rod, Bar, Profiles, and Tube	all		all		. . .	205	. . .	125	12	10
T4 T4510[F] T4511[F]	Extruded Wire, Rod, Bar, Profiles, and Tube	all		all		345	. . .	240	. . .	12	10
T42[G]	Extruded Wire, Rod, Bar, Profiles, and Tube	all		all		345	. . .	200	. . .	12	10
T6 T6510[F] T6511[F]	Extruded Wire, Rod, Bar, Profiles, and Tube	. . .	12.50	all		415	. . .	365	. . .	7	6
		12.50	18.00	all		440	. . .	400	. . .	. . .	6
		18.00	. . .	. . .	16 000	470	. . .	415	. . .	. . .	6
		18.00	. . .	16 000	20 000	470	. . .	400	. . .	. . .	5
T62[G]	Extruded Wire, Rod, Bar, Profiles, and Tube	. . .	18.00	all	. . .	415	. . .	365	. . .	7	6
		18.00	. . .	. . .	16 000	415	. . .	365	. . .	. . .	6
		18.00	. . .	16 000	20 000	415	. . .	365	. . .	. . .	5
				Alloy 2024[E]							
O	Extruded Wire, Rod, Bar, and Profiles	all		all		. . .	240	. . .	130	12	10
T3 T3510[F] T3511[F]	Extruded Wire, Rod, Bar, and Profiles	. . .	6.30	all		395	. . .	290	. . .	12	. . .
		6.30	18.00	all		415	. . .	305	. . .	12	10
		18.00	35.00	all		450	. . .	315	. . .	. . .	9
		35.00	. . .	. . .	16 000	485	. . .	360	. . .	. . .	9
		35.00	. . .	16 000	20 000	470	. . .	330	. . .	. . .	7
T3 T3510[F] T3511[F]	Extruded Tube	. . .	6.30	all		395	. . .	290	. . .	10	. . .
		6.30	18.00	all		415	. . .	305	. . .	10	9
		18.00	35.00	all		450	. . .	315	. . .	. . .	9
		35.00	. . .	. . .	16 000	485	. . .	330	. . .	. . .	9
		35.00	. . .	16 000	20 000	470	. . .	315	. . .	. . .	7
T42[G]	Extruded Wire, Rod, Bar, Profiles, and Tube	. . .	18.00	all		395	. . .	260	. . .	12	10
		18.00	35.00	all	. . .	395	. . .	260	. . .	. . .	9
		35.00	. . .	. . .	16 000	395	. . .	260	. . .	. . .	9
		35.00	. . .	16 000	20 000	395	. . .	260	. . .	. . .	7
T81 T8510[F] T8511[F]	Extruded Wire, Rod, Bar, Profiles, and Tube	1.20	6.30	all		440	. . .	385	. . .	4	. . .
		6.30	35.00	all		455	. . .	400	. . .	5	4
		35.00	. . .	. . .	20 000	455	. . .	400	. . .	. . .	4