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Aluminium Alloys 5052 and 5251
– Quite Similar but Completely Different

BACKGROUND

These two commonly available flat rolled aluminium alloys share much but have some differences. There has been a tendency for some segments of the Australasian market to regard these as interchangeable alloys; in some cases this has been entirely acceptable and justified, but there have also been some concerns when one grade was ordered and the other was delivered. It is true that for some applications these two alloys can be regarded as functional alternatives, but they are not equivalents. It is usually the case that if a drawing or part specification requires use of Alloy 5052, then the use of Alloy 5251 should only be by acceptance under concession.

This Atlas TechNote sets down the facts about these two alloys so that informed decisions can be made.

WHAT 5052 AND 5251 ARE

These are both "5000-series" magnesium alloys. They are non-heat treatable, so both can only be made stronger by cold working, by which method ¼ Hard (Hx2) and ½ Hard (Hx4) Tempers are commonly commercially available. In addition the standards list higher strength ¾ (Hx6) and Full Hard (Hx8) Tempers. Annealed Temper O is also possible, as well as some other specials. Both are commonly used in construction of boats and similar light fabrication, made possible by their good corrosion resistance, in particular to marine environments. Both are readily formed and welded.

THE AUSTRALASIAN SUPPLY POSITION

Some generic aluminium flat rolled products are stocked in this region and other products are specially imported. "Floor stock" held by some importers is Alloy 5251 while other apparently competing product is 5052; both alloys are available although 5052 is more common.

SPECIFICATION OF ALUMINIUM ALLOYS

In Australia aluminium alloys have been specified most commonly to either AS 1734, ASTM B209M or "AA spec".

- AS 1734 is an Australian standard last revised in 1997. It reflects what was then local Australian production of aluminium flat rolled coil, sheet and plate. It includes both 5052 and 5251.
- ASTM B209 / B209M is an American specification, revised frequently. (The alternative for ship building alloys is ASTM B928/B928M, covering alloys such as 5083.) Both B209 and B928 include 5052 but neither includes Alloy 5251.
- AA – the Aluminum Association in USA publishes a book of Aluminum Alloy Data, extracted largely from ASTM and ASME data. This very informative book again includes 5052 but has no mention of Alloy 5251.
- EN 485 is a European "Euronorm" standard. This has not been commonly referenced in Australasia, but it is useful as it does specifically cover Alloy 5251, as well as 5052.

A problem is that mills producing flat rolled aluminium sold into the Australasian market are located in various parts of the world, and in the absence of specific direction may manufacture and certify to the specification of their choice. This can include all of the above but also their own proprietary specifications. Some mills only poorly certify aluminium products, with little regard to specifications.

COMPOSITION

Alloy	Mg	Cr	Cu	Fe	Mn	Si	Zn	Ti	Others (each)	Others (Total)
5052	2.2 – 2.8	0.15 – 0.35	0.1 max	0.4 max	0.1 max	0.25 max	0.1 max	-	0.05	0.15
5251	1.70 – 2.40	0.15 max	0.15 max	0.50 max	0.10 – 0.50	0.40 max	0.15 max	0.15 max	0.05	0.15

- The limits listed for Alloy 5052 in this table are common to AS, ASTM and AA specifications.
- Alloy 5251 limits are from AS 1734; other specifications may have slightly different composition limits.

From these composition data, and most obviously the Cr (chromium) limit, it is clear that it is not possible for a piece of aluminium to comply with both 5052 and 5251. No matter how carefully the composition is controlled Alloy 5251 does not comply with 5052 composition.

MECHANICAL PROPERTIES

Alloy		Specification	Tensile Strength (MPa)	Yield Strength 0.2% Proof Stress (MPa)	Elongation (% in 50mm)
H32	5052	ASTM B209M	215 - 265	160 min	7 min *
		EN 485-2	210 - 260	130 min	7 min **
		AS 1734	215 - 265	160 min ^	7 min ***
	5251	EN 485-2	190 - 230	120 min	8 min **
		AS 1734	200 - 255	130 min ^	7 min ***
H34	5052	ASTM B209M	235 - 285	180 min	6 min *
		EN 485-2	230 - 280	150 min	6 min **
		AS 1734	235 - 285	180 min ^	6 min *
	5251	EN 485-2	210 - 250	140 min	6 min **
		AS 1734	230 - 275	180 min ^	6 min ***

* 1.2 – 3.2mm thick. ** 1.5 – 3.0mm thick *** 1.3 – 2.6mm thick
^ AS 1734 yield strengths are not determined or guaranteed unless specifically requested.

1. EN 485-2 5251 and AS 1734 5251 both have lower strength than 5052 in ASTM B209M. The specified minimum yield strength of EN 485-2 5251 H32 is 25% lower than that of 5052 H32; this is a substantial reduction.

2. There is no known specification for Alloy 5251 that gives guaranteed mechanical properties equivalent to those of the industry standard ASTM B209M 5052.

3. Mechanical property limits given in EN 485-2 for 5052 are lower than those for the same alloy in ASTM B209M, for both H32 and H34 tempers. The difference is most severe in yield strengths, and in H32. EN 485-2 5052 should not be regarded as an equivalent to ASTM B209M 5052 of the same temper.

4. Engineering design using these alloys will assume particular minimum specified properties; a design based on a yield strength of 160MPa minimum may be invalidated if the metal actually used has a specified minimum of 120 or 130MPa.

FABRICATION

Various listings of fabrication characteristics (eg that given in AS 1734 Appendix B) show similar good properties for forming and welding of these alloys, and similar fair machinability. Both can be anodised for improved corrosion resistance but are not recommended for decorative anodising. At a specific level however, the formability of an alloy with a yield strength of 150MPa will be different from that of the same shape at 180MPa ... this is the main concern.

SUMMARY OF THE DIFFERENCES

1. Chemical compositions of 5052 and 5251 are different. It is not possible to "dual certify" an Alloy 5052 / 5251.
2. There are also differences between ASTM, Euronorm and Australian specifications for 5052 and also for 5251.
3. Specified strength of 5251, in the common H32 and H34 tempers, is lower than for the same temper in 5052. The most striking difference is that the permitted yield strength of 5251 is substantially lower than for 5052.
4. The commonly specified ASTM B209M 5052 H32 or H34 should be regarded as the benchmark. Other specifications carry risk of reduced strength.

THE ATLAS POSITION

- Atlas prefers to stock and sell only 5052 as this is the better recognised alloy.
- Where the only available product, to meet customer delivery requirements, is 5251, this may be offered to a potential customer. Customers may accept or reject these offers.
- Atlas buys, stocks and sells these as two distinct alloys, named as 5052 and 5251. The SAP computer system tracks every batch. Alloys are identified as what they are.
- This TechNote is specifically written to inform any choices between these similar grades.

REFERENCES & FURTHER INFORMATION

- ASTM B209M – "Aluminum and aluminum-alloy sheet and plate [metric]"
- AA book – "Aluminium standards and data" - 2009 Metric SI. Aluminum Association.
- EN 485 – "Aluminium and alloys - sheet strip and plate"
  Part 2 - Mechanical Properties
- AS 1734 – 1997 "Aluminium and aluminium alloys - flat sheet, coiled sheet and plate"

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