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## Magnesium and magnesium alloys — Wrought magnesium and magnesium alloys

*Magnésium et alliages de magnésium — Magnésium et alliages de  
magnésium corroyés*

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## Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see [www.iso.org/directives](http://www.iso.org/directives)).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see [www.iso.org/patents](http://www.iso.org/patents)).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see [www.iso.org/iso/foreword.html](http://www.iso.org/iso/foreword.html).

This document was prepared by Technical Committee ISO/TC 79, *Light metals and their alloys*, Subcommittee SC 5, *Magnesium and alloys of cast or wrought magnesium*.

This fifth edition cancels and replaces the fourth edition (ISO 3116:2007), which has been technically revised to include wrought magnesium alloys that have been developed in the past few years.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at [www.iso.org/members.html](http://www.iso.org/members.html).

## Introduction

This document classifies the commercially available magnesium alloys into a number of grades suitable for the application to which they might be put.

Some of the alloys referenced in this document can be the subject of a patent or of patent applications and their listing herein is not to be construed in any way as the granting of a licence under such patent rights.

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# Magnesium and magnesium alloys — Wrought magnesium and magnesium alloys

## 1 Scope

This document specifies the chemical composition and mechanical properties of magnesium and magnesium alloys for wrought products in the form of bars and solid sections, tubes and hollow sections, forgings, and plate and sheet.

## 2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 80000-1:2009, *Quantities and units — Part 1: General*

ISO 6892-1, *Metallic materials — Tensile testing — Part 1: Method of test at room temperature*

EN 515, *Aluminium and aluminium alloys — Wrought products — Temper designations*

## 3 Terms and definitions (standards.iteh.ai)

No terms and definitions are listed in this document.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <http://www.electropedia.org/>

## 4 Designation

### 4.1 Material

The material shall be designated by symbols as given in [Tables 1](#) to [47](#).

The designation for alloys shall consist of a prefix character “M”, which represents magnesium, and not more than three capital letters representing the alloying elements specified in the greatest amount, arranged in order of decreasing percentages, or in alphabetical order if of equal percentages, followed by the respective percentages rounded off to whole numbers and a serial letter in lower case.

The letters used to represent the alloying elements shall be those in [Table 1](#). The third letter is used when the third largest amount of element is above or equal to 1 wt.%. If the third and fourth largest amount of elements are above or equal to 1, the higher amount of elements is taken; if of equal percentage, the third letter is decided by the producer who developed the alloy.

Table 1 — Letters representing alloying elements

Letters	Element	Name of element	Letters	Element	Name of element
A	Al	Aluminium	N	Ni	Nickel
B	Bi	Bismuth	P	Pb	Lead
C	Cu	Copper	Q	Ag	Silver
D	Cd	Cadmium	R	Cr	Chromium
E	RE	Rare Earth	S	Si	Silicon
F	Fe	Iron	T	Sn	Tin
H	Th	Thorium	V	Gd	Gadolinium
J	Sr	Strontium	W	Y	Yttrium
K	Zr	Zirconium	X	Ca	Calcium
L	Li	Lithium	Y	Sb	Antimony
M	Mn	Manganese	Z	Zn	Zinc

In rounding percentages, the nearest whole number shall be used. If two choices are possible, for example when the decimal is followed by a 5 only or a 5 followed only by zeros, the nearest even whole number shall be used. When a range is specified for the alloying element, the rounded mean shall be used in the designation. When only a minimum percentage is specified for the alloying element, the rounded minimum percentage shall be used in the designation. For example:

- an aluminium content of 1,2 wt.% is written as A1;
  - an aluminium content of 1,5 wt.% is written as A2;
  - an aluminium content of 2,5 wt.% to 3,6 wt.% is written as A3;
  - an aluminium content of 2,5 wt.% is written as A2.
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The serial letter is defined as “a” or “b” when the two compositions have only minor difference.

For example, ISO-MgAl<sub>3</sub>Zn<sub>1</sub>(A) is designated as MAZ31a and ISO-MgAl<sub>9</sub>Ca<sub>1</sub>Zn<sub>1</sub> is designated as MAXZ911.

A list of national designations corresponding to this document is given in [Annex A](#). A table of physical properties of the listed alloys is given in [Annex B](#).

## 4.2 Temper designation

The following symbols shall be used for temper designation:

- O: annealed;
- F: as fabricated;
- H × 8: fully hardened (strain hardened to give maximum ultimate tensile strength);
- H × 4: half hardened (strain hardened to give an ultimate tensile strength approximately midway between that of annealed and H × 8 temper);
- H × 2: quarter hardened (strain hardened to give an ultimate tensile strength approximately midway between that of annealed and H × 4 temper);
- H112: Strain hardened from working at elevated temperature or from a limited amount of cold work, and for which there are mechanical properties limits.
- T5: cooled from an elevated temperature shaping process and then artificially aged;
- T6: solution heat treated and then artificially aged.



The temper designations shall be in accordance with EN 515.

Details of heat treatments are given in [Annex C](#).

### 4.3 Designations of product form

The following symbols shall be used for product form:

- B: bars and solid sections;
- T: tubes and hollow sections;
- F: forgings;
- P: plate and sheet.

### 4.4 Designation for ordering

EXAMPLE

An order for magnesium bars, conforming to this document, of magnesium alloy MAZ31a, delivered in the as-fabricated condition (F) is as follows:

ISO 3116 - ISO-MgAl3Zn1 (A) (or MAZ31a) - F - B

Tonnage and dimensions shall be specified in addition.

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## 5 Requirements

### 5.1 Chemical composition

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The chemical composition of wrought magnesium alloys, taken as cast analysis at the time the material is cast, shall conform to the requirements for the appropriate material given in [Table 2](#).

### 5.2 Mechanical properties

The minimum values of the mechanical properties of wrought products in magnesium alloys in the defined temper conditions shall be as given in [Tables 3](#) to [48](#).

### 5.3 Frequency of testing

The frequency of testing shall be subject to an agreement between the manufacturer and the purchaser.

## 6 Sampling

Conditions for sampling, formation of batches and frequency of verification shall be subject to an agreement between the manufacturer and the purchaser.

## 7 Test pieces

Test pieces shall be taken in the longitudinal direction. For rolled flat products of thickness > 0,6 mm, test pieces may be taken in the long transverse direction.

## 8 Test methods

### 8.1 Chemical composition

The determination of the alloying elements given in [Table 2](#) shall be performed in accordance with the relevant International Standards, or other standards as agreed between the supplier and the customer.

### 8.2 Tensile test

Tensile tests shall be carried out in accordance with ISO 6892-1.

## 9 Retests

Conditions for retests shall be subject to an agreement between the manufacturer and the purchaser.

## 10 Rounding of results

The number representing the result for any value specified in this document shall be expressed to the same number of decimal places as the corresponding number in this document. The rounding of numbers shall meet the requirements of ISO 80000-1:2009, B.3, rule A or B. The choice shall be left to the discretion of the manufacturer, unless the use of one of the rules is agreed by the time of acceptance of the order.

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Table 2 — Chemical composition of wrought magnesium and magnesium alloys

Alloy group	Material designation			Prod-uct form	Composition % (mass fraction)																Oth-ers each	Oth-ers total
	Symbol	Number	Designa-tion		Ele-ment	Mg	Al	Zn	Mn	Gd	RE	Li	Zr	Y	Ca		Si	Fe	Cu	Ni		
Mg	ISO-Mg9999	ISO-WD11000	MG9999	B	min. max.	99,99	0,002	0,003	0,002	—	—	—	—	—	—	—	0,002	0,002	0,003	0,003	0,002	0,01
MgAlAg	ISO-MgAl8Ag	ISO-WD25110	MAQ80	F,P	min.	Rem. <sup>a</sup>	7,5	0,35	0,15	—	0,01	—	—	—	0,001	0,02	—	—	—	—	—	—
					max.	—	8,5	0,55	0,35	—	0,10	—	—	0,02	0,8 Ag	0,05	0,02	0,02	0,001	0,01	0,30	
MgAlCa	ISO-MgAl5Ca1	ISO-WD25120	MAX51	B,T	min.	Rem.	4,5	—	0,15	—	—	—	—	0,7	—	—	—	—	—	—	—	
					max.	—	5,4	0,30	0,40	—	—	—	1,5	—	0,10	0,005	0,05	0,005	0,05	0,30		
	ISO-MgAl6Ca1	ISO-WD25130	MAX61	B,T,P	min.	Rem.	5,5	—	0,15	—	—	—	0,7	—	—	—	—	—	—	—		
					max.	—	6,5	0,30	0,40	—	—	—	1,5	—	0,10	0,005	0,05	0,005	0,05	0,30		
MgAlLi	ISO-MgAl6Ca2	ISO-WD25140	MAX62	B,T,P	min.	Rem.	5,5	—	0,15	—	—	—	1,6	—	—	—	—	—	—	—		
					max.	—	6,5	0,30	0,40	—	—	—	2,5	—	0,10	0,005	0,05	0,005	0,05	0,30		
	ISO-MgAl3Li2	ISO-WD26110	MAL32	P	min max.	Rem. —	2,5 3,5	0,50 0,8	0,20 0,40	— —	— —	1,0 3,0	— —	— —	— —	— —	— 0,01	— 0,005	0,00 0,15	— 0,02	— 0,15	
MgAlMn	ISO-MgAl6Mn	ISO-WD21240	MAM60	B,T,P	Min. max.	Rem. —	5,5 6,5	0,30 0,40	0,15 0,40	— —	— —	— —	— —	— —	— —	— 0,10	— 0,005	— 0,01	— 0,005	— 0,05	— 0,30	
	ISO-MgAl1Sn1	ISO-WD25150	MAT11	B,P	min. max.	Rem. —	0,50 1,2	— —	0,10 0,30	— —	— —	— —	— —	— —	— 0,6	— 1,2Sn	— 0,004	— —	— —	— 0,01	— 0,15	
MgAlSn	ISO-MgAl6Sn1	ISO-WD25160	MAT61	B,P	min. max.	Rem. —	6,0 6,8	— —	0,2 0,4	— —	— —	— —	— —	— —	— 1,3Sn	0,7	— 0,025	— 0,005	— —	— 0,05	— 0,15	
	ISO-MgAl3Sr1	ISO-WD21450	MAJ31	B	min. max.	Rem. —	2,5 3,5	0,25 0,8	0,6 0,8	— —	— —	— —	— —	— —	— 0,9	— 1,5Sr	— 0,10	— 0,02	0,05 0,005	— 0,05	— 0,15	
MgAlSr																						
Key																						
B = bars and solid sections																						
T = tubes and hollow sections																						
F = forgings																						
P = plate and sheet																						
RE = neodymium and other heavy rare earth metals																						
a RemAlnder.																						
Zn+Ag.																						

Table 2 (continued)

Alloy group	Material designation			Product form	Composition % (mass fraction)																Oth- ers total	Oth- ers each	
	Symbol	Number	Designa- tion		Ele- ment	Mg	Al	Zn	Mn	Gd	RE	Li	Zr	Y	Ca		Si	Fe	Cu	Ni			
MgAlZn	ISO-MgAl3Zn1(A)	ISO-WD21150	MAZ31a	B,T,F,P	min. max.	Rem. —	2,4 3,6	0,50 1,5	0,15 0,40	— —	— —	— —	— —	— —	— —	— —	— 0,10	— 0,005	— 0,05	— 0,005	— —	— 0,30	
	ISO-MgAl3Zn1(B)	ISO-WD21151	MAZ31b	B,T,F,P	min. max.	Rem. —	2,4 3,6	0,5 1,5	0,05 0,4	— —	— —	— —	— —	— —	— —	— —	— 0,10	— 0,05	— 0,05	— 0,005	— —	— 0,30	
	ISO-MgAl3Zn1(C)	ISO-WD21153	MAZ31c	B, P	min. max.	Rem. —	2,5 3,5	0,50 1,5	0,20 0,40	— —	— —	— —	— —	— —	— —	— —	— 0,05	— 0,008	— —	— —	— 0,02	— 0,15	
	ISO-MgAl6Zn1	ISO-WD21160	MAZ61	B,T,F, P	min. max.	Rem. —	5,5 6,5	0,50 1,5	0,15 0,40	— —	— —	— —	— —	— —	— —	— —	— 0,10	— 0,005	— 0,05	— 0,005	— —	— 0,30	
	ISO-MgAl8Zn	ISO-WD21170	MAZ80	B,T,F	min. max.	Rem. —	7,8 9,2	0,20 0,8	0,12 0,40	— —	— —	— —	— —	— —	— —	— —	— 0,10	— 0,005	— 0,05	— 0,005	— —	— 0,30	
	ISO-MgAl9Zn1	ISO-WD21180	MAZ91	B,T	min. max.	Rem. —	8,6 9,5	0,35 1,0	0,15 0,50	— —	— —	— —	— —	— —	— —	— —	— 0,10	— 0,005	— 0,05	— 0,005	— —	— 0,30	
<b>Key</b> B = bars and solid sections T = tubes and hollow sections F = forgings P = plate and sheet RE = neodymium and other heavy rare earth metals a RemAlnder. Zn+Ag.																							