Welding Fillers

ELISENTAL

Aluminium and Magnesium

Ideas are impulses towards unlimited possibilities

Founded in 1919, Elisental continues to operate independently as a non-corporate enterprise and started specialising in the use of aluminium as a material at a very early stage. Today, the company is one of the leading European manufacturers of aluminium wire.

Aluminium welding fillers have been part of the company's range of products for the past 40 years.

This product group underwent persistent technical development and modification from the very beginning in order to comply fully with the continually increasing demands of the industrial sector.

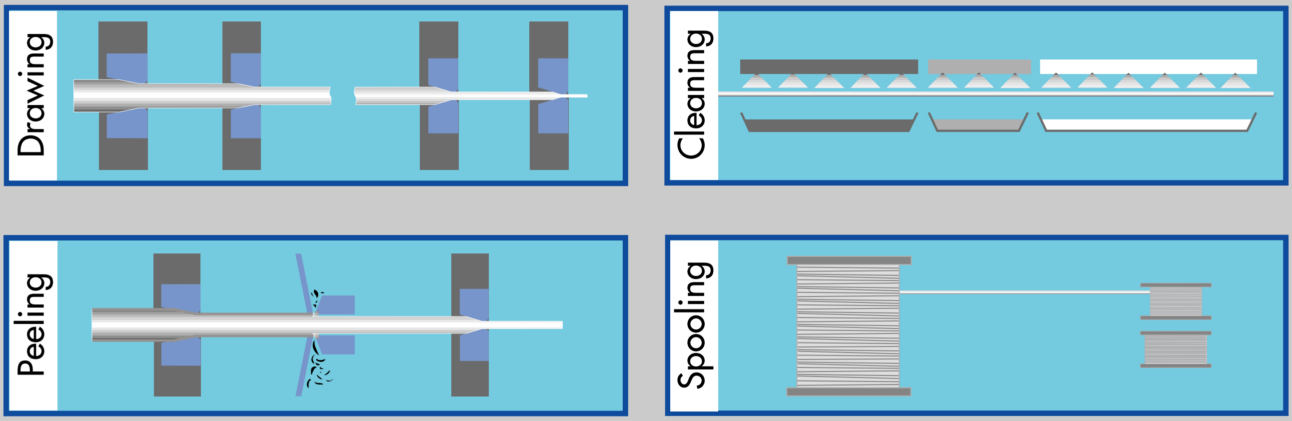
Following years of intensive cooperation with the suppliers of basic materials, we succeeded in implementing closely limited chemical compositions which produce optimal strength and stability with the smallest dimensional tolerances.

Modern drawing plants, diversified peeling processes as well as newly developed cleaning methods guarantee superior weldability of our twist-free and layer-wise spooled welding fillers.

We fully utilised our comprehensive know-how in the field of drawing technology. As a result, we are now in a position to introduce – for the first time worldwide – a completely drawn magnesium welding filler.

Numerous permits from the various classification companies confirm the superior quality of wire manufactured by Elisental.

Manufacturing stages



Fields of application for Elisental welding-fillers

Aviation

Transport

Quality assurance

Forms of supply	Ø	Tolerances
Spools	0.60	+ 0.01 − 0.03
	0.80 1.00 1.20 1.60 2.40	+ 0.01 − 0.04
Drums	1.20 1.60	+ 0.01 − 0.04
Bars/Rods	1.40 1.60 2.00 2.50 3.20 4.00 5.00 6.00	± 0.10

Shipbuilding

Pressure vessel construction

Building industry

Rail traffic

Automobile industry

Offshore applications

Application recommendations

Selection of welding filler types for the wrought and casting basic materials to be welded.*

Basic mat. (Groups)	AlCuMn	AlCu	AlSiCu	AlSiMg	AlZnMg	AlMgSi	AlMg5% a.s. with Mn	AlMg3% a.s. with Mn	AlMg<1%	AlMn	Al
Al			4 4 4	4 4 4	5 5 5	4 or 5 5 4	5 5 5	4 or 5 5[d] 4 or 5	4 or 5 1 4	4 or 5 1 4	4 1 4
AlMn			4 4 4	4 4 4	5 5 5	4 or 5 5 4	5 5 5	5 5[d] or 3 4	4 4 4	3 or 4 3 4	
AlMg<1%[a]			4 4 4	4 4 4	5 5 5	4 or 5 5 4	5 5 5	5 5[d] 4	4 4 4		
AlMg3% a.s. with Mn			4 4 4	4 4 4	5 5 5	5 5 4	5 5 5	5 5[d] 5			
AlMg5%[b] a.s. with Mn			4 4 4	4 4 4	5 5 5	5 5 4	5 5 5				
AlMgSi[c]		4 4 4	4 4 4	4 4 4	5 5 5	4 or 5 5 4					
AlZnMg		4 4 4	4 4 4	4 4 4	5 5 5						
AlSiMg[e]		4 4 4	4 4 4	4 4 4							
AlSiCu[e,f]		4 4 4	4 4 4								
AlCu[e]		 4									
AlCuMn	2 2 2										

The basic materials are listed according to their chemical composition without reference to wrought or casting materials

Details within each box:

1. Line = optimal mechanical properties
2. Line = optimal corrosion properties
3. Line = optimal welding suitability

No details = no recommendation

* The welding filler ultimately selected from the respective type series is determined by the specific welding assignment (refer also to the relevant footnote).

Group Categorisation of the Welding Fillers

Type	Numerical Designation	Works-Designation	Chemical Designation	Remarks
Type 1	R 1098 A R 1080 A R 1450	(DE 50) (DE 52) (DE 53)	R - AL 99,98 R - AL 99,8 (A) R - AL 99,5 Ti	Ti causes fine grain structure and subsequently reduces the formation of solidification cracks
Type 2	R 2319	(DE 71)	R - ALCu6Mn (A)	
Type 3	R 3103	(DE 54)	R - ALMn1	
Type 4	R 4043 A R 4018 R 4046 R 4047 A	(DE 59) (DE 68) (DE 61) (DE 60)	R - ALSi5 (A) R - ALSi7Mg R - ALSi10Mg R - ALSi12 (A)	Weld seams produced with Si-filler oxidise during anodising or as a result of ambient influences and, depending on the size of the Si-content, produce a grey to dark grey colouring which leads to colour differences between the seam and the basic material. However, their application is particularly suitable in order to prevent the formation of solidification cracks (self-healing effect).
Type 5	R 5249 R 5754 R 5356 R 5556 A R 5183 R 5087	(DE 57) (DE 56) (DE 58) (DE 70) (DE 63) (DE 64)	R - ALMg2Mn0,8Zr R - ALMg3 R - ALMg5Cr (A) R - ALMg5Mn R - ALMg4,5Mn0,7 (A) R - ALMg4,5MnZr	If good corrosion resistance and colour adaptation effect are of primary importance, then the Mg-content of the welding filler should be equal to that of the basic material. When high yield strengths and fracture strengths are specified, a welding filler with an Mg-content of 4.5 – 5.5% should be used. Cr = reduction of solidification cracks Zr = reduction of hot cracks

Note: The type numbers 1, 2, 3, 4 and 5 coincide with the first digit of the numerical alloy designation.

Explanation of footnotes

a) When welding without a filler, these alloys are susceptible to the formation of solidification cracks. This can be prevented with the use of solid restraints. Otherwise, a basic material change with Mg>3% is to be given preference.

b) Under certain ambient conditions, such as under temperature application > 65°C, alloys with an Mg-content >3% can be susceptible for intergranular corrosion and/or stress crack corrosion. Susceptibility increases with increasing Mg-content, in which case the mixing degree is to be given due consideration

c) These alloys are not to be recommended for welding without a filler because they are susceptible for the formation of cold cracks.

d) The resistance against intergranular corrosion and stress crack corrosion of type 5 according to chart 1 is increased if the Mg-content does not exceed ~ 3%. For application conditions, which possibly cause intergranular corrosion and/or stress crack corrosion , the Mg-content of the welding material should be similar to that of the basic material and not substantially greater. Accordingly, this is to be observed when welding the basic materials with the corresponding alloys for the welding fillers.

e) The Si-content of the welding fillers should be selected in such a way that it has the maximum possible adaptation to that of the casting basic material.

f) Die casting alloys, depending on the gas content, are only weldable under certain conditions.

References to Standards/Codes

1. (DIN) EN 759	Technical delivery conditions for metallic welding fillers; type of product, sizes, limit dimensions and designation, German version EN 759: 1997
2. (DIN) EN 573-3	Aluminium and aluminium alloys: chemical composition and form of semi-finished material; Part 3: chemical composition
3. (DIN) EN ISO 18273	Welding – recommendations for the welding of metallic materials – part 4: arc welding of aluminium and aluminium alloys
4. prEN 1011-4	Wire electrodes, wires and bars/rods for arc welding of aluminium and aluminium alloys; introduction (ISO/DIS 182373: 1999); German version prEN ISO 1823:1999
5. DIN 4113-2	Aluminium structures under predominantly resting loading; calculation of welded aluminium structures
6. prEN ISO 15614-2	Requirement and recognition of welding procedures for metallic materials – welding procedure test - ; part 2: arc welding of aluminium and its alloys
7.ISO 10042	Arc welding joints on aluminium and its (is presently under revision) alloys suitable for welding

Permits

Symbol of source of issue	Permits	Usable welding fillers	numerical designation
	Germanischer Lloyd Schipbuilding	DE 56 DE 58 DE 63 DE 64	R 5754 R 5356 R 5183 R 5087
	Lloyd's Register of Shipping Schipbuilding	DE 63 DE 56 DE 58 DE 63	R 5183 R 5754 R 5356 R 5183
DNV	Det Norske Veritas Schipbuilding	DE 58 DE 63	R 5356 R 5183
ABS	American Bureau of Shipping Schipbuilding	DE 58 DE 63	R 5356 R 5183
BV	Bureau Veritas Schipbuilding	DE 63 DE 64	R 5183 R 5087
DB	Deutsche Bahn AG (German Rail) Rail vehicle construction	DE 51 DE 53 DE 56 DE 57 DE 58 DE 59 DE 60 DE 63 DE 64	R 1080 A R 1450 R 5754 R 5249 R 5356 R 4043 A R 4047 A R 5183 R 5087
TÜV	Technical Inspection Association Pressure vessel construction	DE 50 DE 51 DE 53 DE 56 DE 57 DE 58 DE 63 DE 64 DE 65	R 1098 A R 1080 A R 1450 R 5754 R 5249 R 5356 R 5183 R 5087 not standardised
BWB	Federal Agency for military defence technology and procure- ment of high-stressed components for military defence material	DE 63 DE 64	R 5183 R 5087

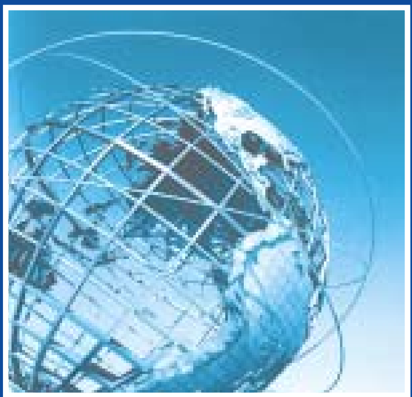
Welding faults

<table>
<tr><th>Most frequent fault sources</th><th>Causes/TIG-welding</th><th>Causes/MIG-welding</th></tr>
<tr><td>Arc fails to ignite, or arc poorly ignites</td><td>Failure of power circuit, no earthing connection, disturbance of the HF or impulse unit, lack of shield gas supply</td><td>Welding power circuit disrupted, incorrect poling, disturbance in the wire feed (e.g. resulting from wear).</td></tr>
<tr><td>Fluctuating arc</td><td>Irregular network voltage, no-load voltage too low, disturbance of condenser, electrode diameter too thick, workpiece too cold.</td><td>Disturbed wire feed (wear, buckled wire electrode, excessively bent hose assembly), worn down contact tube</td></tr>
<tr><td rowspan="2">Grey-black and rough seam surface, spatter formation (more frequent with MIG-welding)</td><td colspan="2">Disturbed shield gas atmosphere (e.g., air draught), leakage in cooling water or shield gas line system, fouling in the seam flank zone or at the welding filler, excessively large nozzle clearance, too little – too much and damp or non-pure shield gas.</td></tr>
<tr><td>Fouled tungsten electrode as a result of contact with melted workpiece</td><td>incorrect holding of burner, arc too long</td></tr>
<tr><td rowspan="2">Porous weld seams/oxide inclusions (more frequent with MIG-welding)</td><td colspan="2">The above-mentioned causes can also be extensively responsible for pores (hydrogen bubbles) and oxide inclusions.</td></tr>
<tr><td>Welding current too low, contact of the melted welding rod end with the air outside of the shield gas zone</td><td>Faults on the weld filler surface, badly fouled gas nozzle caused by spatter (beware of an unsuitable anti-adhesive spray), wrong holding of burner, inadequate degasification of weld material as a result of excessively fast freezing (welding done too cold), speed of wire feed too low, arc too short, uncleaned interim seam surfaces with multiple-layer welding. (Welding filler diameter too thin).</td></tr>
<tr><td>Lack of fusion (more frequent with MIG-welding)</td><td colspan="2">Inadequate seam edge preparation (unclean, too steep), inadequate heat-up of the welding location and its ambient area (thick plates not pre-heated), insufficient melting of basic material (usually one-sided) as a result of excessively high welding speed or differently thick materials.</td></tr>
<tr><td>Weld seam cracks</td><td colspan="2">Unsuitable welding filler, occurrence of excessively large welding stresses and, subject to constructive conditions, shrinkage obstruction (non-optimal welding sequence), starting-point crater cracks and end crater cracks as a result of insufficient feed of welding filler (if possible, locate end crater on extension plate or work with crater filling program (MIG).</td></tr>
<tr><td>Faulty full penetration weld</td><td colspan="2">Too much or too little welding power (voltage/additional supply), welding speed too high or too low, with the weld pool too hot or too cold, incorrect welding gap.</td></tr>
<tr><td>Inadequate penetration</td><td colspan="2">Incorrect joint (groove) form, welding speed too high, arc too long, power source not transistor-controlled.</td></tr>
<tr><td>Stick melt/burn-back (only with MIG-welding)</td><td></td><td>If the wire feed is disturbed or too small in relation to the arc voltage, the welding wire burns back and melts solidly on the copper nozzle of the burner.</td></tr>
<tr><td colspan="3">With reference to the shield gas:
Argon-helium gas mixtures improve the penetration and can also support pore reduction as a result of the higher heat application. Low-level oxygen or nitrogen additives in the gases – so-called “doped” gases – stabilise the arc, and this can lead to a finer seam formation and to a reduction of spatter.</td></tr>
<tr><td>Characteristics of unobjectionable weld seams</td><td>Good TIG-seams are essentially a result of optimally set welding parameters. These seams have a regular ripple finish. On both sides of the seam there is a narrow, white (deoxidised) zone. The seam surface has a bright finish and, by contrast with MIG-welding, is smooth and free of scaling deposits.</td><td>Good MIG-seams are essentially the result of optimally set welding parameters. They have a uniform, fine ripple finish on the seam with an excellent transition to the basic material. The precipitation occurring occasionally on the surface can be easily brushed off.</td></tr>
</table>

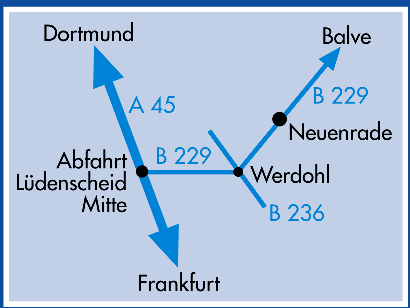
Unlimited Possibilities

by means of the allround materials aluminium and magnesium

Aluminium wire products are indispensable in all industrial sectors. Persistent developments and modifications of alloys over the past decades have enhanced the basic material to such an extent that the application options are practically unlimited.



Ideas are impulses towards unlimited possibilities. We have ideas.



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DRAHTWERK ELISENTAL ·W. Erdmann GmbH & Co.

Werdohler Straße 40 · D-58809 Neuenrade

Phone: + 49 (0)2392/697-0 · Telefax + 49 (0)2392/62044

e-mail: info@elisental.de · Int: www.elisental.de