

# (Aluminum & Aluminum Based-Alloy)

: LG

## 1.

Aluminum		Table 1, 2		
1000	7000	4		
	가			
	Al	99.0%	Al	1XXX
	Al-Cu			2XXX
	Al-Mn			3XXX
	Al-Si			4XXX
	Al-Mg			5XXX
	Al-Mg-Si			6XXX
	Al-Zn-(Mg, Cu)			7XXX
				8XXX
		( )		9XXX

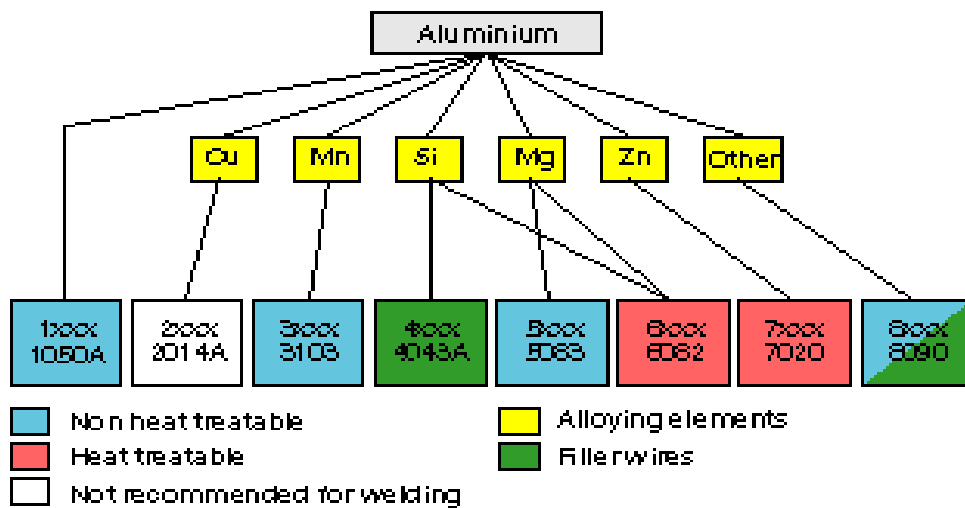


Fig. 1

Table 1 Aluminum

Alloy Group	Material
1000	Al 가
2000	Cu 가 Mg ( 2219 Rivet )
3000	Mn 가 Al 가
4000	Si 가
5000	Mg 가
6000	Mg Si 가
7000	Zn 가 Mg 가

Table 2 Al

	Al (%)									
	Si	Fe	Cu	Mn	Mg	Zn	Cr	Ti		Al
1060	0.25	0.35	0.05	0.03	0.03	0.05	-	0.03		99.6
1100	1.0		0.05~0.20	0.05	-	0.10	-	-		99.0
2011	0.40	0.7	5.0 ~ 6.0	-	-	0.30	-	-	Pb : 0.20~0.6 Bi : 0.20~0.6	Remainder
2014	0.50 ~ 1.2	0.7	3.9 ~ 25.0	0.40 ~ 1.2	0.20 ~ 0.8	0.25	0.10	-	Zr + Ti : 0.20	Remainder
2024	0.5	0.5	3.8 ~ 4.9	0.30 ~ 0.9	1.2 ~ 1.8	0.25	0.10	-	Zr + Ti : 0.20	Remainder
2219	0.20	0.30	5.8 ~ 6.8	0.20~0.40	0.02	0.10	-	0.02 ~ 0.10	V : 0.05~0.15 Zr : 0.10~0.25	Remainder
3003	0.6	0.7	0.05~0.20	1.0 ~ 1.5	-	0.10	-	-		Remainder
3004	0.30	0.7	0.25	1.0 ~ 1.5	0.8 ~ 1.3	0.25	-	-		Remainder
3005	0.6	0.7	0.30	1.0 ~ 1.5	0.20 ~ 0.6	0.25	0.10	0.10		Remainder
4032	11.0 ~ 13.5	1.0	0.50 ~ 1.3	-	0.8 ~ 1.3	0.25	0.10	-	Ni : 0.5 ~ 1.3	Remainder

	(%)									
	Si	Fe	Cu	Mn	Mg	Zn	Cr	Ti		Al
4043	4.5 ~ 6.0	0.8	0.03	0.05	0.05	0.10	-	0.20		Remainder
5005	0.30	0.70	0.20	0.20	0.5 ~ 1.1	0.25	0.10	-		Remainder
5052	0.25	0.40	0.10	0.10	2.2 ~ 2.8	0.10	0.15~0.35	-		Remainder
5083	0.40	0.40	0.10	0.40 ~ 1.0	4.0 ~ 4.9	0.25	0.05~0.25	0.15		Remainder
5082	0.20	0.35	0.15	0.15	4.0 ~ 5.0	0.25	0.15	0.10		Remainder
6061	0.40 ~ 0.8	0.7	0.15~0.40	0.15	0.8 ~ 1.2	0.25	0.04~0.35	0.15		Remainder
6063	0.20 ~ 0.6	0.35	0.10	0.10	0.45 ~ 0.9	0.10	0.10	0.10		Remainder
6N01	0.40 ~ 0.9	0.35	0.35	0.50	0.40 ~ 0.8	0.25	0.30	0.10		Remainder
6951	0.20~0.50	0.8	0.15~0.40	0.10	0.40 ~ 0.8	0.20	-	-		Remainder
7003	0.30	0.35	0.20	0.30	0.50 ~ 1.0	5.0 ~ 6.5	0.20	0.20	Zr : 0.05~0.25	Remainder
7072	0.7		0.10	0.10	0.10	0.8 ~ 1.3	-	-		Remainder
7075	0.40	0.5	1.2 ~ 2.0	0.30	2.1 ~ 2.9	5.1~6.1	0.18 ~ 0.35	-	Zr + Ti : 0.25	Remainder
7N01	0.30	0.35	0.20	0.20 ~ 0.7	1.0 ~ 2.0	4.0 ~ 5.0	0.30	0.20	Zr : 0.25 V : 0.10	Remainder

●

Aluminum Association

## 1.1 Aluminum

가

pH 4.5 ~ 8.5

Fe, Cu, Pb

ppm

가

(Mn, Si, Mg, Cu, Zn, Cr )

가

4

2

### 1.1.1

#### (1) 가

Al Al 가 가 , 가  
가 가 Mn, Si, Mg  
가 H 가 가  
가 .

#### (2)

Al Cu , 4~5 가  
가 .

#### (3)

Al 2 .  
1.5

#### (4)

Al ,  
50~100 Al 2270~3070K Arc  
Al  
3.75~4.0 Al  
가  
가 Al

## 1.2

### 1.2.1

(Mg) (Si), (Fe), (Mn),  
Table 1 2 1XXX, 3XXX, 4XXX,  
5XXX

가

가

가

343 ~ 410

가

Table 3

Table 3

	Nominal Composition (%)					
	Cu	Mn	Mg	Cr		
1080	99.8% Min. Aluminum					Tank
1070	99.7% Min. Aluminum					
1060	99.6% Min. Aluminum					
1050	99.5% Min. Aluminum					
1020	99.2% Min. Aluminum					
1100	99.0% Min. Aluminum					
3003	0.12	1.2	-	-	1100 1100	
3004	-	1.2	1.0	-	3003 가 Deep Draw	Can Body, Base, , Color Al
5005	-	-	0.8	-	3003 가 가	低 ,
5050	-	-	1.4	-		3003 5005
5052, 5652	-	-	2.5	-		Tank, 가
5082	-	-	4.5	0.15	5083 가 가 가 , 가	Can End
5083	-	0.7	4.4	0.15	가 , .	, ,

	Nominal Composition (%)					
	Cu	Mn	Mg	Cr		
5086	-	0.45	4.0	0.15		
5154, 5254	-	-	3.5	0.25	5052 5083 中 가	
5454	-	0.8	2.7	0.12		
5456	-	0.8	5.1	0.12		
5N01	-	-	0.4	-		

-X

Table 4

- 0	Annealed, recrystallized	가
- F	As fabricated	가 가 가
- H1	Strain hardened only	가 가
- H2	Strain hardened and then partial annealed	
- H3	Strain hardened and then stabilized	

Table 5

/	Yield Strength (Kgf/mm <sup>2</sup> )	Tensile Strength (Kgf/mm <sup>2</sup> )	Elongation thickness (1.6mm %)	Brinell Hardness	(Kgf/mm <sup>2</sup> )	(Kgf/mm <sup>2</sup> )
1070 -O	4.50	7.00	37	18		
-H14	8.00	11.00	8	32		
-H18	15.00	16.00	5	38		
1050 -O	3.00	8.00	39	20	6.50	3.00
-H14	10.50	11.00	10	32	7.00	3.50
-H16	12.50	13.50	8	36	8.00	4.00
-H18	15.00	16.00	7	40	8.50	5.00
1100 -O	3.50	9.00	35	23	6.50	3.50

/	Yield Strength (Kgf/mm <sup>2</sup> )	Tensile Strength (Kgf/mm <sup>2</sup> )	Elongation thickness (1.6mm %)	Brinell Hardness	(Kgf/mm <sup>2</sup> )	(Kgf/mm <sup>2</sup> )
-H12	10.50	11.00	12	28	7.00	4.00
-H14	12.00	12.50	9	32	7.50	5.00
H16	14.00	15.00	6	38	8.50	6.50
-H18	15.50	17.00	5	44	9.00	6.50
1200-O	4.00	9.50	38	23	6.50	3.50
-H14	11.50	12.00	9	32	8.00	5.00
-H16	13.50	14.50	6	38	8.50	6.00
-H18	17.00	18.00	6	44	9.00	6.00
3003-O	4.00	11.00	30	28	7.50	5.00
-H12	12.50	13.50	10	35	8.50	5.50
-H14	15.00	15.50	8	40	10.00	6.50
-H16	17.50	18.50	5	47	10.50	7.00
-H18	19.00	20.50	4	55	11.00	7.00
3004-O	7.00	18.50	20	45	11.00	10.00
-H32	17.50	22.00	10	52	12.00	10.50
-H34	20.50	24.50	9	63	12.50	10.50
-H36	23.00	26.50	5	70	14.00	11.00
-H38	25.50	29.00	5	77	15.00	11.00
5005-O	4.00	12.50	25	28	7.50	-
-H12	13.50	14.00	10	-	10.00	-
-H14	15.50	16.00	6	-	10.00	-
-H16	17.50	18.50	5	-	10.50	-
-H18	19.50	20.50	4	-	10.00	-
-H32	12.00	14.00	11	36	11.00	-
-H34	14.00	16.00	8	41	10.00	-
-H36	17.00	18.50	6	46	10.50	-
-H38	19.00	20.50	5	51	11.00	-
5052-O	9.00	19.50	25	47	12.50	11.00
-H32	19.50	23.00	12	60	14.00	12.00
-H34	22.00	26.50	10	68	15.00	12.50
-H36	24.50	28.00	8	73	16.00	13.50
-H38	26.00	29.50	7	77	17.00	14.00
5056-O	15.50	29.50	-	65	18.50	14.00
-H18	41.50	44.50	-	105	24.00	15.50
-H38	35.00	42.00	-	100	22.50	15.50
5083-O	15.00	29.50	-	-	17.50	-
-H321	23.00	32.50	-	-	-	16.00
5086-O	12.00	26.50	22	-	16.00	-
-H32	21.00	29.50	12	-	-	-
-H34	26.00	33.00	10	-	19.00	-
-H38	13.50	27.50	14	-	-	-
5086-O	5.50	12.50	25	30	8.5	6.50
-T4, T451	15.00	24.50	22	25	17.00	10.00
-T6, T651	28.00	31.50	12	17	21.00	10.00





7004	-	-	-	1.5	4.2	-	-	가 ,
7005	-	-	0.45	1.4	4.5	-	0.13	가 ,
7039	-	-	0.30	2.8	5.6	-	0.23	,
7075	1.6	-	-	2.5	5.6	-	0.23	2024 Al 가 ,
7079	0.6	-	-	3.3	4.3	-	0.20	가 76.2mm ,
7178	2.0	-	-	2.8	6.8	-	0.23	, 7075

가

-X

Table 7

- 0	Annealed	,
- F	As fabricated	,
- W	Solution heat treated	.
- T1	Cooled from an elevated-temperature shaping process and naturally aged to a subsequent stable condition	가 가 가
- T2		가 가 가
- T3	Solution heat treated, cold worked, and naturally aged to a substantially stable condition.	가 가 가
- T4	Solution treated and naturally aged to a substantially stable condition	가 가 가
- T5	Cooled from an elevated-temperature shaping process and then artificially aged	가 가 가
- T6	Solution heat treated and stabilized	가 가 가

- T7	Solution heat treated and stabilized	가
- T8	Solution heat treated, cold worked, and then artificially aged	가 , 가
- T9	Solution heat treated, artificially aged, then cold worked	가
- T10	Cooled from an elevated-temperature shaping process, cold worked, and then artificially aged.	가 가 ,

Table 8

/	Yield Strength (Kgf/mm <sup>2</sup> )	Tensile Strength (Kgf/mm <sup>2</sup> )	Elongation thickness (1.6mm %)	Brinell Hardness	(Kgf/mm <sup>2</sup> )	(Kgf/mm <sup>2</sup> )
2014-O	10.00	19.00	-	45	12.50	9.00
-T4, T451	29.50	43.50	-	105	26.50	14.00
-T6, T651	42.00	49.00	-	135	29.50	12.50
2017-O	7.00	18.00	-	45	12.50	9.00
-T4, T451	28.00	43.50	-	105	26.50	12.50
2024-O	8.00	19.00	20	47	12.50	9.00
-T3	35.00	49.00	18	120	29.00	14.00
-T351, T4	33.00	48.00	20	120	29.00	14.00
-T36	40.00	50.50	13	130	29.50	12.50
6063-O	5.00	9.00	-	25	7.00	5.50
-T1	9.00	15.50	20	42	10.00	6.50
-T4	9.00	17.50	22	-	-	-
-T5	15.00	19.00	12	60	12.00	7.00
-T6	22.00	24.50	12	73	15.50	7.00
-T83	24.50	26.00	9	82	15.50	-
-T831	19.00	21.00	10	70	12.50	-
-T832	27.50	29.50	12	95	19.00	-
7075-O	10.50	22.50	17	-	15.50	-
-T6, T651	47.00	53.50	11	-	32.50	-

## 2.

### 2.1

#### 2.1.1

JIS Z 3232                      (BY)                      Wire (WY)  
 ASME Sec. II Part C              SFA 5.10  
 ASME Sec. II Part C              SFA 5.10

Table 9    (SFA-5.10)

	UNS No.	(wt%)									Others		Aluminum
		Si	Fe	Cu	Mn	Mg	Cr	Ni	Zn	Ti	Each	Total	
ER1100 R1100	A91100	Si + Fe < 0.95		0.05 ~ 0.20					0.10		0.05 <sup>A</sup>	0.15	99.0% Min.
ER1188 <sup>B</sup> R1188 <sup>B</sup>	A91188	0.06	0.06	0.00 5	0.01	0.01			0.03	0.01	0.01 <sup>A</sup>		99.88% Min.
ER2319 <sup>C</sup> R2319 <sup>C</sup>	A92319	0.20	0.30	5.8 ~ 6.8	0.20 ~ 0.40	0.02			0.10	0.10 ~ 0.20	0.05 <sup>A</sup>	0.15	Rem.
ER4009 R4009	A94009	4.5 ~ 5.5	0.20	1.0 ~ 1.5	0.10	0.45 ~ 0.6			0.10	0.20	0.05 <sup>A</sup>	0.15	Rem.
ER4010 R4010	A94010	6.5 ~ 7.5	0.20	0.20	0.10	0.30 ~ 0.45			0.10	0.20	0.05 <sup>A</sup>	0.15	Rem.
R4011	A94011	6.5 ~ 7.5	0.20	0.20	0.10	0.45 ~ 0.7			0.10	0.04 ~ 0.20	0.05 <sup>A</sup>	0.15	Rem.
ER4043 R4043	A94011	4.5 ~ 6.0	0.8	0.30	0.05	0.05			0.10	0.20	0.05 <sup>A</sup>	0.15	Rem.
ER4047 R4047	A94047	11.0 ~ 13.0	0.8	0.30	0.05	0.05			0.20		0.05 <sup>A</sup>	0.15	Rem.
ER4145 R4145	A94515	9.3 ~ 10.7	0.8	3.3 ~ 4.7	0.15	0.15	0.15		0.20		0.05 <sup>A</sup>	0.15	Rem.
ER4643 R4643	A94643	3.6 ~ 4.6	0.8	0.10	0.05	0.10 ~ 0.30			0.10	0.15	0.05 <sup>A</sup>	0.15	Rem.
ER5183 R5183	A95183	0.40	0.40	0.10	0.50 ~ 1.0	4.3 ~ 5.2	0.05 ~ 0.25		0.25	0.15	0.05 <sup>A</sup>	0.15	Rem.
ER5356 R5356	A95356	0.25	0.40	0.10	0.05 ~ 0.20	4.5 ~ 5.5	0.05 ~ 0.20		0.10	0.06 ~ 0.20	0.05 <sup>A</sup>	0.15	Rem.
ER5554 R5554	A95554	0.25	0.40	0.10	0.50 ~ 1.0	2.4 ~ 3.0	0.05 ~ 0.20		0.25	0.05 ~ 0.20	0.05 <sup>A</sup>	0.15	Rem.
ER5556 R5556	A95556	0.25	0.40	0.10	0.50 ~ 1.0	4.7 ~ 5.5	0.05 ~ 0.20		0.25	0.05 ~ 0.20	0.05 <sup>A</sup>	0.15	Rem.
ER5654 R5654	A95654	Si + Fe < 0.45		0.05	0.01	3.1 ~ 3.9	0.15 ~ 0.35		0.20	0.05 ~ 0.15	0.05 <sup>A</sup>	0.15	Rem.
R-206.0 <sup>D</sup>	A902060	0.10	0.15	4.2 ~ 5.0	0.20 ~ 0.50	0.15 ~ 0.35		0.05	0.10	0.15 ~ 0.33	0.05	0.15	Rem.

	UNS No.	(wt%)									Others		Aluminum
		Si	Fe	Cu	Mn	Mg	Cr	Ni	Zn	Ti	Each	Total	
										0			
R-C355.0	A33550	4.5 ~ 5.5	0.20	1.0 ~ 1.5	0.10	0.40 ~ 0.6			0.10	0.20	0.05	0.15	Rem.
R-A356.0	A13560	6.5 ~ 7.5	0.20	0.20	0.10	0.25 ~ 0.45			0.10	0.20	0.05	0.15	Rem.
R-357.0	A03570	6.5 ~ 7.5	0.15	0.05	0.03	0.45 ~ 0.6			0.05	0.20	0.05	0.15	Rem.
R-A357.0 <sup>E</sup>	A13570	6.5 ~ 7.5	0.20	0.20	0.10	0.40 ~ 0.7			0.10	0.04 ~ 0.20	0.05	0.15	Rem.

Note :

A : Beryllium content shall be 0.0008% maximum.

B : Vanadium content shall be 0.05% maximum. Gallium content shall be 0.03% maximum.

C : Vanadium content shall be 0.5 ~ 0.15%. Zirconium content shall be 0.10 ~ 0.25%.

D : Tin content shall not exceed 0.05%

E : Beryllium content shall be 0.04 ~ 0.07%

Rem : Remainder

### 2.1.2

가

- 1)
- 2)
- 3)
- 4)
- 5)
- 6) Anodizing

(1)

가

가 가

가 가

가

(Hot short)

가

가 가

가 가

가 가

가

가

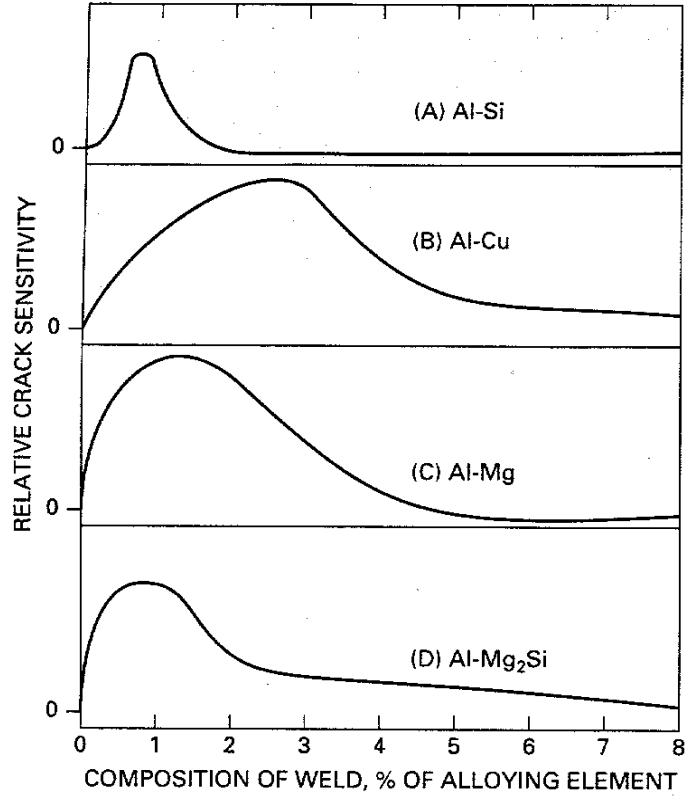
7-9

Al-Si (4XXX ), Al-Mg (5XXX ),

Al-Cu (2XXX ), Al-Mg<sub>2</sub>Si (6XXX )

Silicon Manganese

가



7-9

(2)

가

가

(3)

Al-Mg

3%

Mg

66

Mg

가

Table 10

	, wt%									Al	
	Si	Fe	Cu	Mn	Mg	Cr	Zn	Ti	Each		Total
1100	Si + Fe < 0.95		0.05~ 0.20	0.05	-	-	0.10	-	0.05	0.15	99.0 Min.
1188	0.06	0.06	0.005	0.01	0.01	-	0.03	0.01	0.01	-	99.88 Min.
2319	0.20	0.03	5.8 ~ 6.8	0.20~ 0.40	0.02	-	0.10	0.10~ 0.20	0.05	0.15	Remainder
4009	4.5~ 5.5	0.20	1.0~ 1.5	0.10	0.45~ 0.6	-	0.10	0.10~ 0.20	0.05	0.15	Remainder
4010	6.5~ 7.5	0.20	0.20	0.10	0.30~ 0.45	-	0.10	0.20	0.05	0.15	Remainder
4011	6.5~ 7.5	0.20	0.20	0.10	0.45~ 0.7	-	0.10	0.04~ 0.20	0.05	0.15	Remainder
4043	4.5~ 6.0	0.8	0.30	0.05	0.05	-	0.10	0.20	0.05	0.15	Remainder
4047	11.0~ 13.0	0.8	0.30	0.15	0.10	-	0.20	-	0.05	0.15	Remainder
4145	9.3~ 10.7	0.8	3.3~ 4.7	0.15	0.15	0.15	0.20	-	0.05	0.15	Remainder
4643	3.6~ 4.6	0.8	0.10	0.05	0.10~ 0.30	-	0.10	0.15	0.05	0.15	Remainder
5183	0.40	0.40	0.10	0.50~ 0.10	4.3~ 5.2	0.05~ 0.25	0.25	0.15	0.05	0.15	Remainder
5356	0.25	0.40	0.10	0.05~ 0.20	4.5~ 5.5	0.05~ 0.20	0.10	0.06~ 0.20	0.05	0.15	Remainder
5554	0.25	0.40	0.10	0.50~ 0.10	2.4~ 3.0	0.05~ 0.20	0.25	0.05~ 0.20	0.05	0.15	Remainder
5556	0.25	0.40	0.10	0.50~ 0.10	4.7~ 5.5	0.05~ 0.20	0.25	0.05~ 0.20	0.05	0.15	Remainder
5654	Si + Fe < 0.45		0.05	0.01	3.1~ 3.9	0.15~ 0.35	0.20	0.05~ 0.15	0.05	0.15	Remainder

(4)

Galvanic  
가  
Al-Mg  
가

(5)

Si Mg

Al-Si 4043

**(6) Anodizing**

가  
(Si) (Cr)  
가  
(Si) 가  
가 Al-Si  
(Cr) 가  
(Cu) (Mn)

**2.2**

Aluminum 가

**2.2.1 Gas Tungsten Arc Welding**

Al GTAW Cleaning  
Ar 가  
가 GTAW

Arc

Shielding Gas

가

## 2.2.2 Gas Metal Arc Welding

### (1) Short Circuit Arc

(Metal Transfer)가 Wire  
 $\varnothing 0.6\sim 1.2\text{mm}$ , 20~150A 3mm

### (2) Pulsed Arc

MIG Wire 가  
 (Spray)  
 Drop Globular  
 Arc 가 (Peak)  
 Wire Arc  
 Wire 1.2, 1.6  $\varnothing$ , 2.4  $\varnothing$

### (3) Spray Arc

GMAW Wire 1.0~2.4mm  $\varnothing$   
 100~500A 가

## 2.2.3 가

가 가 , 가 ,  
 , Al ,  
 Flux .  
 가 가 ,  
 - , - 가 .

## 2.2.4

(Stud Welding), (Electron Beam Welding),  
 Plasma Arc ,  
 Stud Welding .



## 2.3

### 2.3.1

(1)

가

Al

GTAW, MIG Arc

Air-plasma

, Air plasma

가

,

가

가

(2)

가

가

Grind

Table 11

Sodium Hydroxide (Caustic Soda)	NaOH 50 grams with 1 Water	140 ~ 160 (60 ~ 71 )	10 ~ 60 가	
Nitric Acid	HNO <sub>3</sub> (68%)		30	
Nitric Acid				
Sulfuric-Chromic	H <sub>2</sub> SO <sub>4</sub> 1 gal (3.79 ) CrO <sub>3</sub> 45oz (1.28kg) Water 9 gal (34.1 )	160 ~ 180 (60 ~ 82 )	2 ~ 3	
Phosphoric-Chromic	H <sub>3</sub> PO <sub>4</sub> (75%) 3.5gal (13,3 ) CrO <sub>3</sub> 1.75lb (79.4 grams) Water 100gal (379 )	200 (93 )	5 ~ 10	
Sulfuric Acid	H <sub>2</sub> SO <sub>4</sub> 5.81 oz (165 grams) Water 0.26 gal (1 )	165 (73 )	5 ~ 10	
Ferrous Sulfate	Fe <sub>2</sub> SO <sub>4</sub> H <sub>2</sub> 10% by Volume	80 (26.8 )	5 ~ 10	

(3)

1) 가 (Tack Weld)

Al

(JIG)

Table 12 가 (Tack Weld)

	(mm)		
GTAW	5 ~ 8	20 ~ 30mm	50 ~ 150mm
MIG	5 ~ 8	30 ~ 50mm	100 ~ 200mm

2)

가

3

100mm

가

2.3.2

(1)

1)

Al

가

가

가

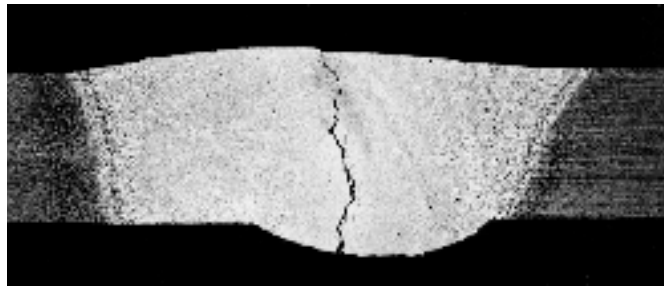


Fig.

2) ,  
 1000, 3000, 4000, 5000  
 ,  
 5000 Al-Mg. Mg 가  
 가 Mg 가  
 Mg 가  
 가 .

6000 Al-Mg-Si  
 Al-Mg Al-Si  
 6000 Mg Si  
 가 .

3) 가 , 가 , 가  
 가 Butt ,  
 Fillet .  
 ,  
 Arc .  
 Bead .  
 End TAB  
 Crater .  
 가  
 가 가  
 가 가

(2)

Al

가

가  
가

Al

가  
가

가

Table 10

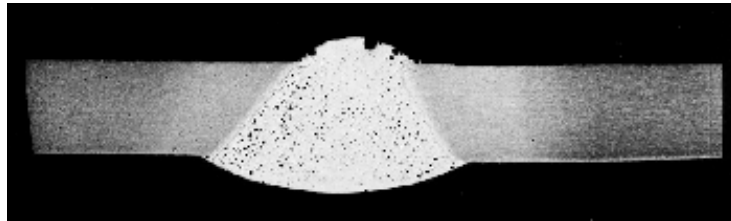


Fig.

Table 13

1.	
2.	(型材)
1.	가
2.	
3.	
4.	Torch

	Touch 가 (233K )
5.	Arc start .
6.	가 End-TAB Bead ( start ) ( 85~90% ) ( 1m/sec )
1.	가
2.	.
3.	Feedback .

(3)

Al

가

가

GTAW

Wire brush