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# Brazing Basic

 LG Electronics Air-Conditioning Academy

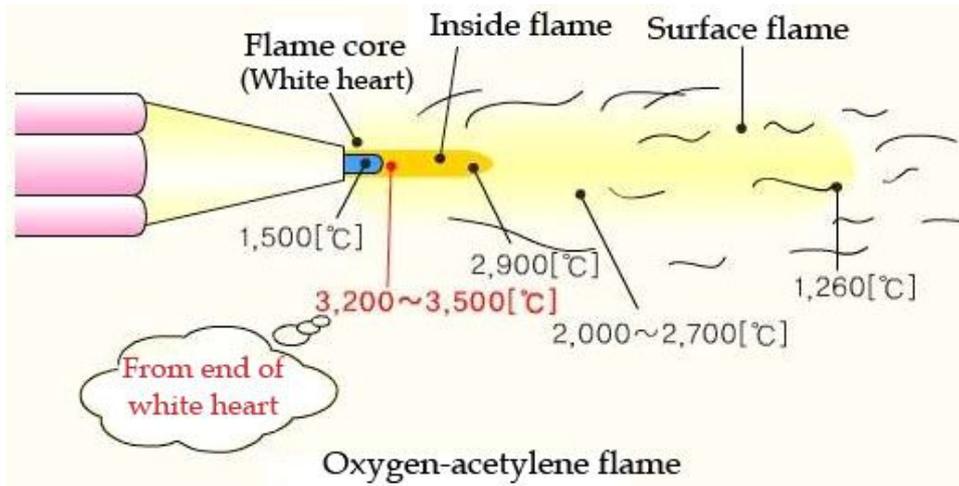
## What's Brazing ?



- .Brazing is a kind of welding binding two metals with another melted metal (so called “solder”) which has lower melting temperature point. In this case, the parent metal is not melted except the tiny alloy state surfaces. The melting temperature of solder is over 450°C. (cf. soldering)

# 1.Component of the Flame

## Component of the fire



–. the temperature of the oxy-acetylene flame is about over  $3200^\circ\text{C}$ , which is sufficient to melt edges of steel components and mild steel filler rods. Amount of oxygen should be 2.5 times more than acetylene

## Component of the fire

Type	Specific Gravity	Gas Mixture Ratio (combustible Gas : Oxygen)			Max fire Temp [ °C ]
		Max	Min	Optimum	
Acetylene (C <sub>2</sub> H <sub>2</sub> )	0.9656	1 : 1.1	1 : 1.8	1 : 1.7	3,430
Hydrogen (H <sub>2</sub> )	0.9696	1 : 0.5	1 : 0.5	1 : 0.5	2,900
Propane (C <sub>3</sub> H <sub>8</sub> )	1.5223	1 : 3.75	1 : 4.75	1 : 4.5	2,820
Methane (CH <sub>4</sub> )	0.5545	1 : 1.8	1 : 2.25	1 : 2.1	2,700

## 2. Soldering Materials

## Soldering Materials

### ■ Silver Solder

kind	Chemical ingredient (%)								Reference value		
	Ag	Cu	Zn	Cd	Al	Sn	Ni	Pb+Fe	Solid line temp.	Liquid line temp.	Soldering temp.
A :	44~46	14~16	14~18	-	-	-	-	UNDER 0.15	605	620	620~760
BAG-1											
B :	49~51	14.5~16.5	17~19	-	-	-	-	UNDER 0.15	605	630	635~760
BAG-1A											
C	34~36	25~27	19~23	17~19	-	-	-	UNDER 0.15	605	700	700~845
BAG-2											
D:	49~51	14.5~16.5	13.5~17.5	15~17	2.5~3.5	-	-	UNDER 0.15	630	790	690~815
BAG-3											
E:	39~41	29~31	26~30	-	1.5~2.5	-	-	UNDER 0.15	670	780	780~900
BAG-4											
F:	44~46	29~31	23~27	-	-	1.5~2.5	-	UNDER 0.15	675	745	745~845
BAG-5											
G:	49~51	33~35	14~18	-	-	-	-	UNDER 0.15	690	775	775~870
BAG-6											
H:	55~57	21~23	15~19	-	-	4.5~5.5	-	UNDER 0.15	620	650	650~760
BAG-7											
I:	71~73	27~29	-	-	-	-	-	UNDER 0.15	780	780	780~900
BAG-8											
J:	71~73	REST	-	-	-	-	0.15~0.3	UNDER 0.15	770	770	770~870
BAG-8A											

- Soft welding material made of mainly silver is called silver welding solder. It is marked like "BAG-O" by KS, JIS, AWS regulations, but there are a lot of other materials in use.
- Silver solder welding is the most popular, because it has the best feature in melting point, strength, easy using, and surface in comparison with other soft welding materials.

 Generally, C-Type containing 34~36% of Ag is widely used in brazing Cu-alloy and brass parts.

## Soldering Materials

### ■ Cu-P Solder

#### \* Features of Cu-P material

kind	Chemical ingredient (%)				Reference value		
	Cu	P	Ag	Others	Solid line temp.	Liquid line temp.	Solid line temp.
BCUp-1	Remains	4.8~5.3	-	Under 0.2	705	900	785~925
BCUp-2	Remains	6.8~7.5	-	Under 0.2	705	900	735~840
BCUp-3	Remains	5.8~6.7	4.7~6.3	Under 0.2	640	900	705~840
BCUp-4	Remains	6.8~7.7	4.7~6.3	Under 0.2	640	900	705~815
BCUp-5	Remains	4.8~15.5	14.5~15.5	Under 0.2	640	900	705~815

- Cu-P is a material of which the melting point is lowered by adding phosphorus to copper, and has Self-Fluxing effect on same matrix.
- Ag-Cu-P alloy has more productivity, ductility by adding silver to Cu-P alloy. P-Cu welding material is well-known by its mechanical strength, durability and used mainly in brazing of Cu-alloy, shipbuilding, heat exchanger, and others related with electronics.

 Solders containing 5.8~6% of Ag is used in A/C pipe brazing.

## 3. Copper Pipe

## Copper Pipe

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### 1) Shape



### 2) Feature

- Oxygen is less than 200ppm :  
phosphorus deoxidized from absorbing oxygen in melting and the softening temperature is more or less high.
- Appropriate to a welding rod because it doesn't absorb the oxygen in high temperature
- Seamless phosphorus deoxidized copper with high pressure resistance
- High purity with Cu more than 99.9%
- Ingredient P should be 0.015~0.04.

## Copper Pipe

### 3) Standard material and thickness of connecting pipe

Out diameter(φ)	R22		R410A	
	Note 1) C1220T- O	Note 2) C1220T- H	Note1) C1220T- O	Note 2) C1220T- H
Ø6.35	0.7	/	0.7	/
Ø9.52	0.8		0.8	
Ø12.70	0.8		0.8	
Ø15.88	1.0		1.0	
Ø19.05	1.0			
Ø22.22	Do not use soft type	1.0	Do not use soft type	1.0
Ø25.40		1.0		1.0
Ø28.58		1.0		1.0
Ø31.75		1.1		1.1
Ø34.9		1.1		1.2
Ø38.10		1.15		1.35
Ø41.3		1.2		1.45
Ø44.45		1.35		1.55



The above is LG material standard of copper pipe.

Design pressure of copper tube for welding is 30kgf/cm<sup>2</sup> (R22), 37kgf/cm<sup>2</sup> (R410A), Others is more than KS D 5301.

**Note 1)** C1220T- O : phosphorus deoxidized copper **soft type**

**Note 2)** C1220T- H : phosphorus deoxidized copper **hard type**

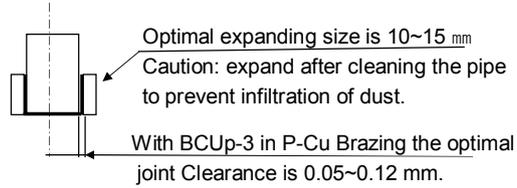
## 4. Brazing Process

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## 4. Brazing Process

### 1) Good fit & Proper clearance

Brazing is filling in melted solder to the clearance of targeting two metals (parent metals) As melted solder spreads by capillary phenomenon, adequate gap is essential for good welding.



Optimal joint clearance.



Large clearance results insufficient filling .



## 4. Brazing Process

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### 2) Cleaning the surface

Only on the clean surface, the proper capillary phenomenon can be obtained. All the foreign material like the **oil, grease, dust, corrosive material etc.** can affect welding quality. They'll block solder flowing, make holes and carbons. Flux welding is not generally used in body work because of the greater prep work after welding and the ability to weld thinner metal is not as good with flux welding .

### 3) Flux painting (not necessarily for the Cu-P soldering)

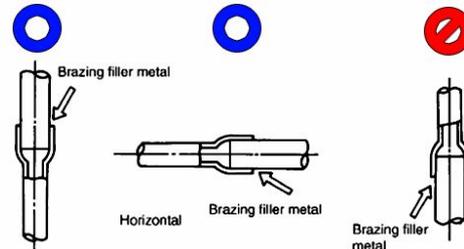
Heating parent metal surface accelerates reaction between oxygen and metal causing **oxidization** which makes defective welding. To prevent this, flux is painted. Flux is a chemical material to form chemical attraction on welding point by **lowering melting temperature of metallic oxide**. It blocks the air contacting metal. Also it **absorbs metal oxide made in the process of welding** and remained in cleaning process.

### 4) Assemble for brazing

Assemble the tubes (parent metal) for welding. For better capillary phenomenon and welding, good arrangement is essential. The easiest way is fixing tubes by **its own weight only**.

## 4. Brazing Process

1. Conduct brazing with the pipe end pointed downward or positioned horizontally. Do not place the pipe end upward when brazing (to prevent leaks.)



<Cautions>

1. Take measures to prevent a possible fire. (preparing the brazing site and keeping a fire extinguisher and water nearby)
  2. Be careful of burning skins.
  3. Check to make sure that the space between the pipe and joint is appropriate. (leak prevention)
  4. Make sure that the pipe is supported properly.
- \* Horizontal pipes (copper pipes) should be supported at the following pitches.

Pitch of copper pipe support (Source: HASS 107-1977)

<b>Nominal diameter (mm)</b>	20 or less	25~40	50
<b>Maximum pitch (m)</b>	1.0	1.5	2.0

\* Do not fix the copper pipe with metal fixture directly

## 4. Brazing Process

### 5) Brazing The Assembly : for the general piping



- ① Check the backfire stopper installed.

## 4. Brazing Process

### 5) Brazing The Assembly : for the general piping



- ② Set propane gas pressure to 0.5~1.0kg/cm<sup>2</sup>.

## 4. Brazing Process

### 5) Brazing The Assembly : for the general piping



- ③ Set oxygen gas pressure to 5~10kg/cm<sup>2</sup>.

## 4. Brazing Process

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### 5) Brazing The Assembly : for the general piping

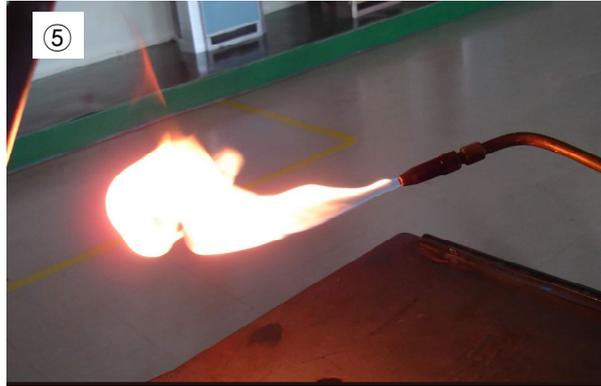


④ Slightly open propane gas valve.(1 scale)

## 4. Brazing Process

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### 5) Brazing The Assembly : for the general piping



⑤ Light a fire. And Set the torch towards down not to hurt man.

## 4. Brazing Process

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### 5) Brazing The Assembly : for the general piping

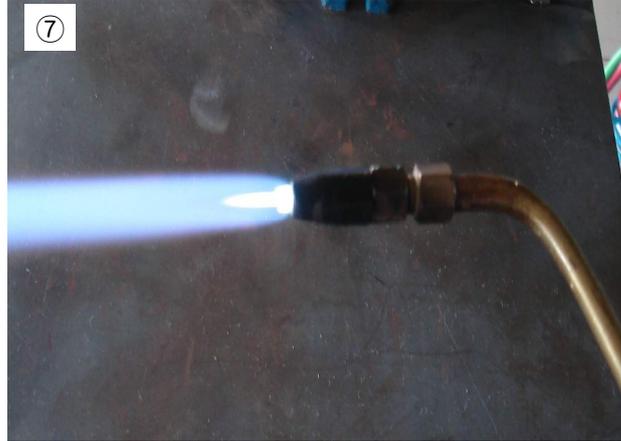


⑥ Open and adjust oxygen gas valve & flame size.

## 4. Brazing Process

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### 5) Brazing The Assembly : for the general piping



⑦ Adjust inner flame size to 1.5~3 Cm

## 4. Brazing Process

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### 5) Brazing The Assembly : for the general piping

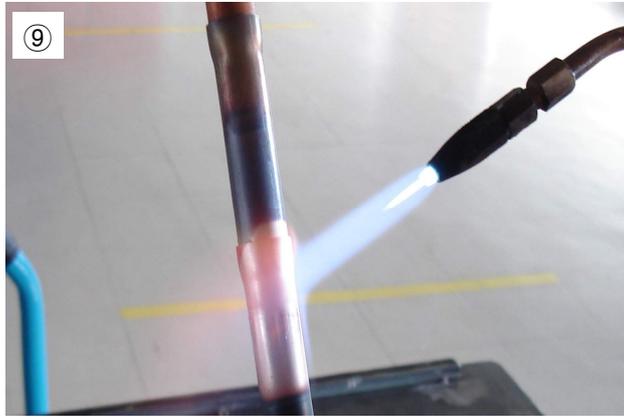


- ⑧ Heat the inner pipe slightly above the welding point till the color changes to red with oxidizing flame.

## 4. Brazing Process

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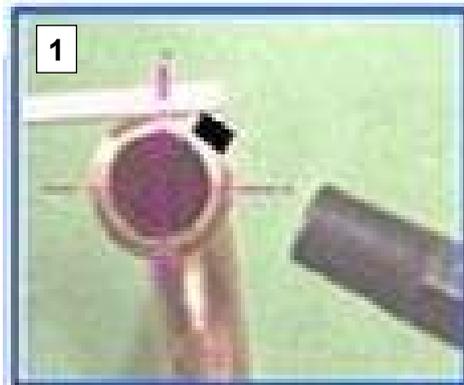
### 5) Brazing The Assembly : for the general piping



- ⑨ Heat the outer pipe slightly below the welding point till the color changes to red with oxidizing flame.

## 4. Brazing Process

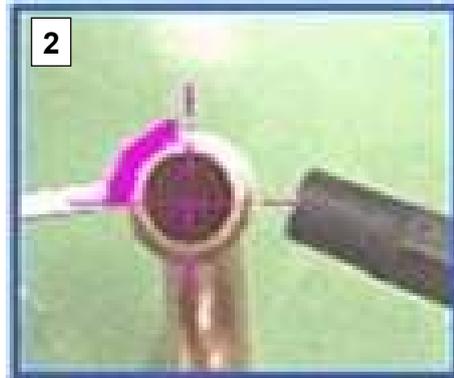
### 5) Brazing The Assembly : for the big pipe or silver soldering



- ① Place the solder rod at 1~2 mm from the back surface of target joint, and start heating. Heat up the parent metal surface widely and evenly. Heating temperature should be above the solder's melting and flowing point and below the parent metal's melting point.

## 4. Brazing Process

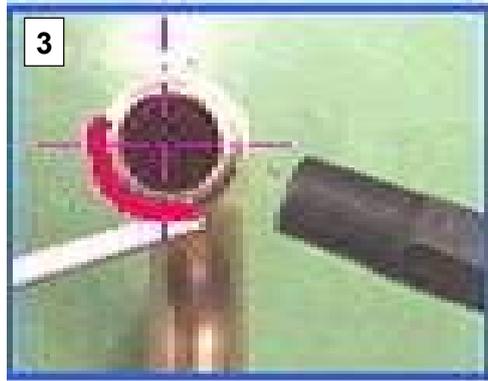
### 5) Brazing The Assembly : for the big pipe or silver soldering



- ② Slide the solder 2~3 times to and fro along with the joint line covering weld part as in fig.2

## 4. Brazing Process

5) Brazing The Assembly : for the big pipe or silver soldering



③ Repeat it for the next half as shown In fig. 3. Be sure the solder not to flow out to the heated surface of copper tube.

## 4. Brazing Process

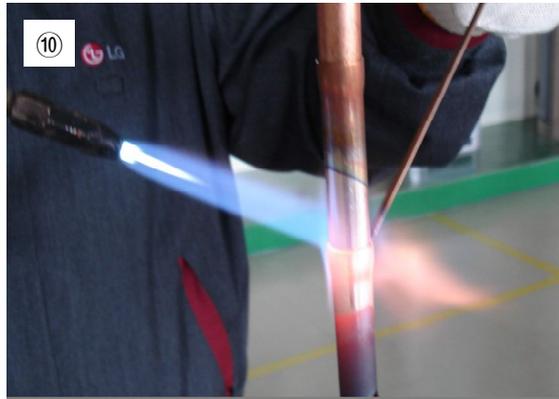
### 5) Brazing The Assembly : for the big pipe or silver soldering



- ④ When the melted solder fills up and covers the whole weld part, soldering is completed. After soldering don't make any kind of shock or vibration to the joint until the joint cools down enough.

## 4. Brazing Process

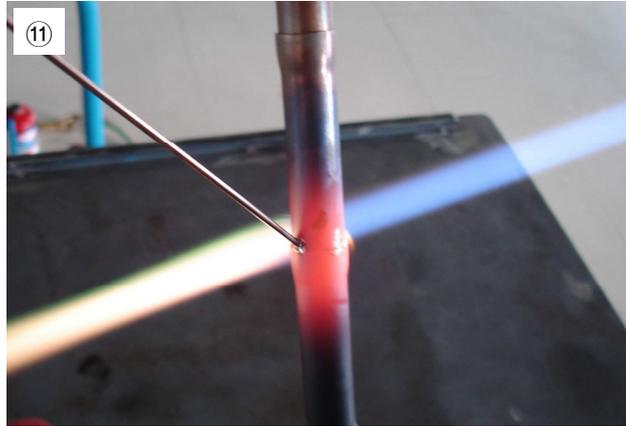
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- ⑩ Heat the welding point till the color changes to red with oxidizing flame, and approach the solder from the other side.

## 4. Brazing Process

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- ⑪ After the melted solder spread along with the welding line draw the torch back, and confirm welding status.

## 4. Brazing Process

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⑫ After welding, close propane gas valve.

## 4. Brazing Process

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⑬ Close oxygen gas valve.

## 4. Brazing Process

### 6) Cleaning The Brazed Joint (only for the flux painted case)

After brazing, all the remained flux, scale and rust should be cleaned. Flux painted welding Makes Good weld appearance (smooth, uniform welds having good contour), but leaves more splatter and produces more smoke .

And remained flush can cause corrosion. That's why we should clear the flux with warm Water or brush.

As flux is water-soluble, it can be removed by dipping into warmed water (above 50 °C), Or dipping warmed tube into water.

### ■ Safety in brazing process

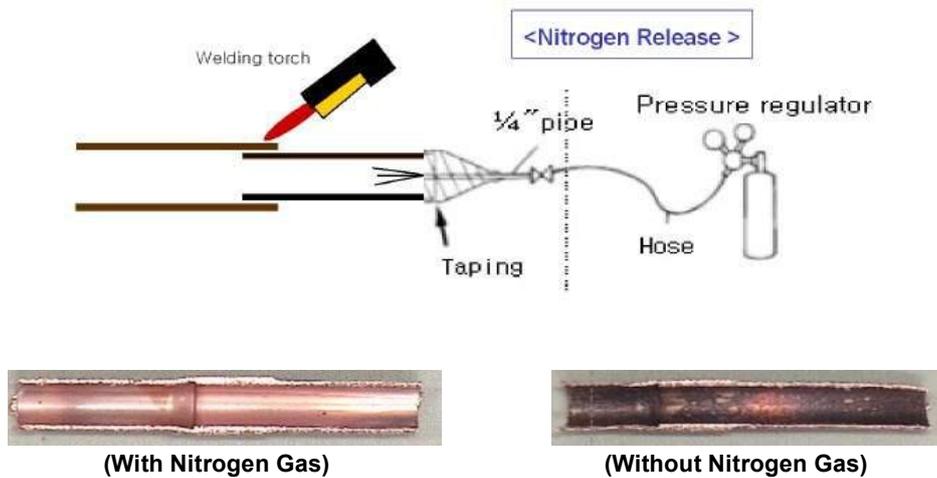
Brazing generates various toxic gases from the filler material made of zinc, cadmium etc, and flux.

Be careful for the followings :

- 1) Ventilate the closed working area.
- 2) Clean the parent metal fully.
- 3) Use enough flux.
- 4) Heat up the parent metal surface widely and evenly.
- 5) understand the parent metal and filler metal clearly.

## 4. Brazing Process

### 7) How to use a Nitrogen Gas



1. Arrange Gas and Piping like this Figure.
2. Regulate the nitrogen gas and release during welding (too high pressure will make leakage, too low will have no effect)

#### **Caution point**

- Gas pressure : 0.1 ~ 0.2 kg/cm<sup>3</sup> (2 ~ 3 psi)
- Release direction : inner pipe side
- Outlet opening : the other side should be opened
- After welding : After welding continue gas has releasing till the welding part cools down ( 4 ~ 5 Minutes)
- If gas stops quickly, scale occurs with the newly entered air.

If do not use a nitrogen gas. Scale occurs in the pipe  
 As you can see in the picture there are so many scale in the pipe that without nitrogen gas, These scale make troubles during circulation in a cycle, like clogging capillary tube, compressors moving parts and various filters.

## 5. Brazing Cycle & Troubles

## 5. Brazing Cycle & Troubles

### ■ Brazing troubles

Troubles	Details	Causes & Measure
Insufficient filling (not even)	A state of filling not evenly in the joint area with solder. An oversupply of welding material is made in some part.	<ul style="list-style-type: none"> <li>- Joint clearance redesign, check the equality of clearance.</li> <li>- Foreign materials – clean the jointing area</li> <li>- Uneven flux painting – check the flux painted area.</li> <li>- Lack of heating temperature – Adjust soldering temp according to the materials.</li> <li>- Equality of heating temp. – check the application of double torch &amp; alteration of tip.</li> </ul>
Lack of solder	A state of filling not sufficiently in the joint area with solder.. Materials fall from the wide crack.	<ul style="list-style-type: none"> <li>- When the joint clearance is wide, the solder falls.</li> <li>- Lack of solder amount</li> <li>- Overheating &amp; delay of brazing</li> </ul>
Pin-Hole	Causing tiny hole around the Brazing.	<ul style="list-style-type: none"> <li>- Oil and dust can be carbonized on matrix by poor cleaning.</li> </ul>
Corrosion of materials	Caused by overheating the parent metal. Results crack and Pin-hole.	<ul style="list-style-type: none"> <li>- Maintain the proper temperature of each materials &amp; keep the brazing time</li> <li>- It can be prevented by releasing the nitrogen gas during brazing work.</li> </ul>
Crack of Brazing part	Small leakage by tiny crack on welding point.	<ul style="list-style-type: none"> <li>- Caused by a rapid cooling after welding.</li> <li>- Impact on half solidified point after welding.</li> </ul>
Crack of parent metal	Stress caused on the metal during welding will make cracks of matrix.	<ul style="list-style-type: none"> <li>- Keep even heat on the welding point.</li> <li>- Don't tilt the welding point</li> <li>- Check the remained thermal stress on the welding point.</li> </ul>

## Appendix. Evaluation of the brazing

### Evaluation of APPEARANCE



## Appendix. Evaluation of the brazing

### Evaluation of BEAD WAVE



## Appendix. Evaluation of the brazing

### Evaluation of WELD DEFECT



## Appendix. Evaluation of the brazing

### Evaluation of OXIDATION



## Appendix. Evaluation of the brazing

### Evaluation of DROP FORMATION



## Brazing Basic

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