ISHIKAWA

Lead free flux-cored solder

EVASOL J3-ESM-3

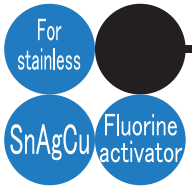

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Table1 Characteristics

Test			Characteristic	Method
Solder alloy	Alloy composition		Sn:balance, Ag:3.0, Cu:0.5	JIS-Z-3910
	Solidus Temperature		217℃	
	Liquidus temperature		220℃	
Flux	Flux type		Fluorine activator type	
	Water solution resistance		More than 700Ωm	JIS-Z-3197 8.1.1
	Halide content		0.16%	JIS-Z-3197 8.1.4.2.1
	Fluorine content		0.33%	Our company method
	Copper mirror test		—	JIS-Z-3197 8.4.2
	Corrosion test with copper plate		No corrosion	JIS-Z-3197 8.4.1
	Silver-chromate paper test		—	JIS-Z-3197 8.1.4.2.3
Flux-cored solder	Spattering test (380℃, 20㎜/sec) 0.8㎜		8.6%	Our company method
	Flux content		3.0%	JIS-Z-3197 8.1.2
	Spreading ratio		78%	JIS-Z-3197 8.3.1.1
	Insulation resistance test	Initial	More than $1.0\times10^{14}\Omega$	JIS-Z-3197 8.5.3 Condition B (85℃85%RH)
		After 168Hr	More than $5.0\times10^{8}\Omega$	
		After 1008Hr	More than $5.0\times10^{8}\Omega$	
	Migration test		No migration	

A. Special feature

1. Solderability test for nickel plated substrate

Conditions

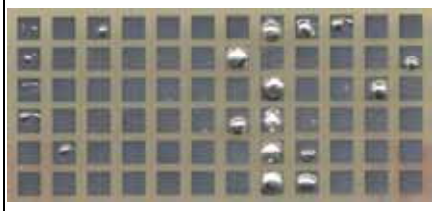
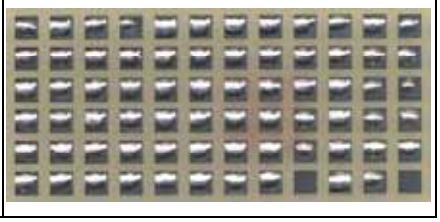
Solder wire diameter: 0.8mm

Feed rate: 20mm/sec

Land: 3mm×3mm (Ni plated substrate)

Result

Fig.1 Solderability test for nickel plated

Temperature	J3-ESM-3	Sn-Ag-Cu RMA type
340℃		
350℃		
380℃		

2. Solderability test for stainless

Conditions

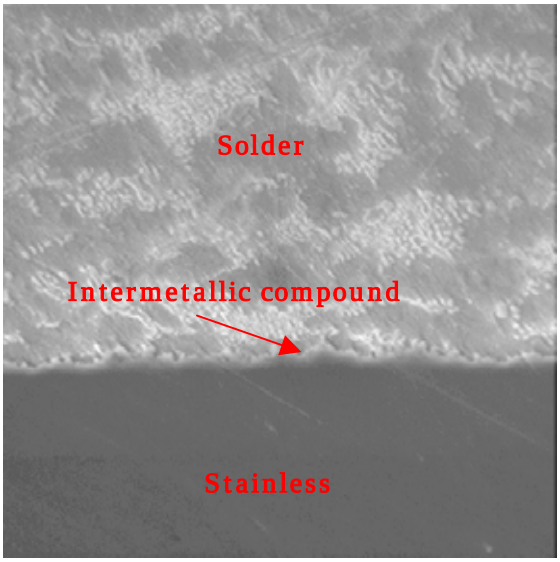
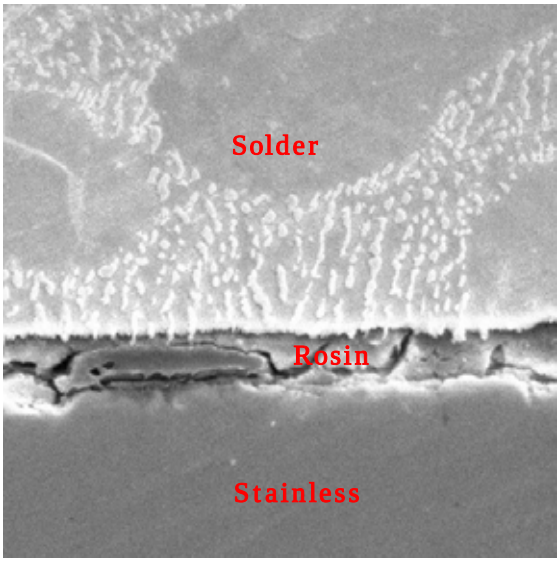
Solder wire diameter: 0.8mm

Soldering iron tip temperature: 380℃

Base metal size: 30×30×0.3mm, stainless (SUS304)

Result

Fig.2 Solderability test for stainless

J3-ESM-3	Sn-Ag-Cu RMA-type
	

In the case of J3-ESM-3, which uses a fluorine activator, it can be observed that a intermetallic compound is formed between the stainless and the solder.

3. Reliability of J3-ESM-3

3-1: Insulation resistance test

Method

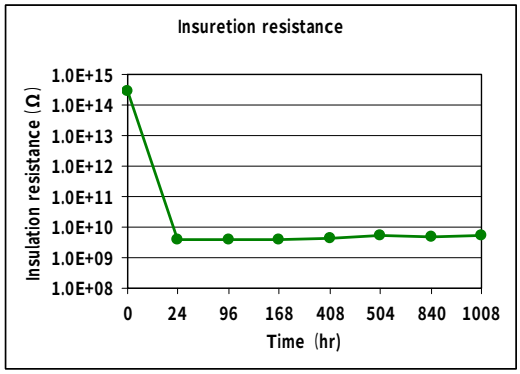
This test method is defined by JIS-Z-3197 8.5.3. Polish the test substrate (comb-shaped electrode substrate for about 30s in refined water with a soft-hair brush, and rinse it with refined water. Polish the test substrate for about 30s in isopropyl alcohol by using soft-hair brush, and rinse it in isopropyl alcohol. Dry it in a drier set at 60ºC for 3h. The flux test solution shall be adjusted to have precise 25 mass% of solid contents with solvent used at extraction.

Specimen shall be applied evenly to cover the total area on the laps of 3 boards and one is lift for reference without applying flux. Dry the boards in a dryer set at (100±3)℃ for 5min. The pattern side of the 3 boards shall be soldered in the soldering bath at (235±3)℃ for (3+1)sec. to be used as the test pieces. Confirm that there is no short circuit on the board. If there is any prepare new board and precondition. After it is left to be cooled as it is, the test piece is made. 3 test pieces shall be prepared. The insulation resistance between the terminals shall be measured at the test voltage of DC 100V by using an insulation resistance tester before test piece is placed in a thermohygrostat.The test piece shall be placed in a thermohygrostat kept at the temperature 85ºC and the relative humidity 85%. The insulation resistance shall be measured at DC 100V in the thermohygrostat at the time of 24h, 96h, 168h, 408h, 648h, 840h, 1008h, after the test piece is placed in it. The test shall be carried out for 3 test pieces, and the geometric mean of the respective measurements shall be calculated.

Result

Table2 Insulation resistance test

	Initial	24hr	96hr	168hr
Sample 1	2.4×10^{14}	3.8×10^{9}	3.9×10^{9}	4.0×10^{9}
Sample 2	2.1×10^{14}	3.5×10^{9}	3.3×10^{9}	3.7×10^{9}
Sample 3	4.2×10^{14}	4.7×10^{9}	4.4×10^{9}	4.7×10^{9}
Average	2.8×10^{14}	4.0×10^{9}	3.8×10^{9}	4.1×10^{9}
	408hr	648hr	840hr	1008hr
Sample 1	4.1×10^{9}	4.8×10^{9}	4.8×10^{9}	5.1×10^{9}
Sample 2	4.2×10^{9}	4.9×10^{9}	4.8×10^{9}	4.9×10^{9}
Sample 3	5.1×10^{9}	5.5×10^{9}	5.2×10^{9}	5.6×10^{9}
Average	4.4×10^{9}	5.1×10^{9}	4.9×10^{9}	5.2×10^{9}



3-2: Humidity test under DC voltage (Migration test)

Method

This test method is defined by JIS-Z-3197 8.5.4. Polish the test substrate (comb-shaped electrode substrate) for about 30s in refined water with a soft-hair brush, and rinse it with refined water. Polish the test substrate for about 30s in isopropyl alcohol by using soft-hair brush, and rinse it in isopropyl alcohol. Dry it in a drier set at 60ºC for 3h.

The flux test solution shall be adjusted to have precise 25 mass% of solid contents with solvent used at extraction. Specimen shall be applied evenly to cover the total area on the laps of 3 boards and one is lift for reference without applying flux. Dry the boards in a dryer set at

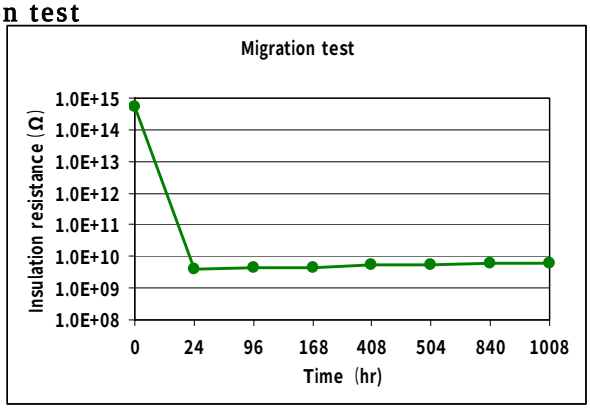
(100±3)℃ for 5min. The pattern side of the 3 boards shall be soldered in the soldering bath at (235±3)℃ for (3+1)sec. to be used as the test pieces.Confirm that there is no short circuit on the board. If there is any prepare new board and precondition. After it is left to be cooled as it is, the test piece is made. 3 test pieces shall be prepared.The insulation resistance between the terminals shall be measured at the test voltage of DC 100V by using an insulation resistance tester before test piece is placed in a thermohygrostat.

The test piece shall be placed in a thermohygrostat kept at the temperature 85ºC and the relative humidity 85%, and apply the voltage DC 48V between the electrodes. The insulation resistance shall be measured at DC 100V in the thermohygrostat at the time of 24h, 96h, 168h, 408h, 648h, 840h, 1008h, after the test piece is placed in it. Take the test piece out of the thermohygrostat 1008h after the test piece is placed in it, and check for the migration by using a magnifier. The test shall be carried out for 3 test pieces.

Result

Table3 Migration test

	Initial	24hr	96hr	168hr
Sample 1	4.1×10^{14}	4.7×10^{9}	3.4×10^{9}	4.6×10^{9}
Sample 2	5.4×10^{14}	3.9×10^{9}	5.1×10^{9}	4.9×10^{9}
Sample 3	6.1×10^{14}	3.6×10^{9}	4.6×10^{9}	4.1×10^{9}
Average	5.1×10^{14}	4.0×10^{9}	4.3×10^{9}	4.5×10^{9}
	408hr	648hr	840hr	1008hr
Sample 1	4.8×10^{9}	4.9×10^{9}	5.3×10^{9}	5.8×10^{9}
Sample 2	5.9×10^{9}	5.9×10^{9}	6.2×10^{9}	6.3×10^{9}
Sample 3	5.3×10^{9}	5.2×10^{9}	5.9×10^{9}	6.2×10^{9}
Average	5.3×10^{9}	5.3×10^{9}	5.8×10^{9}	6.1×10^{9}



No migration occurs.

4. Spreading test

Method

This test method is defined by JIS-Z-3197 8.3.1.1. The one side of the copper plate with the size of 50 x 50 x 0.5mm shall be polished by polishing paper with dropping alcohol and cleaned with alcohol. Put this plate into a dryer set at 150±3ºC for 1h to produce oxidized the plate. Apply the solder paste to the copper plate with a metal mask which has 2.5mm thickness and a hole of 6mm diameter, and use it as a test piece. 5 test pieces shall be prepared. Flux residue shall be removed by suitable solvent. The height of the spread solder by fusing shall be measured by a micrometer. Using this value, the spreading ratio shall be calculated from the formula shown below.

This procedure shall be carried out on the 5 test pieces and the mean value shall be obtained as the spreading ratio of the specimen.

$$S = ((D-H)/D) \times 100$$

where, $D = 1.24V^{1/3}$ (V: mass / density of tested solder)
S: spreading ratio (%)
H: height of the spread solder (mm)

D: diameter of the solder when it is assumed to be a sphere (mm)

Criterion for evaluation

The spreading ratio is more than 75%. (Oxidized copper plate)

Result

Table4 Spreading test

		Spreading retio (%)	Average
Copper plate	Sample1	79.1	**79.0**
	Sample2	79.4	
	Sample3	78.6	
Brass plate	Sample1	80.1	**79.2**
	Sample2	79.2	
	Sample3	78.4	
Nickel plate	Sample1	76.5	**77.2**
	Sample2	78.1	
	Sample3	77.1	

B. Basic characteristic

1. Melting point

Solidus temperature	217℃
Liquidus temperature	220℃

2. Flux content test

Method

This test method is defined by JIS-Z-3197 8.1.2. Take specimen of 30±2g as W_1(g), measuring to the nearest 0.001g and take this as W_1(g). Then add 20ml glycerin and fuse by heating. When solder and flux are separated completely, leave the beaker to cool down and to solidify. Next, take out the solidified solder from the beaker and wash it with water, and after immersing it in 2-propanol for about 5min, wash and dry it at room temperature.

Then, measure the accurate mass of it as W_2(g) and calculate the flux content from the following formula.

$$\text{Flux content (\%)} = (W_1 - W_2) \times 100 / W_1$$

Criterion for evaluation

Flux content shall be 3.0±0.3 (%).

Result

Flux content (%)	**3.0**

3. Halide content test (Potentiometric titration)

Method

This test is defined by JIS Z 3197 8.1.4.2.1. Weigh 0.5±0.1g of flux at the accuracy of 0.001g and put it into a 300ml beaker. Add 200ml of 2-propanol and stir it at normal temperature to make test solution. Putting an electrode into the beaker, place the beaker on a magnetic stirrer. Stir strongly, and titrate with silver nitrate standard solution.

where H : chlorine content in flux(mass%), V : volume of silver nitrate solution(ml)
M : density of silver nitrate solution(mol/l) , f : power value of silver nitrate solution
m : mass of specimen(g)

Criterion for evaluation

Halide content shall be less than 0.4 (%) .

Result

Halide content (%)	**0.20**
Fluorine content (%)	**0.33**

4. Corrosion test with copper plate

Method

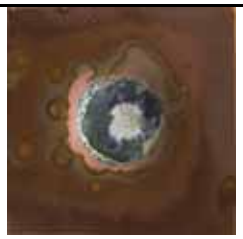
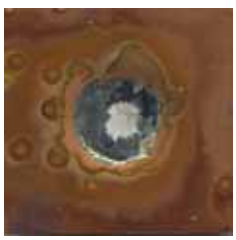
This test method is defined by JIS-Z-3284 8.4.1 pieces of copper plate with the size of 50 x 50 x 0.5mm shall be bent at right angles at 5mm from the both edges and other 2 pieces at 6mm from the both edges, and called plates A and B respectively. Solder paste shall be printed on the copper plate B by using the metal mask, and four circular solder pastes of 6.5mm in diameter and of 0.2mm in thickness shall be made. Put the copper plate A as a cap to be a test piece. Put plate A as a cap on plate B on which solder paste is not applied.(It shall be taken as a blank test piece.) Place the test piece on the surface of soldering bath regulated at 235±2ºC and heat the piece. After fusing of solder, leave it for 5sec, and then take the piece out from the bath horizontally and cool it down for 15min. Leave the test piece and the blank piece in the thermoregulator adjusted at the temperature 40±2ºC and the relative humidity 9 After 96h, take out them from the thermo-regulator and inspect the corrosion. Compare with the reference(blank) piece.

Criterion for evaluation

No corrosion.

Result

Fig.3 Corrosion test

	Initial	After96Hr.
		
	No corrosion	

5. Water solution resistance

Method

This test method is defined by JIS-Z-3197 8.1.1.Measure the resistivity of purified water with an electric conductivity meter. Put the flux containing the solid portion equivalent to 0.10±0.005g into a beaker with 50ml of purified water. Cover the beaker with a watch glass. The beaker capped with a watch glass shall be heated on a hot plate and be boiled 60sec. Then, it shall be cooled in running water and be placed in a test tank kept at 20±2ºC. After heat is balanced, the resistivity of it shall be measured with an electric conductivity meter.

Criterion for evaluation

Water solution resistance shall be more than 1000Ωm.

Result

Table5 Water solution resistance

	Water solution resistance（Ωm）	Average（Ωm）
Sample1	1435	**1257**
Sample2	1120	
Sample3	1215	

6. Spattering test

This test method come out by our company method. Assemble the measuring device in accordance with Fig 4. Measure the flux content of resin flux cored solder(F). Cut the solder at 5m length and weigh the mass of them (W_1). Prepare aluminum foil of 200mm×200mm and make a hole of 11mm diameter at the center and measure the mass(X_1). As shown in Fig 4, place the aluminum foil on the top of metal plate of the device and feed about 7mm at 20㎜/sec and feedback 2mm of solder wire at one time, and set the tip of soldering iron keep at each 340, 360, 380, 400℃. At this time solder is recommended to be pushed at right angles to the top. Measure the remaining resin flux cored solder(W_2). Measure the aluminum foil on which spattered flux sticks(X_2). The spattered flux is expressed in mass% and calculated from the below formula.

where, Fs : mass of flux spattered (mass%)
F : flux content of resin flux cored solder(mass%)
X_1 : mass of aluminum foil(g)
X_2 : mass of aluminum foil with spattered flux(g)
W_1 : mass of 5 pieces of resin solder wire (g)
W_2 : mass of remaining of resin solder wire (g)

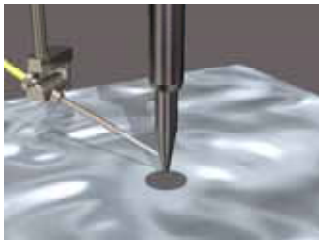


Fig 4. The measuring device

Apparatus:

Soldering iron：made by APOLLO SEIKO LTD.（ＴＴＭ－2000）
The chip of iron：2.4㎜ Driver form（ＴＴＭ－2016）
Provided machine：made by ISHIKAWA METAL.

Result

Table6 Spreading ratio（%）

	340℃	360℃	380℃	400℃
0.5mm	4.1	4.1	4.7	5.1
0.6mm	4.6	4.1	4.5	5.2
0.8mm	10.1	9.6	7.3	9.8
1.0mm	10.0	9.3	8.7	9.9