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TEL: +81-75-311-2121 FAX: +81-75-315-0172
http://www.rohm.com

Product/Process Change Notification
PCN#: 1021009

This is an announcement of change to products which are currently supplied by ROHM.
ROHM sincerely requires acknowledgment of receipt of this notification within 30 days of the date of this notice. Lack of acknowledgment of this notice within 30 days constitutes acceptance of the change.
Your understanding and cooperation would be highly appreciated.

Issue Date: 1st.Sep.2021

Title of change	
Change the wire material from Au wire to Cu wire (LSI)	
Identification of change	
Product name in the label.	
Detailed description of change	
Before Wire Material : Au wire (Gold)	After Wire Material : Cu wire (Copper)
Affected product(s)	
Manufacuture part number	Customer part number
Reason for change	
Increasing the price of Au wire, it has been difficult to keep production by same price. To keep stable production, Rohm recommend to change Cu wire from Au wire.	
Anticipated impact on form, fit, function, quality or reliability	
There are no issue on quality based on attached report.	
Planned date for change	
1st Sep 2022	
Qualification plan schedule, results and samples	
If required, pleaes contact your local ROHM sales office.	
Comments	
Supplier contact	

After acknowledgement of the customer, lack of additional response within 90 day period constitutes acceptance of the change according to JEDEC Standard J-STD-046.

Change the wire material from Au wire to Cu wire (LSI)
1021009

Rohm Internal P/N
BD6967FVM-TR
BD9596BMWV-E2
BA4580RF-E2
BD6290EFV-E2
BD62011FS-E2
BA4558F-E2
BD62017AFS-E2
BA10393F-E2
BA10324AF-E2
BA00CC0WFP-E2
BA2902FV-E2
BD62012FS-E2
BA10339F-E2
BD6971FV-GE2
BA00BC0WFP-E2
BD33KA5WFP-E2
BA2904F-E2
BA10358F-E2
BA00DD0WHFP-TR
BA2903F-E2
BD00C0AWFP-E2
BA5839FP-E2
BA2902SFV-E2
BA6287F-E2
BA05CC0FP-E2
BD9E101FJ-LBGE2
BU24025MWV-E2
BD3491FS-E2
BA6423AF-E2
BD6971FV-E2
BD33KA5WFP-BJE2
BA2903SF-E2
BA2902SF-E2
BD8271EFV-E2
BA10339FV-E2
BA4560RF-E2
BA033FP-E2
BD3571FP-E2

BD9130NV-E2
BU4052BCF-E2
BD6761FS-E2
BA33BC0FP-E2
BA178M05FP-E2
BD25KA5WFP-BJE2
BA2903FVM-TR
BD6968FVM-TR
BA06CC0WFP-E2
BD8163EFV-E2
BD6973FV-E2
BU7150NUV-E2
BA25BC0FP-E2
BR24T16F-WE2
BD12KA5FP-E2
BAJ6DD0WHFP-TR
BU9795AKV-E2
BU9716BK
BU90R104-E2
BD63860EFV-E2
BA2904SFV-E2
BD00KA5WFP-BJE2
BR24T04F-WE2
BD9251FV-E2
BD6231HFP-TR
BA2904SF-E2
BA6424AFS-E2
BD7411G-TR
BA4560F-E2
BD3930FP-E2
BU97941FV-E2
BA2901FV-E2
BD95850F-LBE2
BA10358FV-E2
BD63282EFV-E2
BA4558RFV-E2
BD9584F-E2
BU94502AMUV-E2
BD6974FV-E2
BD82065FVJ-E2
BU90LV048-E2
BD62018AFS-E2
BR24T02FV-WE2

BD62011AFS-E2
BU6574FV-E2
BD45425G-TR
BR24T16FJ-WE2
BD6562FV-LBE2
BU90LV047A-E2
BA2902F-E2
BD5228G-TR
BR24T02F-WE2
BA14741F-E2
BA8391G-TR
BD95820F-LBE2
LM2904DGKR
BR24T32F-WE2

信頼性試験結果報告
Reliability Test Result

2021年 7月 8日　　Rev. J-1

LSI事業本部 LSI高品質設計部
LSI Business Unit,
LSI High Quality Design Division
矢野 茂秀　　S.Yano

機種/TYPE　　:**BA4580RF**

形状/PACKAGE　:SOP8 (Cu wire)

【 信頼性試験結果 】

試験項目 ITEM	試験方法 METHOD	試験時間 DURATION	ｻﾝﾌﾟﾙ数 n (pcs)	不良数 pn (pcs)
半田耐熱性 <#2> Resistance to soldering heat	加湿処理後、赤外線ﾘﾌﾛｰ加熱(ﾋﾟｰｸ260℃) After the moisture soaking treatment,carry out the soldering heat stress(IR reflow :peak260℃) JEITA ED4701-301	10s	22	0
プレッシャークッカー <#1> Pressure Cooker	121℃ / 100% (2.026x10⁵Pa) に放置 Storage at 121℃/100% (2.026x10⁵Pa)	96h	22	0
温度サイクル <#1> Temperature Cycling	Tstg min (30min) / Tstg max (30min) JEITA ED4701-105	100cycles	22	0
高温保存 High Temperature Storage	Tstg max に放置 Storage at Tstg max　JEITA ED4701-201	1000h	22	0
低温保存 Low Temperature Storage	Tstg min に放置 Storage at Tstg min　JEITA ED4701-202	1000h	22	0
高温高湿保存 <#1> Temperature Humidity Storage	85℃ / 85% に放置 Place at 85℃/85%　JEITA ED4701-103	1000h	22	0
高温高湿バイアス <#1> Temperature Humidity Bias	85℃ / 85% にて通電　JEITA ED4701-102 Apply the specified voltage at 85℃/85%	1000h	22	0
高温動作 High Temperature Operation Life	Topr max にて通電　JEITA ED4701-101 Apply the specified voltage at Topr max	1000h	22	0

【 強度試験結果 】

端子強度 (引っ張り)試験 Terminal strength	Pull force = 1N JEITA ED4701-401	10s	5	0
半田付け性試験 Solderability	浸漬温度 215℃、鉛半田 Dipping temperature 215℃, (Pb)　JEITA ED4701-303	10s	22	0
	浸漬温度 245℃、鉛フリー半田 Dipping temperature 245℃, (Pb free)　JEITA ED4701-303	5s	22	0
静電破壊 Electro Static Discharge	C=100pF、R=1.5kΩ、3times、±2000V HBM (Human Body Model)　JS-001 (JEITA ED4701-304)	–	5	0
	C=200pF、R=0Ω、3times、±100V MM (Machine Model)	–	5	0
	±500V CDM (Charged Device Model)　JS-002	–	5	0
ラッチアップ試験 Latch Up	パルス電流注入方法、トリガーパルス電流 ±100mA Pulse current injection、trigger pulse current ±100mA JESD78 (JEITA ED4701-306)	–	5	0

<<#1>> の試験項目につきましては、前処理として半田耐熱性試験を3回行った後に各試験を行います。
Soldering Heat examination is executed 3 times for the precondition.

<<#2>> 加湿処理　一般品 :85℃ 85% 168h / 防湿梱包品 : 30℃ 70% 192h
Moisture soaking treatment　Standard : 85℃ 85% 168h / Dry packing : 30℃ 70% 192h

Change the wire material from Au wire to Cu wire (LSI)

Sep, 1st, 2021
LSI Engineering Div.
AP Production Headquarters.

4M comparison

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			Production line of Au wire	Production line of Cu wire	Difference	Verification item
Package name（e.g.）			HTSOP-J8	HTSOP-J8	Not application(N/A)	N/A
Device name			Refer to device list	Refer to device list	N/A	N/A
Factory	Assembly	Factory name	ROHM Electronics Philippines, Inc.（REPI）	Same as on the left	N/A	N/A
		Headquarters	Philippine	Same as on the left		
		Personnel quantity	4,457（As of 2018）	Same as on the left		
		Cleanliness	Refer to below	Same as on the left		
		（Die bond to Wire bonding）	Class 10,000	Same as on the left		
		(Mold)	Class 10,000	Same as on the left		
	Test	Factory name	ROHM Electronics Philippines, Inc.（REPI）	Same as on the left	N/A	N/A
		Headquarters	Philippine	Same as on the left		
Man	Assembly		Certified operator by ROHM	Same as on the left	N/A	N/A
	Test		Certified operator by ROHM	Same as on the left		
Machine	Assembly	Die bonding	Full-automatic die bonder	Same as on the left	N/A	N/A
		Wire bonding	Full-automatic wire bonder	Same as on the left		
		Molding	Full-auto molding machine	Same as on the left		
		Tie-bar cut	Full-auto tie-bar cut machine	Same as on the left		
		Plating	Full-auto plating machine	Same as on the left		
		Marking	Full-auto marking machine	Same as on the left		
		Lead forming	Full-auto forming machine	Same as on the left		
	Test	Test handler	Full-auto handler	Same as on the left	N/A	N/A
		Tester	Full-auto tester	Same as on the left		
	Taping	Taping	Full-auto taping machine	Same as on the left		
Method	Assembly	Die bonding	Solder die bonding method Dispensed Ag paste method	Same as on the left	N/A	N/A
		Wire bonding	Ultrasonic Nail-head Thermal Compression bonding	Same as on the left		
		Molding	Transfer molding method	Same as on the left		
		Plating	Electroplating method	Same as on the left		
	Test	Test	Contact method using socket	Same as on the left	N/A	N/A
Material	Assembly		Please see another attachment	Please see another attachment	Applicable	We'll compare following page.

Wire type is different.

Change the wire material from Au wire to Cu wire

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【1】 Reason for change
【2】 Changing points and production results
【3】 Risk analysis for the change
【4】 Evaluation contents for the changing risk
【5】 List of the evaluation item
  【5-1】 Basic evaluation result ①～⑤
  【5-2】 Simulation result ①1st Bond ②2nd Bond
  【5-3】 Process margin result ①1st Bond ②2nd Bond
  【5-4】 Reliability test evaluation result
  【5-5】 Electrical characteristic result
【6】 Identification method
【7】 Comparison of the quality control item
【8】 Quality control of the bond strength
【9】 The expiration date of Cu wire

【1】Reason for change

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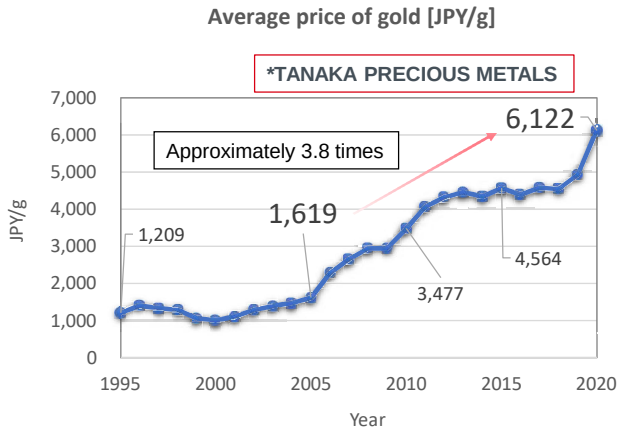
【Reason for change】
*Cu wire is more dominant in electrical characteristic, mechanical characteristic, reactivity with the aluminum (Intermetallic compound), conductivity and Wire sweep in MOLD than Au wire.
*To maintain our competitiveness by minimizing our use of gold which the market price continues to rise. This will be a major parts of cost reduction plan.



After the following page, we attach contents for change and an evaluation result.
For a change, please examine it.

【2】Changing points and production results

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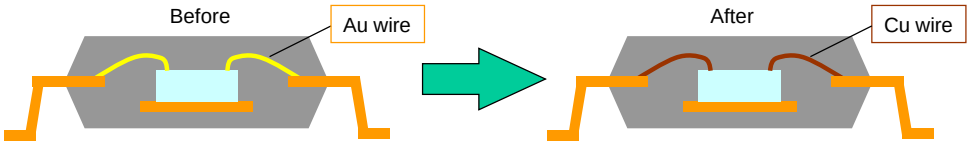
【Changes】
*Change the wire material which connects silicon die and leads to Cu from Au.
*Because there is the fear that halogen in mold resin causes junction corrosion of aluminum/Cu, some packages were changed to the halogen-free resin.
※Please refer to “Change Point in 4M_English.pdf”.



【Manufacturing record】
Our assembly facilities in Thailand and Philippines are both capable of processing copper Wires. Production started in April 2010 and we have already manufactured more than 1,530 million pcs in most recent one year. The products are used in various customers’ applications including car navigation, TV, games, mobile set and other consumer device. Approximately 50% of overall production ratios are copper wire products at present.
(this calculation: use wire length)
Apr. 2010～Sep. 2015：Total about 4,362 million pcs
Apr. 2014～Mar. 2015：Total about 1,530 million pcs
Apr. 2018 ~ Mar. 2021：Total about 4,277 million pcs

【3】Risk analysis for the change ①

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Comparison list of materials properties

Item	Gold Wire	Copper Wire	A merit and demerit of the copper wire	Examination Result
Electrical resistance	2.2μΩ・cm	1.7μΩ・cm	Reduction of Ron	There is no problem in an electrical characteristic.
Thermal conductivity	320W/mK	400W/mK	Higher thermal conductivity of package	There is no problem in an exothermal.
Ultimate tensil strength	100MPa	210MPa	Reduction of wire sweep	The wire sweep rate is equal.
Reaction Rate for IMC Formation w/Al @150℃	1.1×10-14 cm2/s	1.9×10-16 cm2/s	Lower late for Intermetallic compound formation	The kirkendall void does not occur in 4,000 hours either.
Hardness (Young's modulus)	78GPa	130GPa	Higher energy (Ultra sonic and Force) for bonding	By the bond profile for exclusive use of the copper wire, we do the limit evaluation of each parameter. We decide a production margin by the result.
Specific gravity	19.3g/cm3	8.96g/cm3	Lightweighting of the package	There is no problem to package weight.
Coefficient of thermal expansion	14.2ppm/K	16.5ppm/K	Same	By the evaluation result of the TCY examination, there is no problem to coefficient of thermal expansion.
The oxidation and corrosion	Not formation of oxide layer	Formation of oxide layer	Before use: Wire storage and the expiration date	Before use: By an evaluation result, there is no problem.
			Using: Control of gas flow quantity and the density	Using: By an evaluation result, there is no problem.
			After use: Reliability examination under the water environment	After use: By an evaluation result, there is no problem.
			***Elucidation of the corrosion mechanism with the impurities element of resin	

The Cu wire is more dominant for an electrical characteristic and a mechanical characteristic than a Au wire. We take measures of the corrosion by the elucidation of the corrosion mechanism and experiment of the processing point.

【3】Risk analysis for the change ②

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DRBFM work sheet (Design Review Based on Failure Mode)

No. : DRBFM-15-0001_Material_change_of_bonding_wire
Date: 2015/6/22
Revision: 1st edition
Author: Motoharu Haga
DR member: Concerned people in package development department

● Solved ▲ On evaluation
◎ Sure prospect △ Not yet deal with
○ On evaluation (probably good) × NG

Component / Function / Process	Change / Modification Purpose of them			Materials for concern about change: Effect on the component (Failure mode)	Other materials (DRBFM)	How the materials are caused: Factor / Cause	Other factor (DRBFM)	Effect on customer	Countermeasures in order to remove the concern: Designe	Evaluation	Production	Recommended resiction (as a result of DRBFM): Item which should be reflected in design from DRBFM	In-charge / Dead line	Item which should be reflected in evaluation from DRBFM	In-charge / Dead line	Item which should be reflected in production from DRBFM	In-charge / Dead line	Results of countermeasure
Bonding wire / Junction between wire and pad / Make a change from Au to Cu	Material property	Lower electrical resistance than Au	None purpose	Poor characteristics		Breakdown of circuit with overcurrent		Disabled	–	Property comprison of Au and Cu	–	–	–	Each device property was satisfied	●	–	–	Property confirmation of Au and Cu
		Higher heat conduction than Au	None purpose	Poor characteristics		Characteristic variation due to change of heat radiation		Disabled	–	Property comprison of Au and Cu	–	–	–	Each device property was satisfied	●	–	–	Property confirmation of Au and Cu
		Higher tensile strength than Au	None purpose	1st open		Stress on 1st ball during loop formation		Disabled	–	Matrix evaluation of Force vs US	Production within the setup margin	–	–	Margin was checked	●	Specific parameter only can be adjusted	●	Clarification of parameter which can be adjusted in production
		Less metal diffusion with Al than Au	None purpose	1st open due to lost contact		Decline bond strength due to lack of inter metalic formation		Disabled	–	Matrix evaluation of Force vs US	Production within the setup margin	–	–	Margin was checked	●	Specific parameter only can be adjusted	●	Clarification of parameter which can be adjusted in production
		Harder than Au	None purpose	Short due to under PAD crack		Increase of damage to PAD		Disabled	–	Matrix evaluation of Force vs US	Production within the setup margin	–	–	Margin was checked	●	Specific parameter only can be adjusted	●	Clarification of parameter which can be adjusted in production
		Higher thermal expansivity than Au	None purpose	1st open		1st neck cut by thermal cycle		Disabled	–	Solder heat-proof test and temperature cycling test	–	–	–	Pass temperature cycle test, no problem with PKG inside investigation	●	–	–	Carrying out of reliability test
				2nd open		2nd crescent cut by thermal cycle		Disabled	–	Solder heat-proof test and temperature cycling test	–	–	–	Pass temperature cycle test, no problem with PKG inside investigation	●	–	–	Carrying out of reliability test
		More easily oxidized than Au	None purpose	1st open due to lost contact		Decline of bond strength due to oxide film between wire and PAD		Disabled	–	Margin evaluation of initial ball formation	Production within the margin of gas flow and concentration	–	–	Margin was checked	●	Machines stop automatically when gas flow or concentration is abnormal	●	Clarification of parameter for initial ball formation
				2nd open due to lost contact		Decline of bond strength due to oxide film between wire and lead		Disabled	–	Matrix evaluation of storage period vs US	Production under period control after opening nylon bag	–	–	Margin was checked	●	Machines stop automatically when gas flow or concentration is abnormal	●	Clarification of period limit in production
	Process	Bonding profile	Harder wire	Short due to under PAD crack		Thin top Al		Disabled	Limitation of top Al thickness thicker than 1.3um	–	–	Device lomation	●	–	–	–	–	Limitation of top Al thickness thicker than 1.3um
				Short due to under PAD crack		Increase of damage to PAD due to overmuch US		Disabled	–	Matrix evaluation of Force vs US	Production within the setup margin	–	–	Margin was checked	●	Specific parameter only can be adjusted	●	Clarification of parameter which can be adjusted in production
				1st open due to lost contact		Decline bond strength due to lack of US		Disabled	–	Matrix evaluation of Force vs US	Production within the setup margin	–	–	Margin was checked	●	Specific parameter only can be adjusted	●	Clarification of parameter which can be adjusted in production
		Use of forming gas	Antioxidant during electric spark	1st open due to lost contact		Decline of bond strength due to oxide film between wire and PAD		Disabled	–	Margin evaluation of initial ball formation	Production within the margin of gas flow and concentration	–	–	Margin was checked	●	Machines stop automatically when gas flow or concentration is abnormal	●	Clarification of parameter for initial ball formation
		Capillary material	Improvement of wear resistance	Short due to under PAD crack		Increase of damage to PAD due to overmuch US		Disabled	–	Matrix evaluation of Force vs US	Production within the setup margin	–	–	Margin was checked for material change sample	●	Specific parameter only can be adjusted	●	Clarification of parameter which can be adjusted in production
				1st open due to lost contact		Decline bond strength due to lack of US		Disabled	–	Matrix evaluation of Force vs US	Production within the setup margin	–	–	Margin was checked for material change sample	●	Specific parameter only can be adjusted	●	Clarification of parameter which can be adjusted in production
				2nd open due to lost contact		Decline of bond strength due to lack of US		Disabled	–	Matrix evaluation of Force vs US	Production within the setup margin	–	–	Margin was checked for material change sample	●	Specific parameter only can be adjusted	●	Clarification of parameter which can be adjusted in production
	Appearance	Ball thickness / (~=2um thicker)	Capillary dimensions change caused by making process limitation	Short due to under PAD crack		Increase of damage to PAD due to overmuch US		Disabled	–	Matrix evaluation of Force vs US	Production within the setup margin		–	Ball thickness has no influence on bond strength	●	Specific parameter only can be adjusted	●	No problem about 1 ~ 2um thickness change
				1st open due to lost contact		Decline bond strength due to lack of US		Disabled	–	Matrix evaluation of Force vs US	Production within the setup margin	–	–	Margin was checked	●	Specific parameter only can be adjusted	●	Clarification of parameter which can be adjusted in production
		Wire diameter (Depend on original Au wire)	Limitation Due to Cu wire lineup	Poor characteristics		Difference of electrical resistance due to changin wire diameter		Disabled	–	Property comprison of Au and Cu	–	–	–	Each device property was satisfied	●	–	–	Property confirmation of Au and Cu
		Wire sweep ratio	None purpose	Short due to wire touch		Short due to bigger wire sweep than Au wire		Disabled	–	Confirmation of molding parameter	Production within the setup margin	–	–	Wire sweep ratio is equal to Au	●	Same mold parrameter has no problem	●	Current mold parameter has no problem
	Process control	Capillary life	Bonding profile change	Short due to under PAD crack		Over US caused by abnormal capillary tip shape		Disabled	–	Capillary life evaluation	Life control and production within the setup margin	–	–	Life was decided	●	Machine stop automatically when capillary life is ended	●	Clarification of capillary life
				1st and 2nd open due to lost contact		Lack of US caused by abnormal capillary tip shape		Disabled	–	Capillary life evaluation	Life control and production within the setup margin	–	–	Life was decided	●	Machine stop automatically when capillary life is ended	●	Clarification of capillary life
		Wire life after opening nylon bag		1st and 2nd open due to lost contact		Decrease of bond strength due to oxide film between wire and PAD or lead		Disabled	–	Matrix evaluation of storage period vs US	Production under period control after opening nylon bag	–	–	Margin was checked	●	Machine stop automatically when gas flow or concentration is abnormal	●	Clarification of period limit in production
		Packing specification of wire	More easily oxidized than Au	1st and 2nd open due to lost contact		Decrease of bond strength due to oxide film between wire and PAD or lead		Disabled	–	Surface analysis of unopened wire	–	–	–	No wire surface oxidation and sulfurization after 2years	●	–	–	Using special nylon bag and packing silica-gel
		Shear mode / No wire remain after shear test	None purpose	1st open due to lost contact		Decline bond strength due to lack of US		Disabled	–	Matrix evaluation of Force vs US	–	–	–	Slide mark on Pad / Al remain on ball backside	●	–	–	Clarification of standard of shear mode

PESDP025.01

For an extraction risk, we experiment on validity by the evaluation after the following page.

【4】Evaluation contents for the changing risk

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①Basic evaluation

Item		Measuring machine	Criterion
1st Ball Shear	Strength comparison	Shear test M/C	More than Cp：1.33
	Break mode comparison	Microscope (X200)	【Reference①】
Wire pull test	Strength comparison	Pull test M/C	More than Cp：1.33
	Break mode comparison	Microscope (X200)	【Reference②】
Peel test	Break mode comparison	Microscope (X200)	
Under PAD Crack		Microscope (X500)	【Reference③】
Wire sweep		X-rays machine	Less than 10%

②Reliability test

Item	Test Condition	Judgment time	Amount (Min)	Criterion
Resistance to soldering heat	Level 1 or 3	Warranty condition every package type	22pcs ×3Lot	Electrical characteristic SAT (Delamination)
Highly accelerated stress test	130℃/85% Bias	192h	22pcs ×3Lot	Electrical characteristic
Pressure Cooker	121℃/100%	192h	22pcs ×3Lot	Electrical characteristic
Temperature cycling test	150℃/-65℃ 30min/1Cycle	500cyc	22pcs ×3Lot	Electrical characteristic
High temperature storage test	150℃ keep	2,000h	22pcs ×3Lot	Electrical characteristic

【Reference④】Corrosion mechanism

【Reference⑤～⑨】1st bonding confirmation after mold resin de-cap

We judged that a change was possible by confirming the item mentioned above.

【Reference①】Shear test Criteria

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Shear Strength

Φ25um, 30um: More than 200mN

Φ35um: More than 300mN

The standard of copper wire is the same as gold wire.

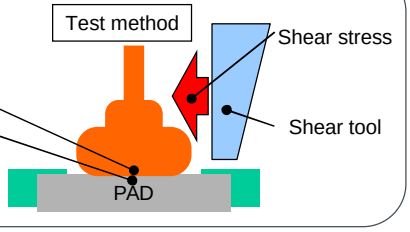
Broken Mode

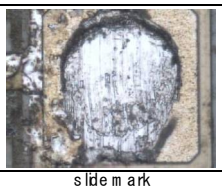
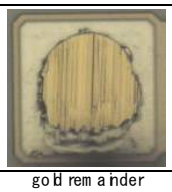
Aluminum attaches under 1st ball

There is a sliding mark on the PAD.

The copper wire broken mode is different from gold wire.

Test method



	Cu wire		Au wire	
	Normal mode	Abnormal mode	Normal mode	Abnormal mode
On the PAD				
	slide mark	No slide mark	gold remainder	No gold remainder
Under 1st Ball			Because the gold wire breaks in 1st ball, we do not confirm the under 1st ball.	
	Aluminum adhesion	No Aluminum adhesion		

【Reference②】Pull & Peel test Criteria

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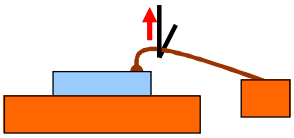
Pull test method

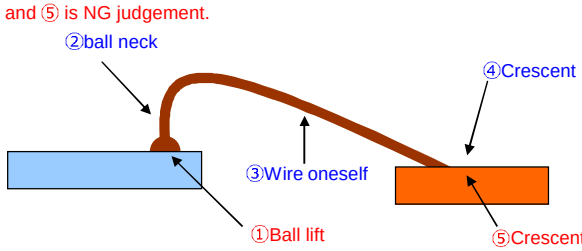


Pull strength

φ25um: More than 40mN
φ30um: More than 60mN
φ35um: More than 80mN

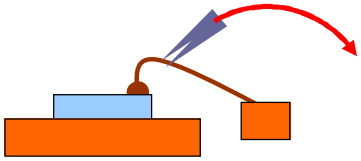
Broken Mode

We raise a wire in the arrow direction in a loop TOP part.
We confirm strength and break mode at that time.
① and ⑤ is NG judgement.



The standard of copper wire is the same as gold wire.

Peel test method



We raise a wire in the arrow direction by tweezers.
We confirm break mode at that time.
⑤ is NG judgement.
*The judgment of the peel test is severer than 2nd pull test.

【Reference③】Under PAD Crack Criteria

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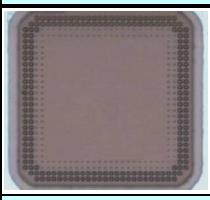
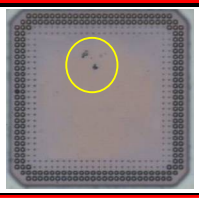
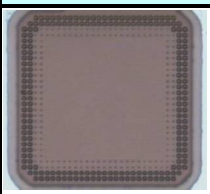
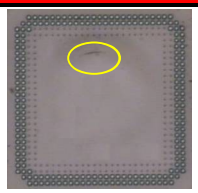
不良モード NG Mode	A Mode ねらい値及び実力値 Aim and ability value	B Mode いつもと違うレベル但し規格内 In standard level different from always	C Mode 規格外 Non-standard	測定方法及び測定ポイント Measuring method and point
クレータリング Cratering				＜測定方法/Measuring method＞ 工場顕微鏡：500倍で確認 Microscope：X500 焦点：PAD上面 Focus：Surface of PAD
判定基準 Judging standard	層間膜にクレータリングがない An interlamellar does not have crater		層間膜にクレータリングがある An interlamellar have crater	
アクション Action	生産続行 The production continuation		異常、アンドンを回しPMと原因調査し、対象LOTの絞込みと回収を行う Cause investigation, LOT collection	
亀裂 Crack				＜測定方法/Measuring method＞ 工場顕微鏡：500倍で確認 Microscope：X500 焦点：PAD上面 Focus：Surface of PAD
判定基準 Judging standard	層間膜の亀裂がない An interlamellar does not have crack		層間膜に亀裂がある An interlamellar have crack	
アクション Action	生産続行 The production continuation		異常、アンドンを回しPMと原因調査し、対象LOTの絞込みと回収を行う Cause investigation, LOT collection	

The standard of Cu wire is the same as Au wire.

【5】List of the evaluation item

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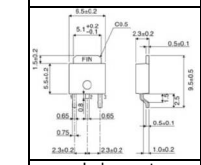
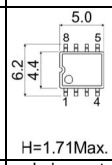
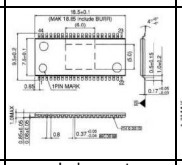
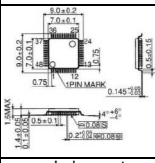
		POWER series	SOP series	HTSSOP series	QFP series	QFN series
Representative package type		TO252-3	SOP8	HTSSOP-A44/B20	VQFP48C	VQFN024V4040
						
		Judgment	Judgment	Judgment	Judgment	Judgment
Basic evaluation	1st ball Dia./Thick.	○	○	○	○	○
	1st ball shear test	○	○	○	○	○
	Wire pull test	○	○	○	○	○
	Peel test	○	○	○	○	○
	Under PAD Crack	○	○	○	○	○
	Section analysis	○	○	○	○	○
	Process condition confirmation	○	○	○	○	○
	Wire sweep	○	○	○	○	○
Reliability test	Resistance to soldering heat	○	○	○	○	○
	Highly acceleated stress test	○	○	○	○	○
	Pressure Cooker	○	○	○	○	○
	Temperature cycling test	○	○	○	○	○
	High temperature storage test	○	○	○	○	○

We classified packages and, in the representative package, evaluated all items. The result does not have any problem.

【5-1】Basic evaluation result ①

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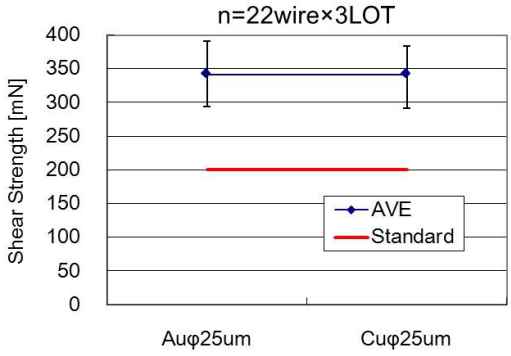
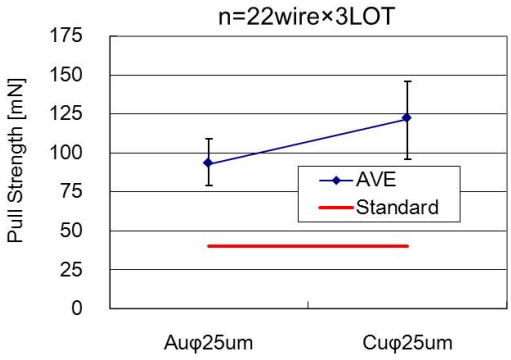
Basic evaluation result

Package: SSOP5
Device Name: BD2232G

	Shear Test		Pull Test	
	Auφ25um	Cuφ25um	Auφ25um	Cuφ25um
Standard	More than 200mN		More than 40mN	
Max	391	384	109	146
AVE	341	341	93	122
Min	294	292	79	96
σ	30.56	27.96	10.64	15.81
Cp	1.54	1.69	1.66	1.72





There is not the significant difference in shear strength, wire pull strength about ability for process.
The breaking mode does not have any problem, too.

【5-1】Basic evaluation result ②

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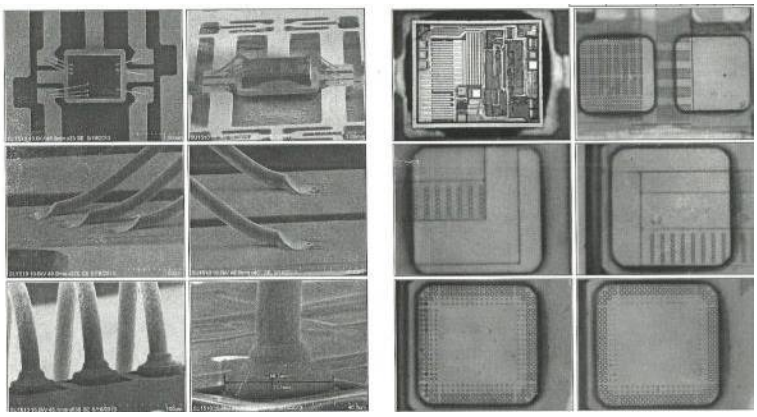
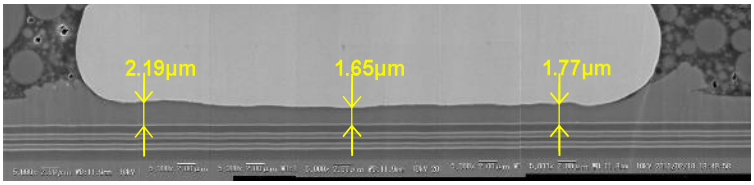
Basic evaluation result
*Appearance observation
with the SEM
*PAD crack observation

Package: SSOP5
Device Name: BD2232G



Basic evaluation result
*1st bond junction



Enough aluminum is left right under 1st ball, and a joining state does not have any problem.
I show the detailed analysis result of the junction by the TEM on the following page.

【5-1】Basic evaluation result ③

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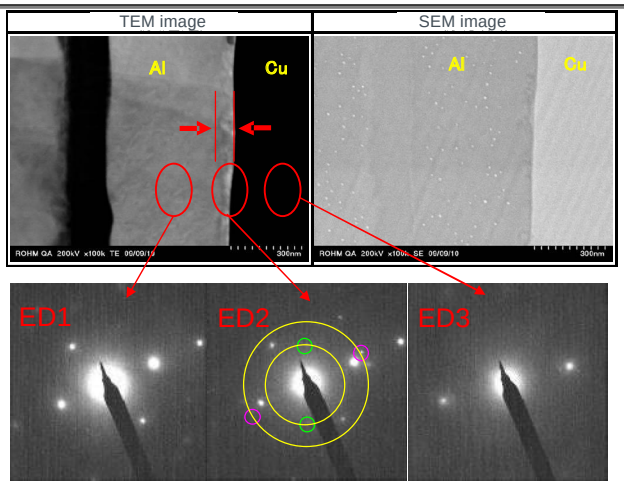
Basic evaluation result: Confirmation of the alloy layer by the TEM



【Calculation method】
Diffraction spot distance: Lλ= dR
L: Camera length, λ: Wavelength of the electron beam
D: Diffraction interval, R: Distance between spots
Standard: Si(111)のLλ：8.02688×10-12（m2）

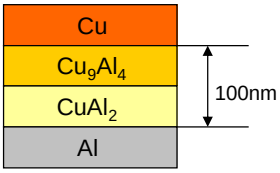
Result: It fitted Lattice constant of Al_4Cu_9(3 0 0) and Al_2Cu(2 0 0).

Lattice constant

Green	Lattice spacing (Å)	
	2.94(2.80～3.09)	
Cu9Al4	2.9	3 0 0
CuAl2	3.0335	2 0 0
CuAl	2.83	2 0 2

Pink	Lattice spacing (Å)	
	1.89(1.80-1.99)	
Cu9Al4	2.05	3 3 0
	1.99	3 3 1
	1.95	4 2 0
	1.9	4 2 1
CuAl2	1.91	3 1 0
	1.9	2 0 2
CuAl	2.023	3 1 0

Schematic view of the junction



An alloy layer of approximately 100nm exists after WB.

【5-1】Basic evaluation result ④

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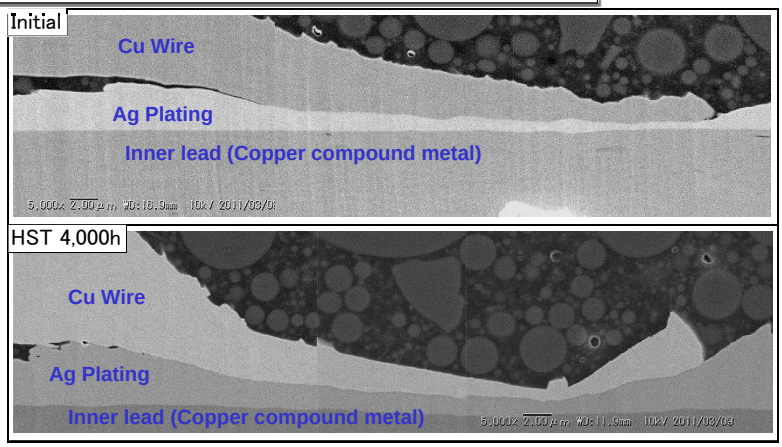
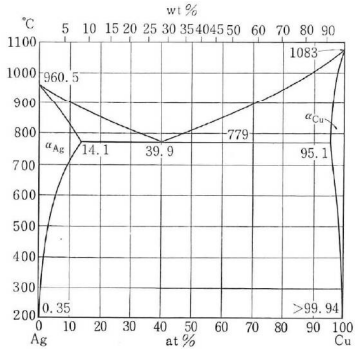
Basic evaluation result: Section observation in the HST4,000h



Phase diagram of AgCu



Generally, in the inner lead of IC parts, there is Ag plating on the Cu frame.
Thus, the Cu wire joins it to an Ag plating. Ag and Cu show a eutectic reaction in the phase diagram.
For example, the compound is not formed in this temperature or less because the melting point (eutectic point) is around 750 degrees.
Thus, the joining of Ag-Cu is stable as above even after HST test (150 degrees 4,000h).
Because the joining of Ag-Cu does not have a compound, there does not corrode in HAST or PCT.

【5-1】Basic evaluation result ⑤

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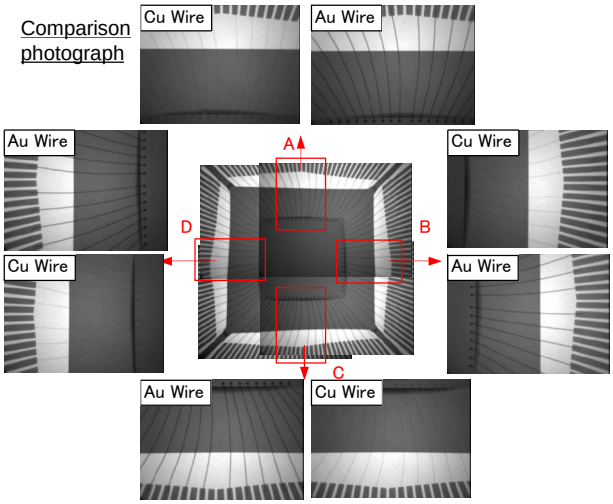
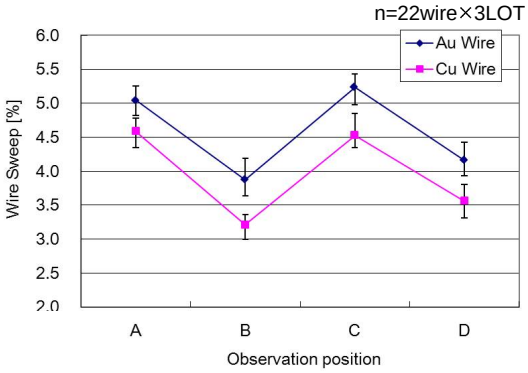
Basic evaluation result: Wire sweep

Comparison photograph



Package: VQFP144
Wire Dia.: φ25um(Gold & Copper)
Loop Height: 180um
Wire Length: MAX 4.0mm

※Because the QFP shape has a long wire, it is easy to compare the sweep ratio.



In the same X-rays observation condition (the current & voltage), it becomes hard to see some copper wires.

It meet the standard within 10% of wire sweep rates, and there is not the significant difference.

【5-2】Simulation result ①

Stress analysis in the constant load (25g, 85g)

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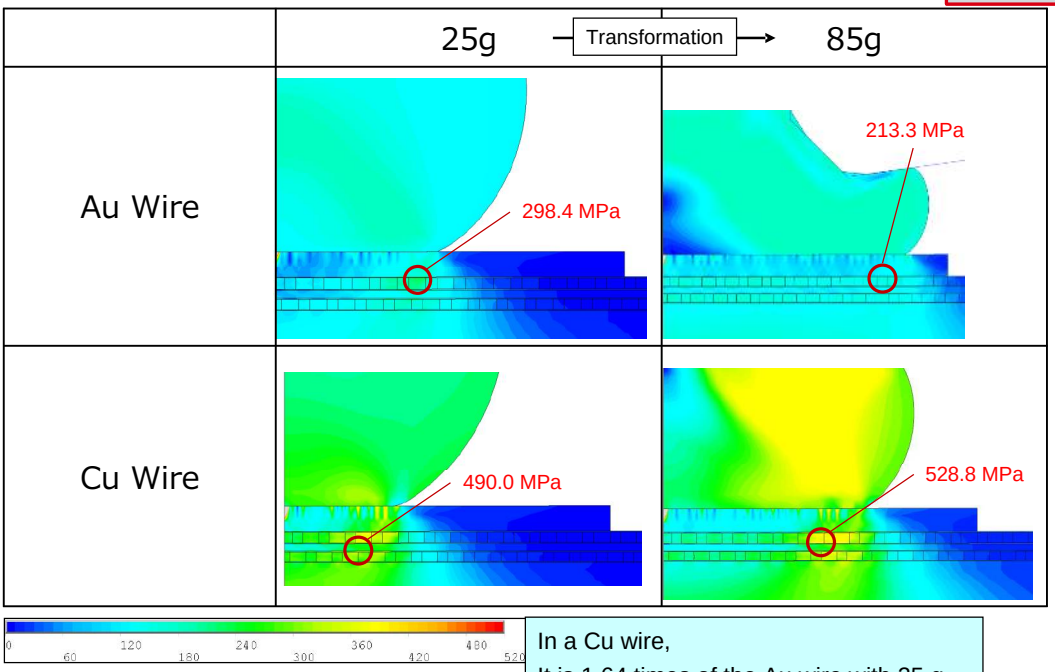
Stress simulation result

1st Ball transformation by the force change



In a Cu wire,
It is 1.64 times of the Au wire with 25 g.
It is 2.48 times of the Au wire with 85 g.
It takes stress under of the 1st ball edge.

【5-2】Simulation result ②

Stress analysis in the bonded 2nd crescent shape

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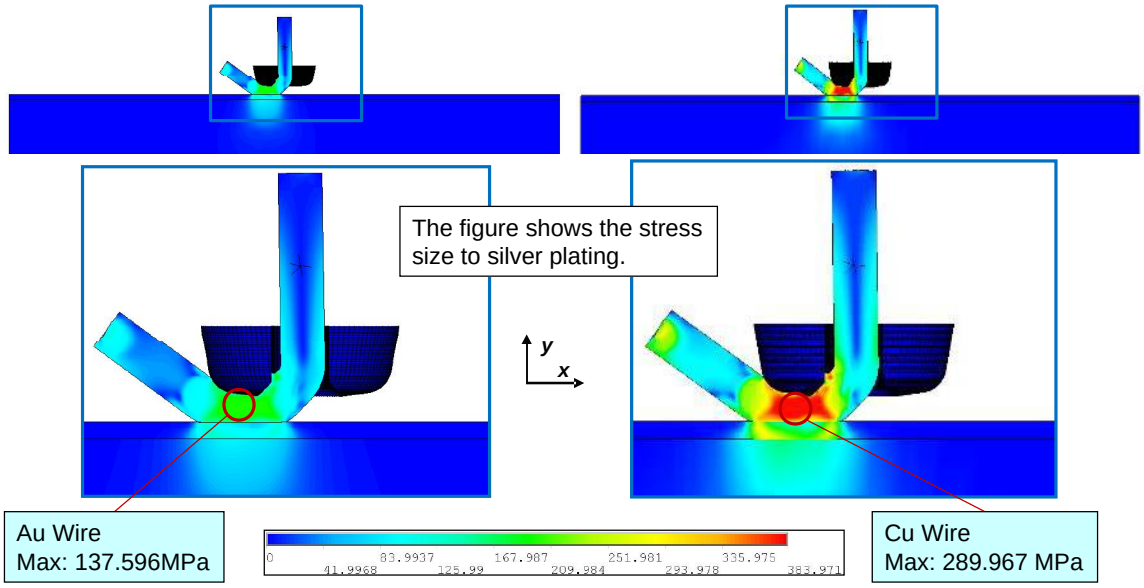
Stress simulation result

Because the element (mesh) of the bonded tail shape becomes small,
we cannot analyze under the constant load.
We carried out the simulation in the heteromorphic process.



Au Wire
Max: 137.596MPa

Cu Wire
Max: 289.967 MPa

The Cu wire becomes 2.1 times stress of the Au wire.

【5-2】Process margin result ①

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Matrix evaluation result of the 1st bond

Package: VQFN020V4040
Device Name: BD9141MUV
Copper Wire Dia.: 30um

Production margin

Force [g]		Ultrasonic [mA]						
		TYP-20mA	TYP-15mA	TYP-10mA	TYP	TYP+10mA	TYP+15mA	TYP+20mA
TYP-10gf	1stBallSize	1.92	1.84	1.77	1.75	1.78	1.88	2.01
	ShearStrength (Cpk)	1.68	1.68	1.74	1.96	1.80	1.89	1.76
	ShearMode PAD	0/66PAD	0/66PAD	0/66PAD	0/66PAD	0/66PAD	0/66PAD	0/66PAD
	ShearMode Ballside	0/66Ball	0/66Ball	0/66Ball	0/66Ball	0/66Ball	0/66Ball	0/66Ball
	NSOP (28W wire/IC)	5/192IC	0/192IC	0/192IC	0/192IC	0/192IC	0/192IC	0/192IC
	UnderPad Crack	0/66PAD	0/66PAD	0/66PAD	0/66PAD	0/66PAD	0/66PAD	7/66PAD
TYP-5gf	1stBallSize	1.93	1.79				1.98	1.88
	ShearStrength (Cpk)	1.88	1.78				1.85	1.72
	ShearMode PAD	0/66PAD	0/66PAD				0/66PAD	0/66PAD
	ShearMode Ballside	0/66Ball	0/66Ball				0/66Ball	0/66Ball
	NSOP (28W wire/IC)	0/192IC	0/192IC				0/192IC	0/192IC
	UnderPad Crack	0/66PAD	0/66PAD				0/66PAD	0/66PAD
TYP	1stBallSize	1.70	1.72				1.98	1.88
	ShearStrength (Cpk)	1.69	1.69				2.00	1.70
	ShearMode PAD	0/66PAD	0/66PAD				0/66PAD	0/66PAD
	ShearMode Ballside	0/66Ball	0/66Ball				0/66Ball	0/66Ball
	NSOP (28W wire/IC)	0/192IC	0/192IC				0/192IC	0/192IC
	UnderPad Crack	0/66PAD	0/66PAD				0/66PAD	0/66PAD
TYP+5gf	1stBallSize	1.76	1.92				1.96	1.92
	ShearStrength (Cpk)	1.70	1.81				1.87	1.69
	ShearMode PAD	0/66PAD	0/66PAD				0/66PAD	0/66PAD
	ShearMode Ballside	0/66Ball	0/66Ball				0/66Ball	0/66Ball
	NSOP (28W wire/IC)	0/192IC	0/192IC				0/192IC	0/192IC
	UnderPad Crack	0/66PAD	0/66PAD				0/66PAD	0/66PAD
TYP+10gf	1stBallSize	1.89	1.96	1.75	1.88	1.68	1.89	1.89
	ShearStrength (Cpk)	1.71	2.01	1.98	1.92	2.00	1.73	1.99
	ShearMode PAD	0/66PAD	0/66PAD	0/66PAD	0/66PAD	0/66PAD	0/66PAD	0/66PAD
	ShearMode Ballside	0/66Ball	0/66Ball	0/66Ball	0/66Ball	0/66Ball	0/66Ball	0/66Ball
	NSOP (28W wire/IC)	0/192IC	0/192IC	0/192IC	0/192IC	0/192IC	0/192IC	0/192IC
	UnderPad Crack	0/66PAD	0/66PAD	0/66PAD	0/66PAD	0/66PAD	0/66PAD	0/66PAD

In force[g] and US[mA] matrix condition, we confirm it to the range beyond the production margin and decide a final production condition.

【5-2】Process margin result ①

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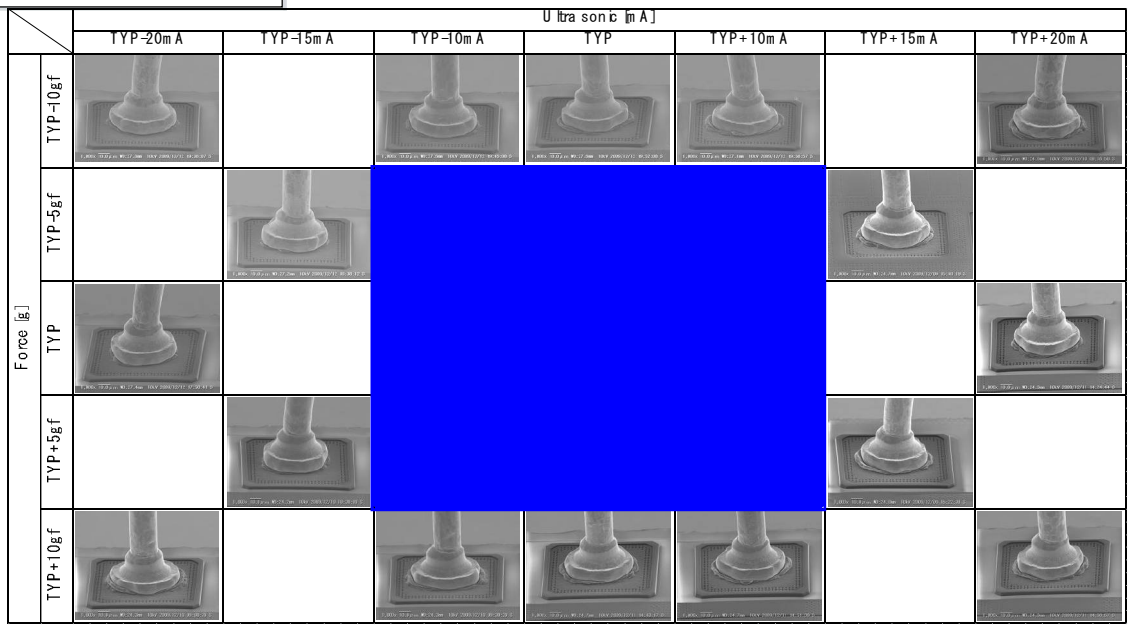
Appearance observation of the 1st bond



There is no abnormality to 1st ball diameter thickness and quantity of aluminum splash.

【5-2】Process margin result ①

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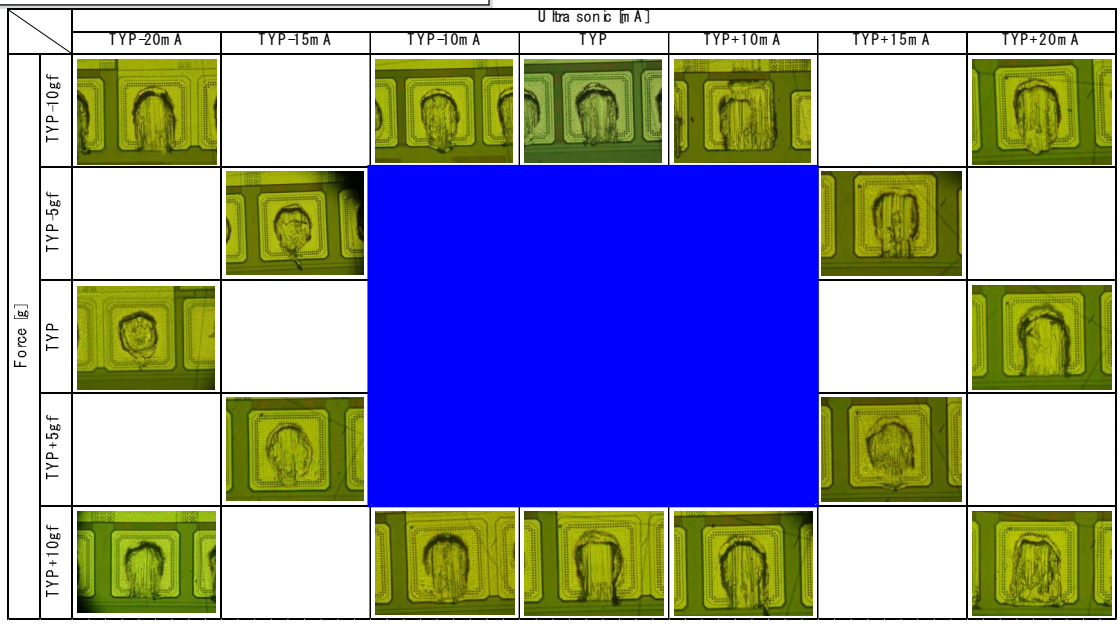
Broken mode confirmation after the share test (On the PAD)



There is a sliding mark on the PAD, and there is no abnormality.

【5-2】Process margin result ①

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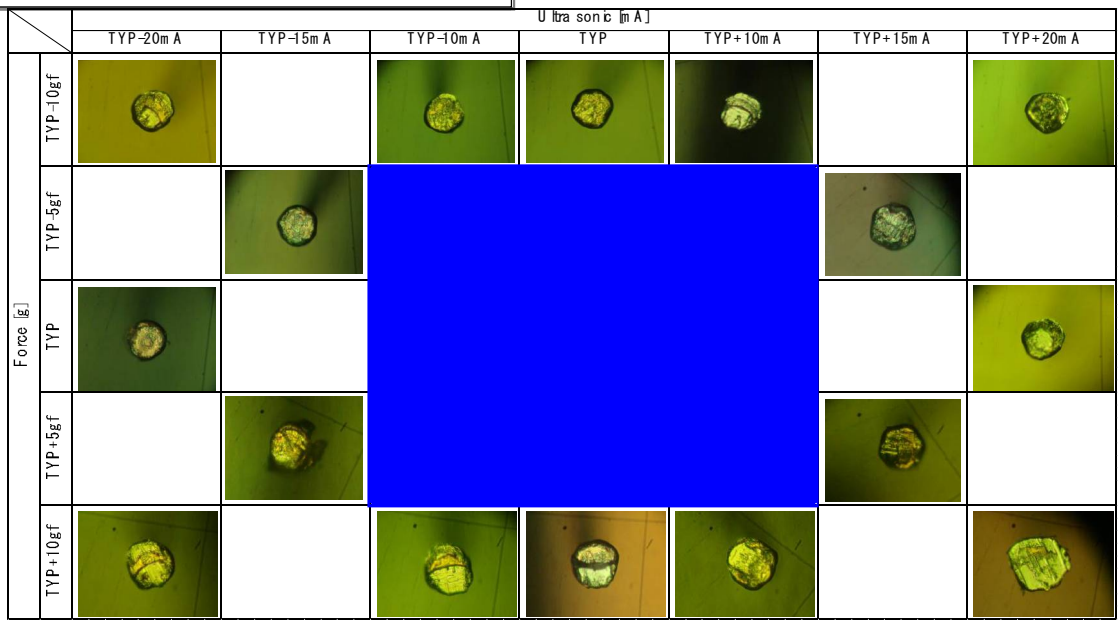
Broken mode confirmation after the share test (Under 1st Ball)



Aluminum attaches under 1st ball, and there is no abnormality.

【5-2】Process margin result ①

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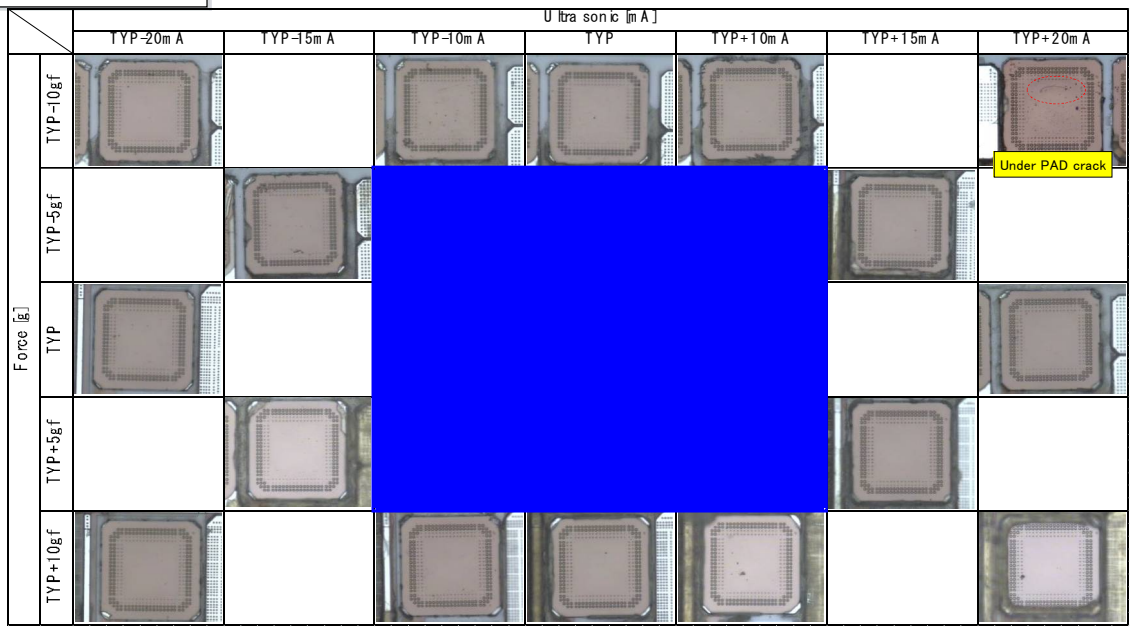
Confirmation of under PAD crack



In the production margin, there is no under PAD crack.

【5-2】Process margin result ②

Confidential

Matrix evaluation result of the 2nd bond

Package: VQFN020V4040
Device Name: BD9141MUV
Copper Wire Dia.: 30um

Production margin

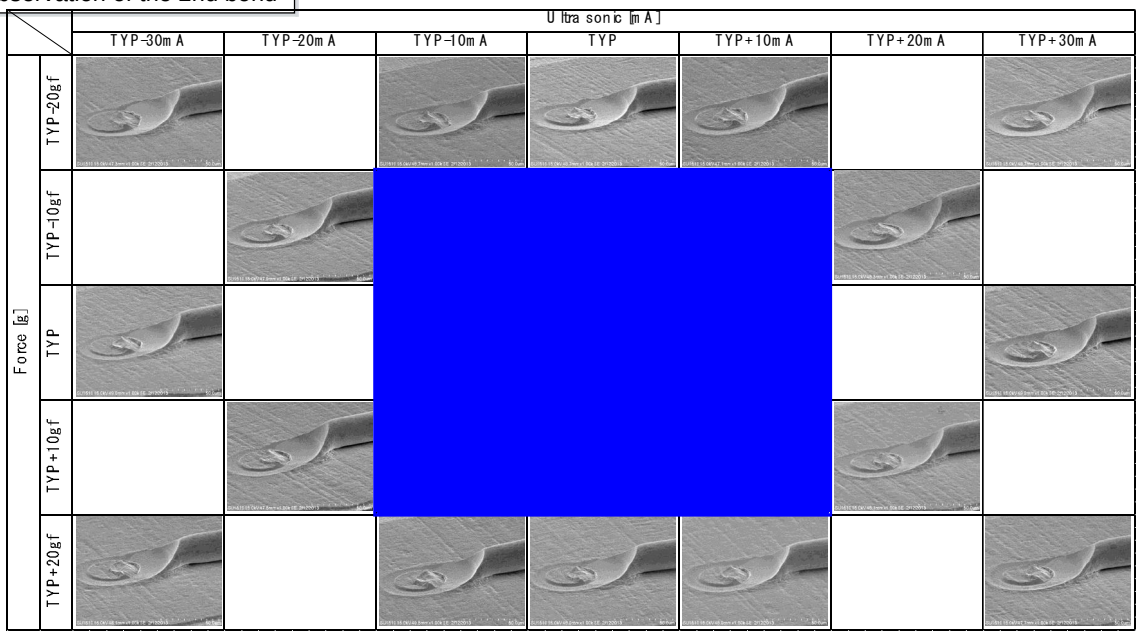
Force [g]			Ultrasonic [mA]						
			TYP-30mA	TYP-20mA	TYP-10mA	TYP	TYP+10mA	TYP+20mA	TYP+30mA
TYP-20gf		Pull CP	1.67	1.85	1.76	1.72	1.86	1.69	1.83
		Peel Mode	0/66Wire	0/66Wire	0/66Wire	0/66Wire	0/66Wire	0/66Wire	0/66Wire
		Short Tail (28Wire/IC)	0/192IC	0/192IC	0/192IC	0/192IC	0/192IC	0/192IC	23/192IC
		NSOL (28Wire/IC)	3/192IC	0/192IC	0/192IC	0/192IC	0/192IC	0/192IC	0/192IC
		Burr of Crescent	0/66Wire	0/66Wire	0/66Wire	0/66Wire	0/66Wire	0/66Wire	0/66Wire
TYP-10gf		Pull CP	1.79	1.90				1.68	1.72
		Peel Mode	0/66Wire	0/66Wire				0/66Wire	0/66Wire
		Short Tail (28Wire/IC)	0/192IC	0/192IC				0/192IC	0/192IC
		NSOL (28Wire/IC)	0/192IC	0/192IC				0/192IC	0/192IC
		Burr of Crescent	0/66Wire	0/66Wire				0/66Wire	0/66Wire
TYP		Pull CP	1.80	1.68				1.82	1.88
		Peel Mode	0/66Wire	0/66Wire				0/66Wire	0/66Wire
		Short Tail (28Wire/IC)	0/192IC	0/192IC				0/192IC	0/192IC
		NSOL (28Wire/IC)	0/192IC	0/192IC				0/192IC	0/192IC
		Burr of Crescent	0/66Wire	0/66Wire				0/66Wire	0/66Wire
TYP+10gf		Pull CP	1.75	1.84				1.79	1.86
		Peel Mode	0/66Wire	0/66Wire				0/66Wire	0/66Wire
		Short Tail (28Wire/IC)	0/192IC	0/192IC				0/192IC	0/192IC
		NSOL (28Wire/IC)	0/192IC	0/192IC				0/192IC	0/192IC
		Burr of Crescent	0/66Wire	0/66Wire				0/66Wire	0/66Wire
TYP+20gf		Pull CP	1.82	1.84	1.71	1.76	1.71	1.81	1.82
		Peel Mode	0/66Wire	0/66Wire	0/66Wire	0/66Wire	0/66Wire	0/66Wire	0/66Wire
		Short Tail (28Wire/IC)	0/192IC	0/192IC	0/192IC	0/192IC	0/192IC	0/192IC	0/192IC
		NSOL (28Wire/IC)	0/192IC	0/192IC	0/192IC	0/192IC	0/192IC	0/192IC	0/192IC
		Burr of Crescent	0/66Wire	0/66Wire	0/66Wire	0/66Wire	0/66Wire	0/66Wire	0/66Wire

In force[g] and US[mA] matrix condition, we confirm it to the range beyond the production margin and decide a final production condition.

【5-2】Process margin result ②

Confidential

Appearance observation of the 2nd bond

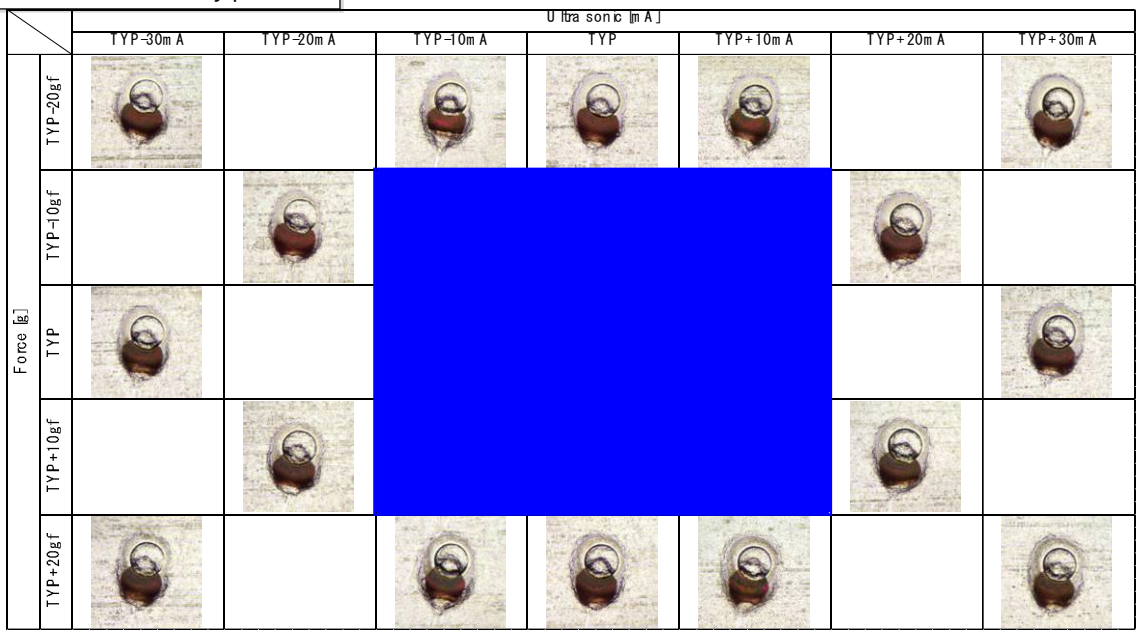


There is no abnormality without a crack or a wound in the Crescent.

【5-2】Process margin result ②

Confidential

Confirmation of the broken mode by peel test



Crescent remains on the lead frame, and there is no abnormality.

【5-4】Reliability test evaluation result

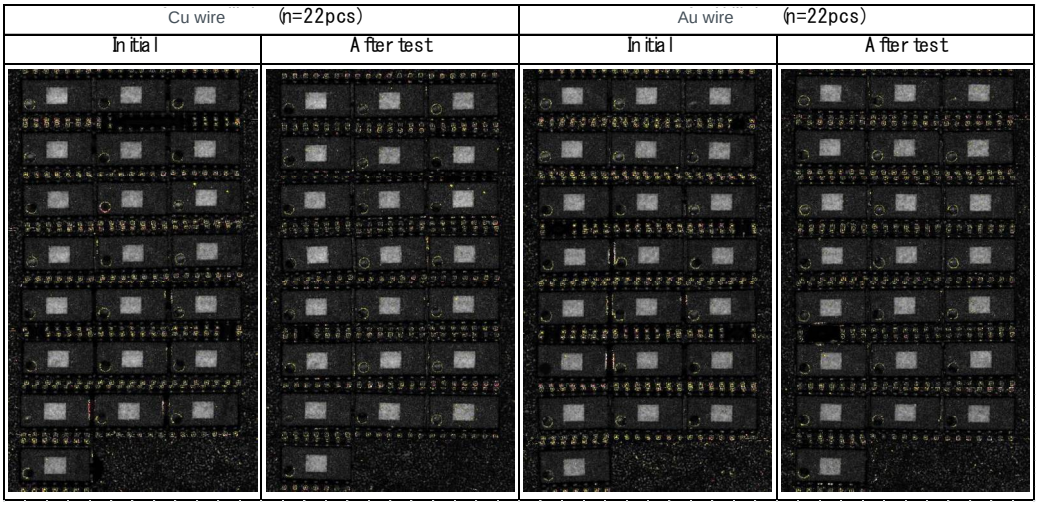
Confidential

Solder heat resistance test

Package: SOP16
Preprocessing condition: 85℃/85% 168h(Moisture absorption)
Reflow condition: 3 times (260℃ peak)
Criteria: There is no delamination on the Chip.

【Result】Pn/n

Wire materials	Copper wire	Gold wire
Initial	0/22	0/22
After test	0/22	0/22



For solder heat resistance, there are not difference between Cu wire Au wire.

【5-4】Reliability test evaluation result

Confidential

Reliability test result

Criteria: Check with electrical characteristic (Pn/n)

Cu wire

Test Condition	Package	100	192
HAST 130℃/85% Bias	HTSSOP-A44	0/66pcs	0/66pcs
	HTSSOP-B20	0/66pcs	0/66pcs
	VQFP48C	0/66pcs	0/66pcs
	VQFN024V4040	0/66pcs	0/66pcs
	SOP8	0/66pcs	0/66pcs
	TO252-3	0/66pcs	0/66pcs

Test Condition	Package	100	192
PCT 121℃/100%	HTSSOP-A44	0/66pcs	0/66pcs
	HTSSOP-B20	0/66pcs	0/66pcs
	VQFP48C	0/66pcs	0/66pcs
	VQFN024V4040	0/66pcs	0/66pcs
	SOP8	0/66pcs	0/66pcs
	TO252-3	0/66pcs	0/66pcs

Test Condition	Package	100	300	500
TCY 150℃/-65℃ (30min/1cyc)	HTSSOP-A44	0/66pcs	0/66pcs	0/66pcs
	HTSSOP-B20	0/66pcs	0/66pcs	0/66pcs
	VQFP48C	0/66pcs	0/66pcs	0/66pcs
	VQFN024V4040	0/66pcs	0/66pcs	0/66pcs
	SOP8	0/66pcs	0/66pcs	0/66pcs
	TO252-3	0/66pcs	0/66pcs	0/66pcs

Test Condition	Package	240	500	1,000	2,000
HST Keep 150℃	HTSSOP-A44	0/66pcs	0/66pcs	0/66pcs	0/66pcs
	HTSSOP-B20	0/66pcs	0/66pcs	0/66pcs	0/66pcs
	VQFP48C	0/66pcs	0/66pcs	0/66pcs	0/66pcs
	VQFN024V4040	0/66pcs	0/66pcs	0/66pcs	0/66pcs
	SOP8	0/66pcs	0/66pcs	0/66pcs	0/66pcs
	TO252-3	0/66pcs	0/66pcs	0/66pcs	0/66pcs

Au wire

Test Condition	Package	100	192
HAST 130℃/85% Bias	HTSSOP-A44	0/66pcs	0/66pcs
	HTSSOP-B20	0/66pcs	0/66pcs
	VQFP48C	0/66pcs	0/66pcs
	VQFN024V4040	0/66pcs	0/66pcs
	SOP8	0/66pcs	0/66pcs
	TO252-3	0/66pcs	0/66pcs

Test Condition	Package	100	192
PCT 121℃/100%	HTSSOP-A44	0/66pcs	0/66pcs
	HTSSOP-B20	0/66pcs	0/66pcs
	VQFP48C	0/66pcs	0/66pcs
	VQFN024V4040	0/66pcs	0/66pcs
	SOP8	0/66pcs	0/66pcs
	TO252-3	0/66pcs	0/66pcs

Test Condition	Package	100	300	500
TCY 150℃/-65℃ (30min/1cyc)	HTSSOP-A44	0/66pcs	0/66pcs	0/66pcs
	HTSSOP-B20	0/66pcs	0/66pcs	0/66pcs
	VQFP48C	0/66pcs	0/66pcs	0/66pcs
	VQFN024V4040	0/66pcs	0/66pcs	0/66pcs
	SOP8	0/66pcs	0/66pcs	0/66pcs
	TO252-3	0/66pcs	0/66pcs	0/66pcs

Test Condition	Package	240	500	1,000	2,000
HST Keep 150℃	HTSSOP-A44	0/66pcs	0/66pcs	0/66pcs	0/66pcs
	HTSSOP-B20	0/66pcs	0/66pcs	0/66pcs	0/66pcs
	VQFP48C	0/66pcs	0/66pcs	0/66pcs	0/66pcs
	VQFN024V4040	0/66pcs	0/66pcs	0/66pcs	0/66pcs
	SOP8	0/66pcs	0/66pcs	0/66pcs	0/66pcs
	TO252-3	0/66pcs	0/66pcs	0/66pcs	0/66pcs

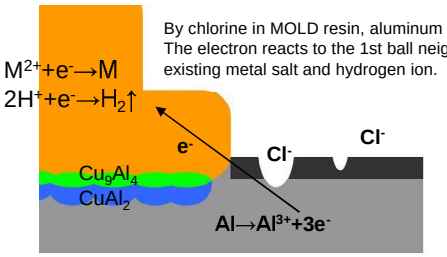
There is no problem in both of a Au wire and the Cu wire.

【Reference④】Corrosion mechanism

Confidential

The 1st bonding junction is corroded in HAST by a kind of the resin.

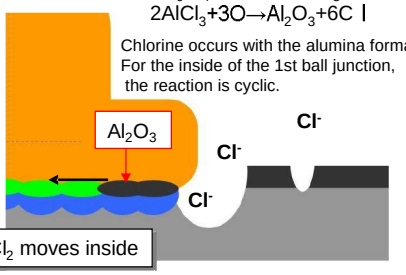
Pitting corrosion:
A metal surface covered with oxide corrode partially



Much Cl- (minus) gathers in applied voltage Pin.

$Cu_9Al_4+12Cl\rightarrow 4AlCl_3+9Cu$
$2AlCl_3+3O\rightarrow Al_2O_3+6C\uparrow$

Chlorine occurs with the alumina formation, too.
For the inside of the 1st ball junction,
the reaction is cyclic.

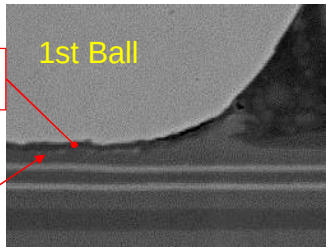


【HAST test result】Pn/n
The defectiveness is electrical opening.

Addition rate	HAST			
	100h	200h	300h	500h
0	12/22	18/22	22/22	22/22
TYP-80%	0/22	0/22	0/22	5/22
TYP-40%	0/22	0/22	0/22	0/22
TYP	0/22	0/22	0/22	0/22
TYP + 20%	0/22	0/22	0/22	0/22

【Section observation】

Cu_9Al_4 becomes extinct,
and alumina (Al_2O_3) is formed.

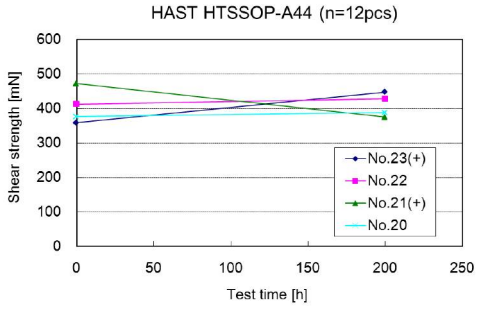


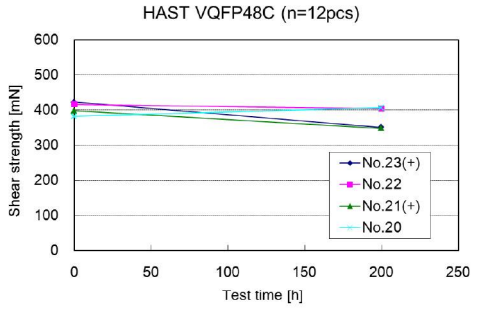
This white line is $CuAl_2$.

Defectiveness is caused by the additive quantity (ion trapper) like the table mentioned above.
We confirm that there is additive quantity of all mold resin with the most suitable value (TYP less than ±10%) on actual HAST.

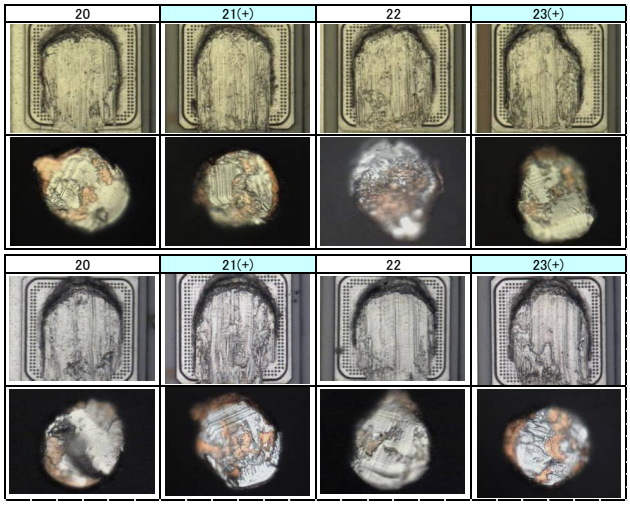
【Reference⑤】Shear strength change (HAST:192h)

Confidential





Share strength standard: More than 200mN

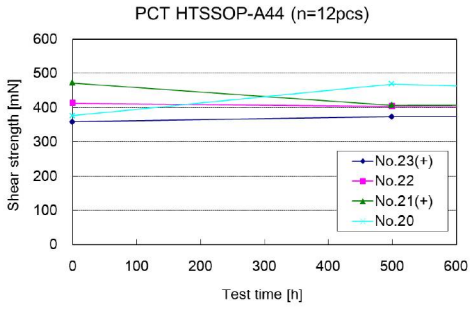


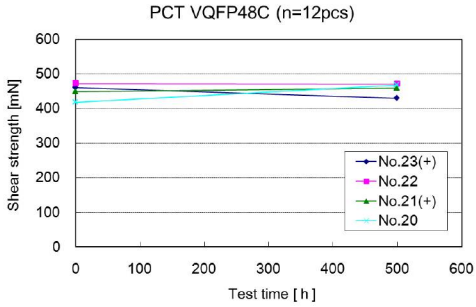
In HAST192h, there is no abnormality in share strength and a broken mode

The number is Pin No. “+” is voltage applying (bias).
There is the meaning that it is as a result of bias examination only.
PCT, TCY, and HST do not have bias.
However, I check a share test in same Pin.

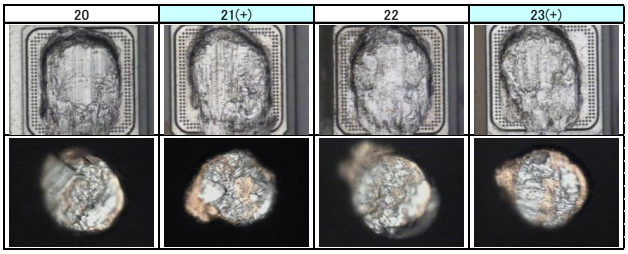
【Reference⑥】Shear strength change (PCT:500h)

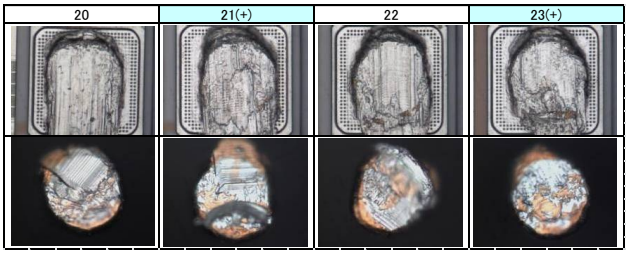
Confidential





Share strength standard: More than 200mN

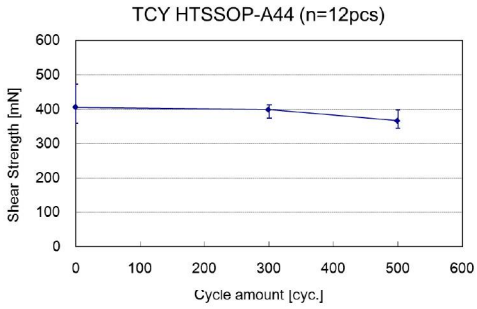


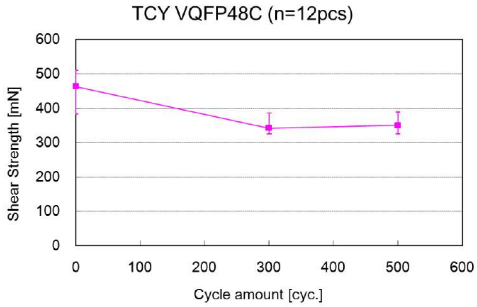


In PCT500h, there is no abnormality in share strength and a broken mode

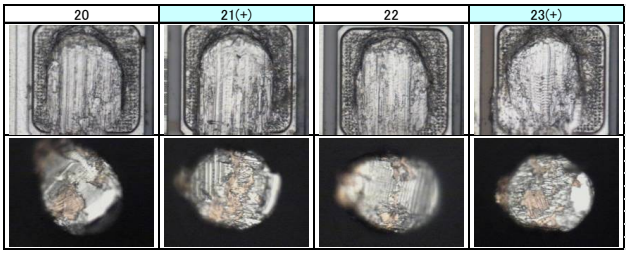
【Reference⑦】Shear strength change (TCY:500cyc)

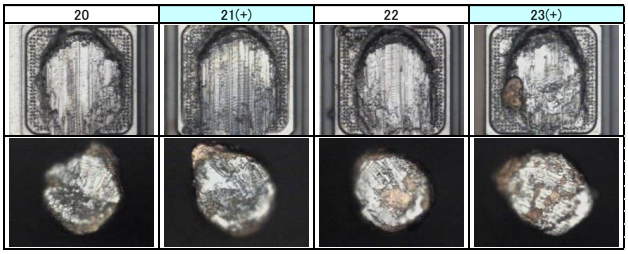
Confidential





Share strength standard: More than 200mN

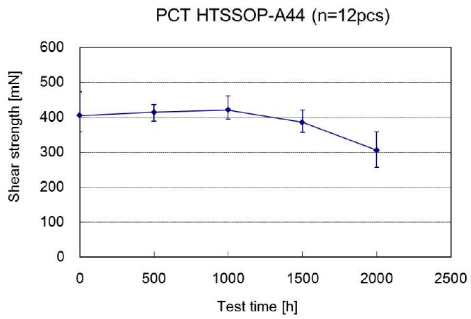


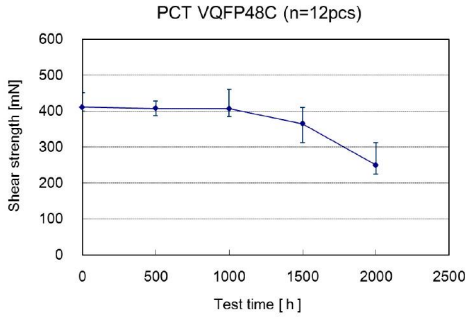


In TCY500cyc, there is no abnormality in share strength and a broken mode

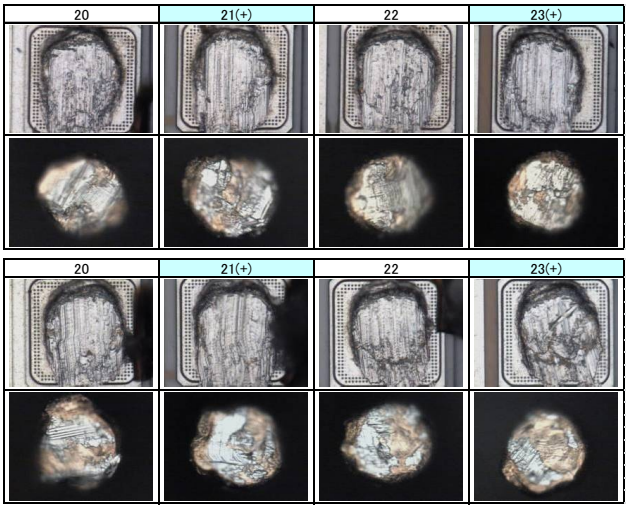
【Reference⑧】Shear strength change (HST:2,000h)

Confidential





Share strength standard: More than 200mN



In HST2,000h, there is no abnormality in share strength and a broken mode

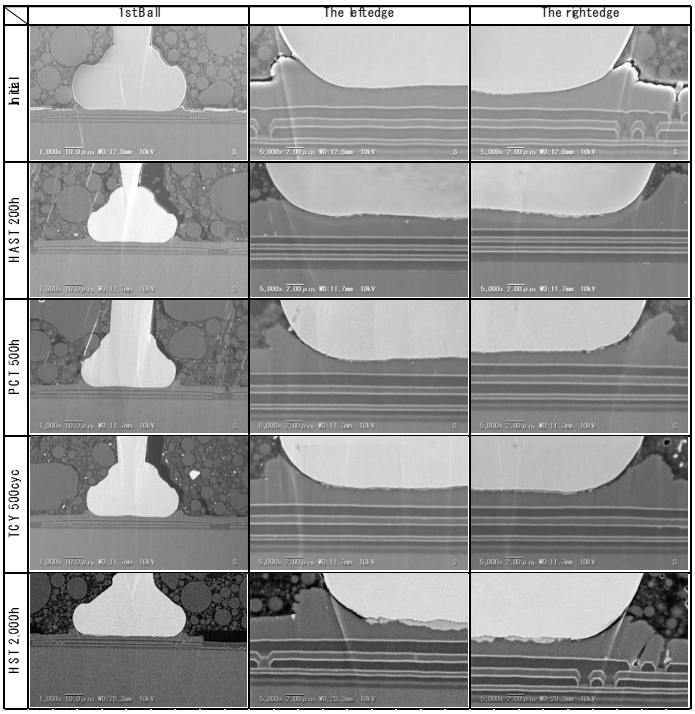
Because an intermetallic compound grows up, the share strength decreases.
However, it meet a judgment standard.

【Reference⑨】1st ball section photograph

Confidential

Package: VQFN020V4040
Device Name: BD8305MUV

There is no abnormality in the section joining state of the 1st ball after each reliability.
※An alloy layer (Intermetallic compound) grows up most in HST2,000h.

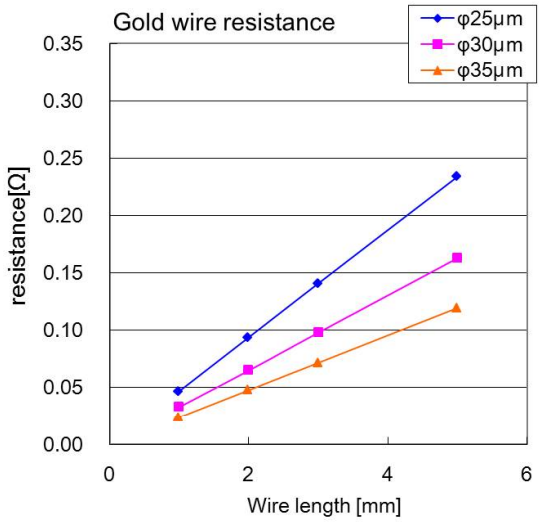


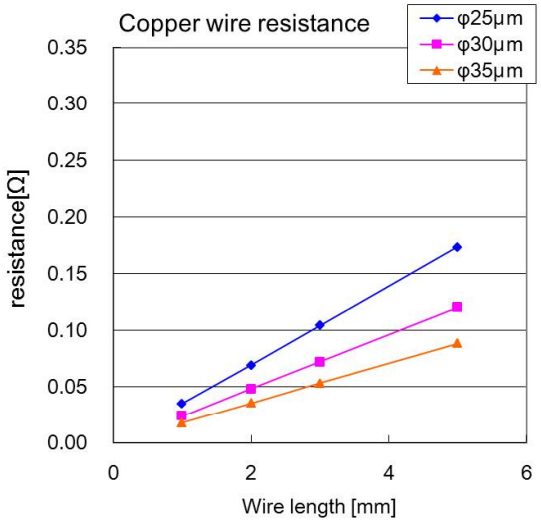
【5-5】Electrical characteristic result ①

Confidential

Wire resistance

Calculating formula
Ω＝ρ(L/S)
ρ: Ratio resistance
ρ(Au)=2.3 / ρ(Cu)=1.7





The Cu wire is more advantageous about electrical resistance than Au wire.

【5-5】Electrical characteristic result ②

Confidential

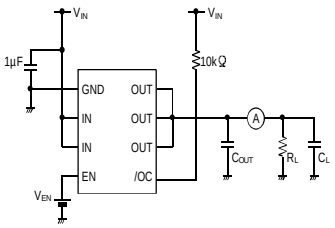
Electrical characteristic

Device Name: BD82065AFJ
*change only wire materials with the same device

Item	Sign	Outside company building spec. (@ 25℃,5.0V)			Result		Ratio	Unit	Measurement condition	Judgment
		Min.	Typ.	Max.	Cu-wire	Au-wire	1-Au/Cu [%]			
◆Electrical characteristic									Ta=R.T., V_{IN}=5.0V, CN=1μF	
Operating Current	IDD	–	110	160	112.4	111.7	0.6	μA	EN=5V, VOUT=OPEN	○
Standby Current	ISTB	–	0.01	5	0.0	0.0	–	μA	EN=0V, VOUT=OPEN	○
EN High inputvoltage	VENH	2.0	–	–	1.51	1.51	0.0	V		○
EN Low inputvoltage	VENL	–	–	0.8	1.37	1.37	0.1	V		○
EN inputcurrent	IEN	-1.0	0.01	1.0	0.0	0.0	–	μA	VEN=5V	○
/OC outputLOW voltage	VOCL	–	–	0.5	0.03	0.03	0.0	V	IOC=0.5mA	○
/OC outputleak current	IOC	–	0.01	1.0	0.0	0.0	–	μA	VOC=5V	○
/OC delay time	TOC	10	15	20	14.23	14.42	-1.3	ms		○
ON resistance	RON	–	70	110	72.2	77.2	-6.9	mΩ	DUT=500mA	○
CurrentLimitThreshold	ITH	1.5	2.4	3.0	1.93	1.96	-1.6	A		○
Short-circuitcurrent(RMS)	ISC	1.1	1.5	2.1	1.34	1.34	0.0	A	VOUT=GND,CL=47μF	○
Outputrise time	TON1	–	0.8	10	0.45	0.45	-1.8	ms	RL=10Ω	○
Outputrise delay time	TON2	–	1.1	20	0.65	0.66	-1.5	ms	RL=10Ω	○
Outputfall time	TOFF1	–	5	20	3.08	3.12	-1.4	μs	RL=10Ω	○
Outputfall delay time	TOFF2	–	10	40	6.64	6.65	-0.1	μs	RL=10Ω	○
Reverse leak current	IREV	–	–	1	0.0	0.0	–	μA	VOUT=5.5V, VIN=0V, VEN=0V	○
UVLO High Threshold	VTUVH	2.1	2.3	2.5	2.256	2.284	-1.2	V	VIN at the time of a rise	○
UVLO Low Threshold	VTUVL	2.0	2.2	2.4	2.159	2.187	-1.3	V	VIN at the time of a drop	○

◆ESD Dosis tolerata
HBM: More than 2000V, MM: More than 200V

◆Evaluation connection diagram

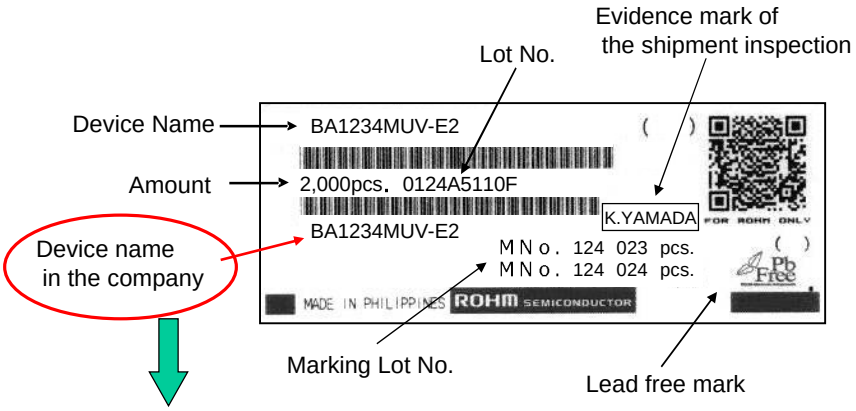


The ON resistance becomes advantageous.
About other items,
the characteristic change of Au wire and Cu wire is the same.

【6】Identification method

Confidential

Label specifications



[Example] Grant of BZ

Gold Wire	Copper Wire (Change product)
BA1234MUV-E2	BA1234MUV-BZE2

The product name does not have the change.

We control it by the change of the device name in the company.

【7】Comparison of the quality control item

Confidential

Item 1	Item 2	Contents	
		Cu wire	Au wire
Materials storage	Maker recommendation The expiration date	Temperature 10～30℃, Humidity Less than 70% less than 6 months from a production date 1 week after opening, Vacuum and Silicagel	Temperature 10～30℃, Humidity Less than 70% less than 6 months from a production date The packing bag is unnecessary
	ROHM control condition	Temperature 22～28℃, Humidity Less than 60% less than 6 months from a production date 1 week after opening, Vacuum and Silicagel	Temperature 22～28℃, Humidity Less than 60% less than 6 months from a production date The packing bag is unnecessary
	WB finished sample	Temperature 22～28℃, Humidity Less than 60% Storage in the plastic case	Temperature 22～28℃, Humidity Less than 60% Storage in the plastic case
WB machine control	Forming gas	Mixture ratio ; H_2 5% : N_2 95%	The forming gas is nonuse
		Density standard ; H_2 4～6%	
		The abnormal detection ; Gas blender machine (density control) Gas cylinder (nspection results by gas maker)	
Process control	Examination with the Cu-Wire change	The forming gas volume 0.35±0.10L/min Alarm with the flowmeter monitor	The forming gas is nonuse
	Control reinforcement contents (item /control level/frequency)	Capillary life 900,000 Bond Monitor of the bond amount	Capillary life 2,520,000 Bond Monitor of the bond amount
		The wire expiration date 168 hours after packing opening Every each LOT confirms a time limit at start time	The packing bag is unnecessary
		UnderPAD crack Capillary type change, Device type change AllPAD /clamp	UnderPAD crack Package type change AllPAD /clamp
	Aluminum splash standard	Satisfied within Pad opening	Satisfied within Pad opening
Method of analysis (Resin opening method)	Medicinal solution / facilities /conditions	Sharpen resin with a laser decap machine →Nitrating acid (room temperature)	Laser decap machine is unnecessary

We clarify the QC control item of a gold wire, the copper wire.

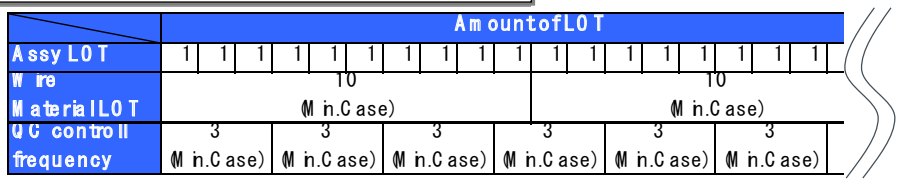
【8】Quality control of the bond strength

Confidential

QC Control frequency

Control item	QC Control Frequency
1st ball shear strength	At the time of Capillary exchange or Device Change : 5wire/chip (all chip/clamp)
Pull strength / Peel mode	At the time of Capillary exchange or Device Change : 5wire/chip (all chip/clamp)

Comparison between wire material LOT and QC control frequency



About the wire,
we inspect the delivery specifications from wire maker for the factory delivery.
※Data every materials LOT of “Breaking load & Elongation” are listed.
We don’t carry out shear / pull TEST, Peel test by the assembly LOT unit.
There is more frequency QC control than wire materials LOT.
Thus, the difference of wire materials LOT is included in this.

【9】The expiration date of Cu wire ①

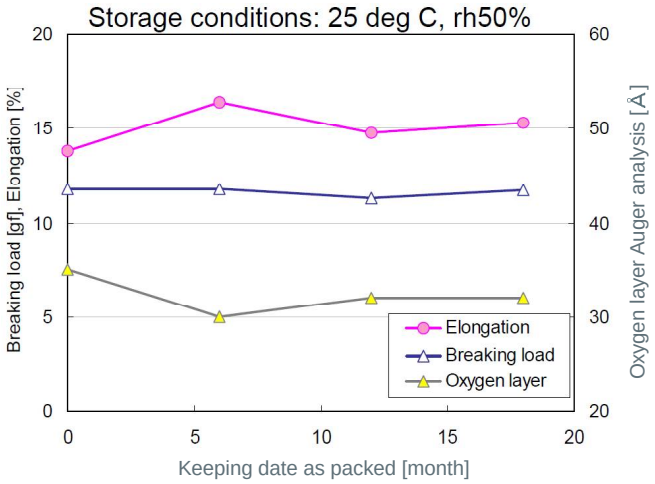
Confidential

Before use①

7days after opening the nylon bag
(previously stored in the sealed package)

Wire storage state

It is delivered in a vacuum state.
A Silicagel is bundled.



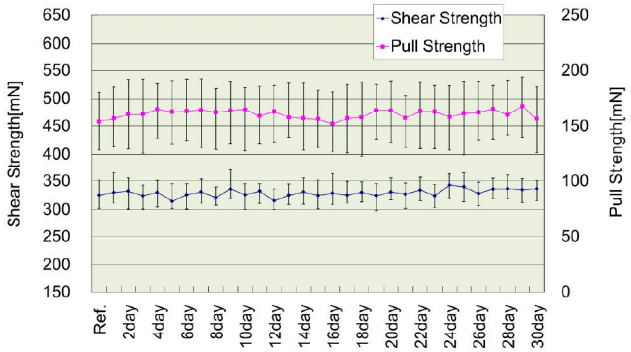
If a nylon bag is unopened,
no change on oxidized surface depth, extension and mechanical strength.

【9】The expiration date of Cu wire ②

Confidential

Before use②

*Store wire in the factory clean room
*Use one fixed machine *No capillary change *Use same one fixed wire
*Do strength test at on fixed position (1st shear strength / Pull strength and the 2nd peel test)

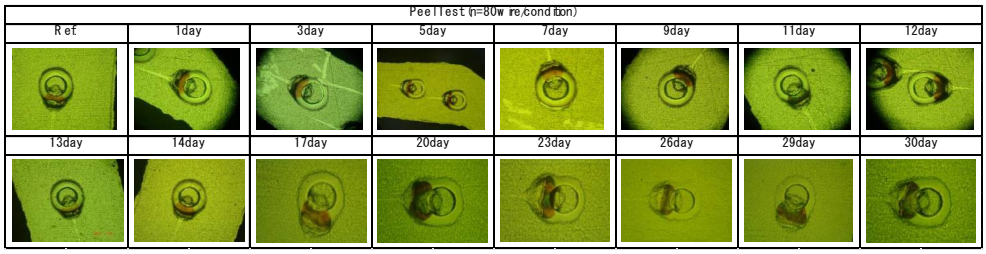


2nd pull standard:
More than 60mN

1st ball shear standard:
More than 200mN

Peel standard:
There is the copper remain.

There is no abnormality
in the broken mode by peel test.



Control standard (expiration date) is168 hours after packing opening.

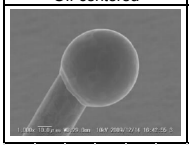
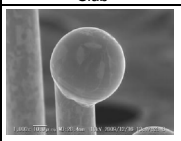
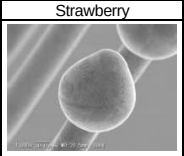
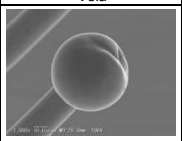
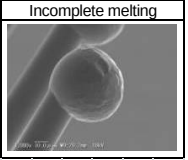
【9】The expiration date of Cu wire ③

Confidential

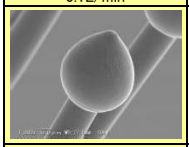
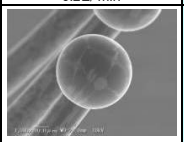
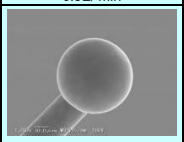
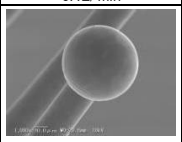
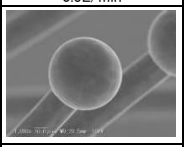
Using Wire①Gas flow volume evaluation

※Wire Diameter: φ25um

(Example)
Kind of abnormal Free Air Ball shape

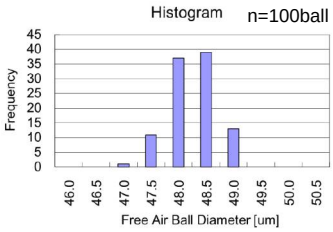
Off-centered	Club	Strawberry	Void	Incomplete melting
				

Confirmation of the gas flow volume margin

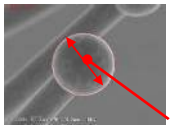
0.1L/min	0.2L/min	0.3L/min	0.4L/min	0.5L/min
				
Pn/n=13/200	Pn/n=0/200	Pn/n=0/200	Pn/n=0/200	Pn/n=0/200

Specification of gas flow volume : 035±0.1L/min

Confirmation of the FAB size



AVE	48.0
σ	0.4
Upper limit	50
Lower limit	46
cpk	1.73



Tube for forming gas environment

For the initial ball formation, copper wire needs spark like gold wire.
However, copper wire must do oxidization prevention.
The gas flow volume is controlled with the flowmeter on the machine and automatically stops it at the time of abnormality.
Work in hand LOT of the case is discarded.

Confirmation method of the size

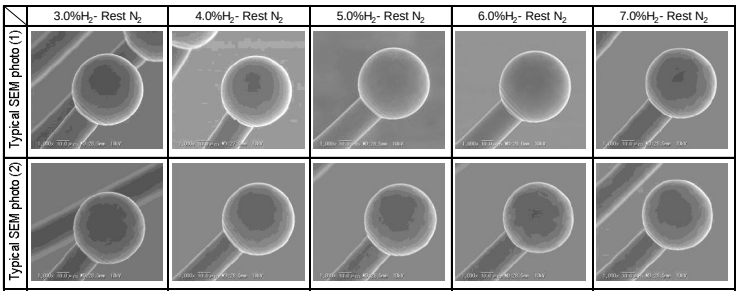
Direct measurement from an SEM photograph

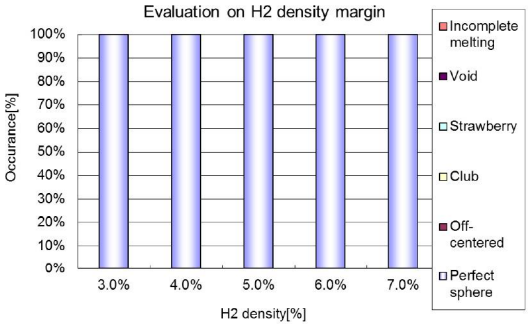
【9】The expiration date of Cu wire ④

Confidential

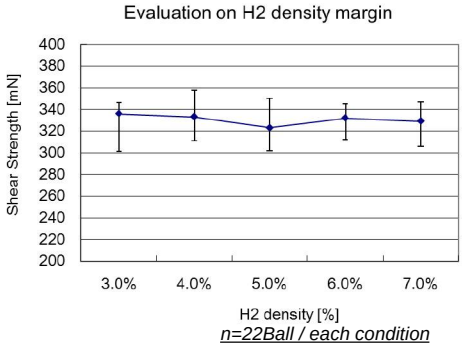
Using Wire②H_2 density evaluation

*Wire Diameter: φ25um
*The gas flow volume condition set it in 0.25L/min of the lower limit level.





n=200Ball / each condition



n=22Ball / each condition

This Criteria is more than 200mN.

Specification of gas composite ratio : 5±1%H_2-restN_2