



**MITSUBISHI
ELECTRIC**

Mitsubishi IC Lead-free Package

Changes for the Better

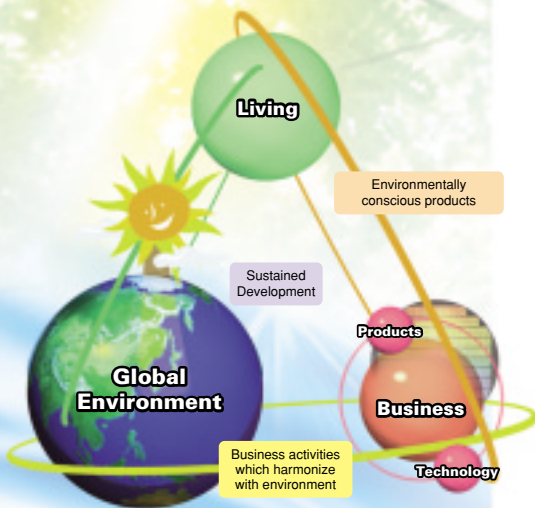




Environmental Philosophy

Basic Environmental Philosophy of Semiconductor Group

In the semiconductor business section we try to maintain and improve the global environment by offering friendly semiconductor products to society, while developing the business activities which harmonize with the environment.



Background to the Lead-free Movement

- Lead is now widely recognized as an environmentally hazardous substance that causes various kinds of damage when absorbed by the human body. To prevent environmental pollution caused by lead dissolution from used electronic equipment and components, a worldwide movement is under way to promote restricted lead use and mandated lead collection. Semiconductor products are no exception: we have been working to make Mitsubishi IC packaging lead-free.
- The RoHS directive is being discussed at the European-Parliament. Under the directive, the use of lead, mercury, cadmium, hexavalent chromium, PBB (polybrominated biphenyl) and PBDE (polybrominated diphenyl ether) will be banned. The ban will be executed between 2006 and 2008, but the directive is likely to be adopted in 2002 at the earliest. Based on the directive, some of the EU countries will revise their laws.

RoHS: Restriction of the use of certain Hazardous Substances in electrical and electronic equipment

Mitsubishi IC Lead-free Policy

- 1) We have already begun selling some lead-free products, and intend to expand our lead-free product lineup.
- 2) We will make many of our products lead-free by 2002-2003.
- 3) We will try to achieve our goal of making all our products lead-free by 2004.



Lead-free Specification

Sn-Cu plating (Pd plating in some cases) is adopted for electrode terminals, and Sn-Ag-Cu for external soldering balls.

Outer Lead
(Lead frame type)

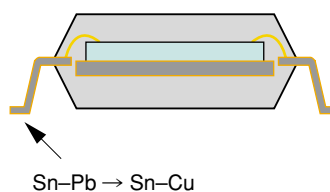
Current	Lead-free Specification
Sn-Pb plating	Sn-Cu plating
Pd plating	Pd plating

Solder Ball
(Area alloy type)

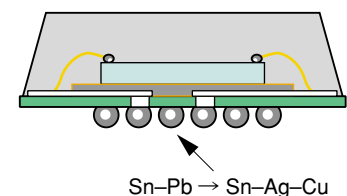
Current	Lead-free Specification
Sn-Pb ball	Sn-Ag-Cu ball

(Sn: tin, Pb: lead, Pd: palladium, Ag: silver, Cu: copper)

Outer Plating



Solder Ball



Discrimination of Lead-free

Pb FREE USE is printed on all label attached on inner bags and inner boxes.

Outer Lead

Reason for Selection of Sn-Cu plating

- 1) Sn-Cu plating can be good soldering for both conventional Sn-Pb soldering paste and lead-free paste (e.g. Sn-Ag-Cu).
- 2) There is no problem of Bi accumulation in the soldering bath and embrittlement of joint soldered sections when flow soldering is used.

Characteristics of representative lead-free plating (Outer lead).

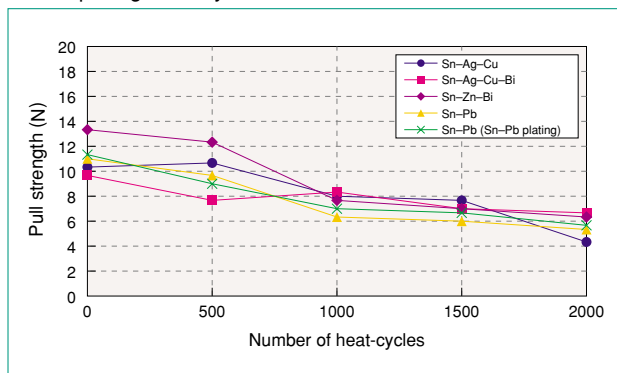
		Sn-Pb plating	Sn-Cu plating	Pd plating	Sn-Bi plating
Composition (Wt%)		Pb: 10	Cu: 1.5	Au/Pd/Ni (Three layer plating)	Bi: 3.0
Performance	Melting point (°C)	210	227	—	226
	Appearance	◎	◎	◎	◎
	Lead adhesion	◎	◎	◎	◎
	Solderability	◎	◎	◎	◎
	Joint strength	◎	◎	◎	◎
Cost		◎	○	△	○
Remarks		Environmental problems	—	Not suitable for 42-alloy lead frame	Consider the embrittlement when using Sn-Pb solder paste

(Au: gold, Ni: nickel, Bi: bismuth)

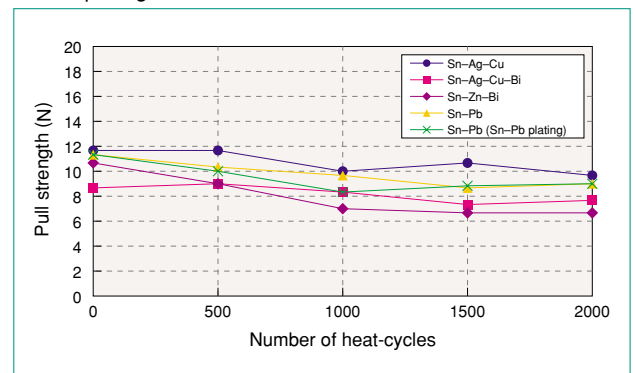
Joint strength after the heat-cycle (-40 to 125°C) stress for Sn-Cu plating and Pd plating with each type of solder paste

It maintains the same level of joint strength as conventional Sn-Pb/Sn-Pb plating, for both 42-Alloy and Cu frames.

Sn-Cu plating/42-Alloy frame



Sn-Cu plating/Cu frame



Pd plating/Cu frame

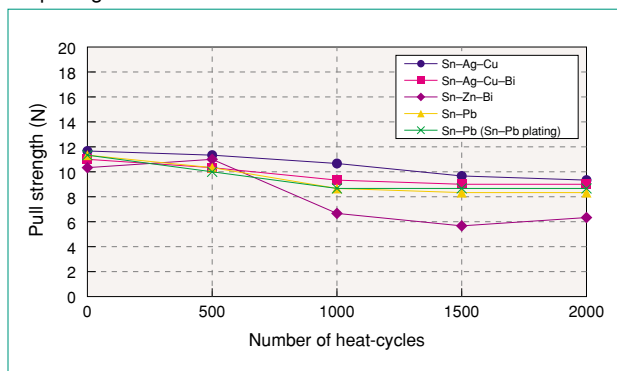
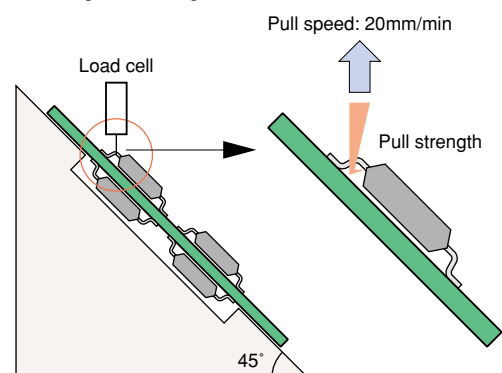


Figure showing measuring conditions



NB: Data given in this catalog are not guaranteed values.

Solder Ball

Reason for Selection of Sn-Ag-Cu Ball

The Sn-Ag-Cu ball was chosen on the basis of comprehensive evaluation in terms of performance, etc.

Characteristics of Representative Lead-free Solder Ball.

		Sn-Pb	Sn-Ag	Sn-Ag-Cu	Sn-Ag-Cu-Bi
Composition (Wt%)		Pb: 37	Ag: 3.5	Ag: 3.5 Cu: 0.5	Ag: 2.0 Cu: 0.5 Bi: 2.0
Performance	Melting point (°C)	183	221	220	222
	Solderability	◎	○	◎	○
	Soldering temperature	◎	△	△	△
	Ball joint strength	◎	○	○	○
	Solder joint reliability	◎	○	◎	×
Cost		◎	○	○	△

Ball Shear Strength

The shear strength of the Sn-Ag-Cu ball is as reliable as the conventional one.

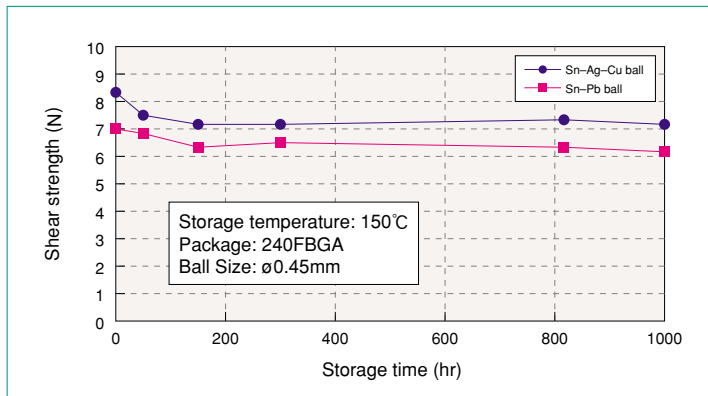
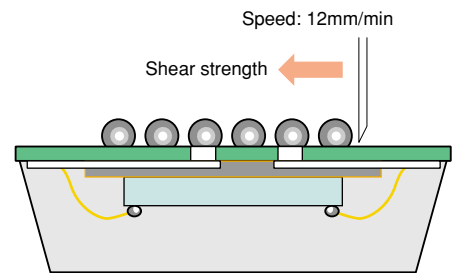
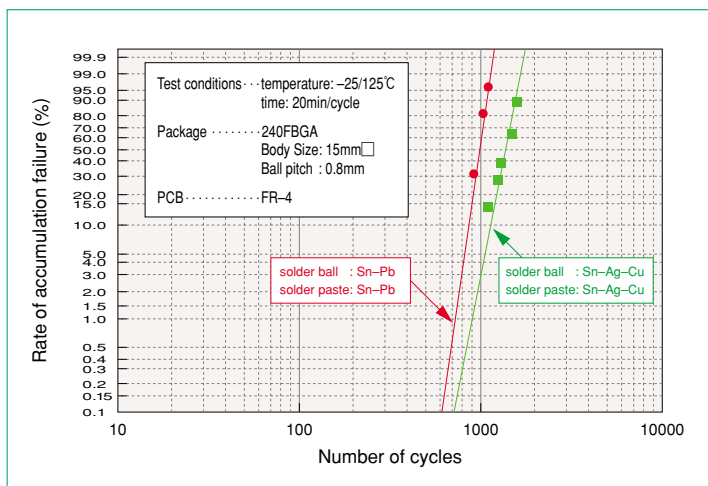


Figure showing measuring conditions

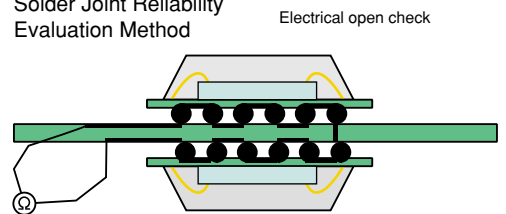


Solder Joint Reliability

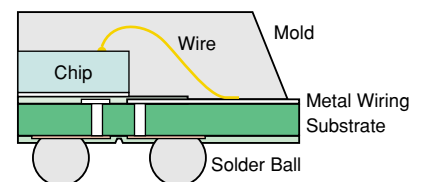
The joint reliability of the Sn-Ag-Cu ball is as same as the conventional one.



Solder Joint Reliability Evaluation Method



Cross-section structure of Package



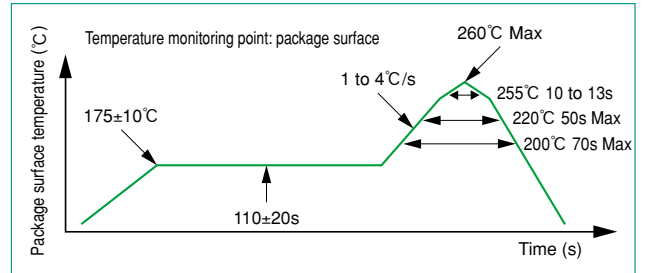
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Lead-free Mounting Conditions

- Sn–Pb eutectic solder can be used under current conditions.
 - Considering the package crack resistance, when the temperature rises by using lead-free paste, we do a temperature profile test (peak temperature: 260°C), as shown in the figure at right, and confirm soldering heat resistance.
- For further details, we would like to talk over a requirement on Moisture Sensitivity Level with customer individually for each product.

Classification Reflow Profile for Lead-free Paste



NB: This profile does not guarantee heat resistance.

Package Line-up and Lead-free Specifications

						Lead-free Specifications			
						Sn–Cu plating	Pd plating	Sn–Ag–Cu ball	
MITSUBISHI IC package	SMD (Surface Mount Devices)	Package (Ex. Application)	Thin/Small PKG (Small mobile system)	Dual Type	TSOP/SSOP		○		
				Quad Type	MCP/S–MCP/S–μ MCP		○		
				Array Type	QFN (to 100pin)		○	○	
			Middle pin count PKG (Portable consumer)	Array Type	TQFP/LQFP (to 200pin)		○		
				Array Type	Stacked CSP (to 100pin)				○
					Fine pitch BGA (to 200pin)				○
		THD (Through Hole Devices)	High pin count PKG (High performance system)	Quad Type	QFP/LQFP (to 300pin)		○		
					Array Type	Fine pitch BGA (200 to 500pin)			
				Array Type	Flip-chip BGA (700 to 2000pin)				○
			High power dissipation PKG (Plastic PKG use)	Dual Type	Pwr BGA (350 to 1100pin)				○
					Overmold BGA (250 to 700pin)				○
				Quad Type	HSOP		○	○	
	Low pin count PKG	Dual Type	DIP/SDIP		○				
		Vertical PKG	Zigzag Type	ZIP		○			

NB: Outsourcing products may differ from these specifications.