



Renesas Semiconductor Lead-Free Packages

Renesas Technology Corp. Sales Strategic Planning Div. Nippon Bldg., 2-6-2, Ohte-machi, Chiyoda-ku, Tokyo 100-0004, Japan

Keep safety first in your circuit designs!

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Background to the Trend toward Lead-Free Products

It is widely recognized that the absorption of lead into the human body can lead to a variety of health problems. To protect the environment against contamination by lead from waste electronic equipment and components, there is a growing worldwide movement to restrict the use of lead. Semiconductor products are no exception, and moves are also underway toward making Renesas semiconductor packages lead-free.

The European Union has agreed to implement the RoHS directive (the restriction of the use of certain Hazardous Substances in electrical and electronic equipment), starting in July 2006, prohibiting the use of lead, mercury, cadmium, hexavalent chromium, PBB (polybrominated biphenyls), and PBDE (polybrominated diphenyl ethers). This directive was published in the official journal of the European Union in February 2003.



Lead-free packaging

- Using lead free materials for semiconductors. Initially, priority will be given to making terminals lead-free.*
- The higher melting points of lead-free solders and the resulting higher mounting temperatures require enhanced heat resistance in components.

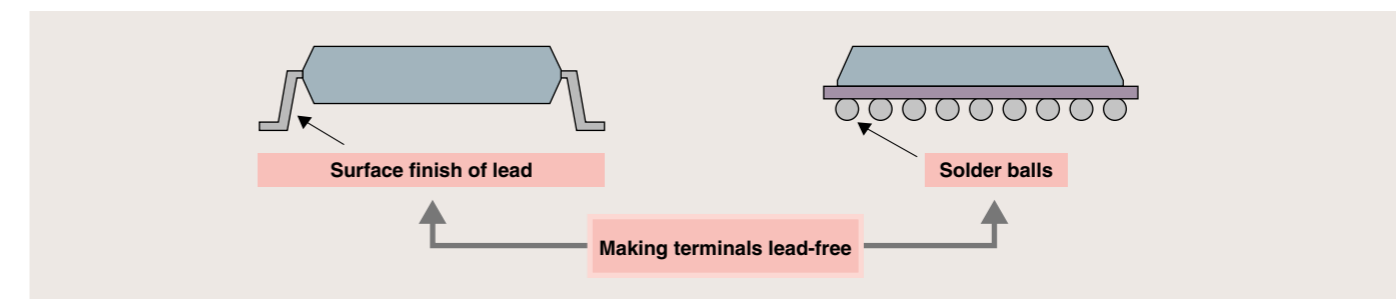
* Technologies are under development for eliminating lead inside packages, including sealing glass, and also die-bonding materials in some products.

The Renesas approach

- Heat-resistance improvement and provisions for mass production of lead-free terminals have been completed for all product families, and some products are already in mass production. consult a Renesas sales representative for the mass production details concerning particular products.
- The target date for the total abolition of lead from terminals is end of 2005.
- Lead-free products are differentiated from conventional products by a "Pb-Free T." marking on the label of the inner bag, box.

Lead-free packaging

Making package terminals lead-free



Lead-free specifications

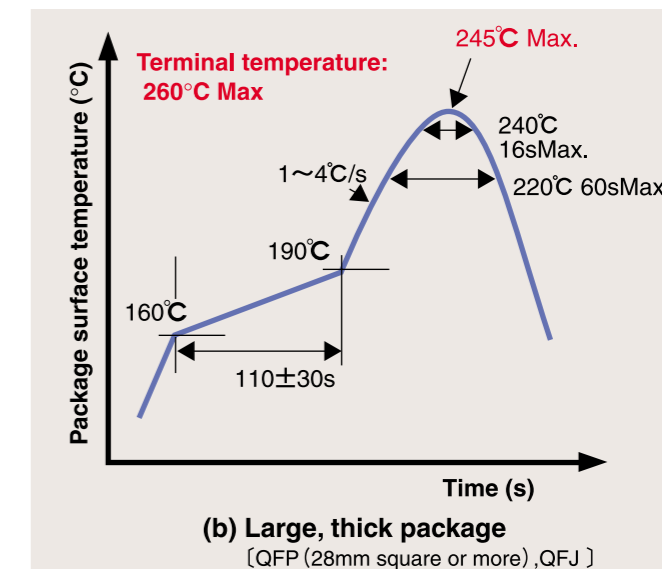
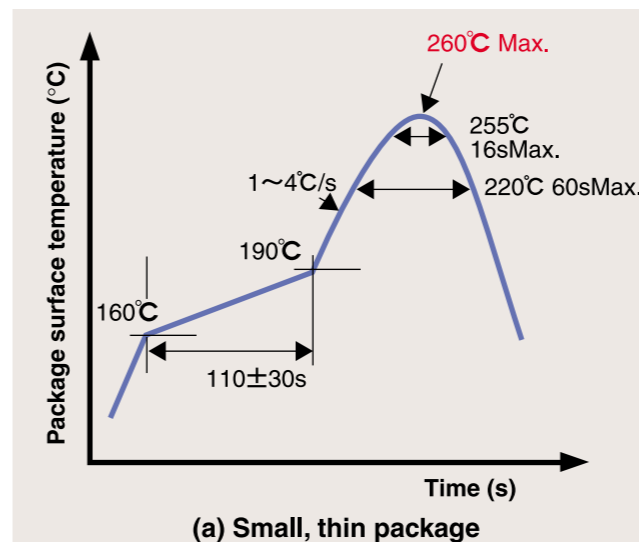
Package	Conventional specifications	Lead-free specifications
Surface-mount type (SMD)	Sn-Pb plating	Sn-Bi plating Ni/Pd/Au plating Sn-Cu plating
	Ni/Pd/Au plating	Same as conventional specifications
	Sn-Pb ball	Sn-Ag-Cu ball
Pin insertion type (THD)	Sn-Pb plating	Sn-Bi plating Sn-Cu plating
	Sn-Pb dipping	Sn-Cu dipping Ni/Pd/Au plating
	Sn-Cu plating	Same as conventional specifications
	Au plating	Same as conventional specifications

Improving heat resistance

Lead-free soldering generally requires higher reflow temperature. Renesas has set the heat-resisting temperature of a surface-mount type package at 260°C or 245°C to withstand mounting with an Sn-Ag-Cu or similar high-melting-point lead-free solder. Solder heat-resistance is defined by the package surface temperature, and an appropriate temperature profile is offered according to the heat capacity of the package. Heat-resistance reflow profiles of small, thin packages and large, thick packages are shown below.

IR/air reflow profiles of small, thin packages and large, thick packages

Information is available on an individual basis for devices that do not conform to the profiles shown below.



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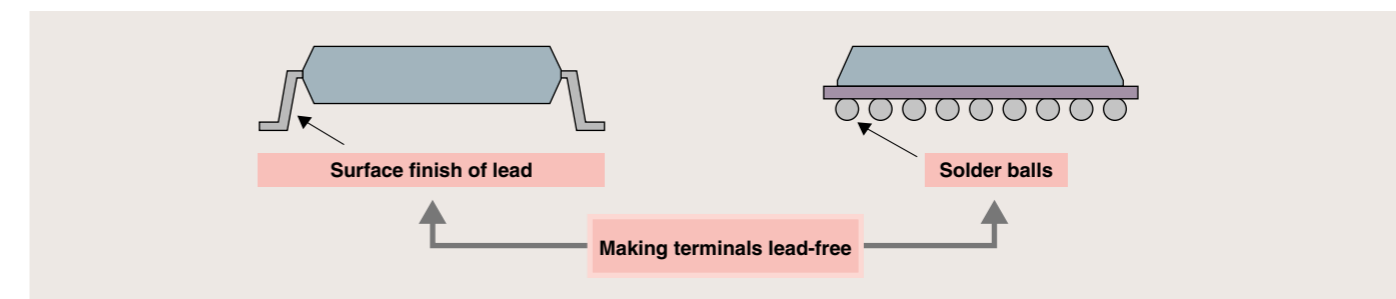
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Lead-free packaging

Making package terminals lead-free



Lead-free specifications

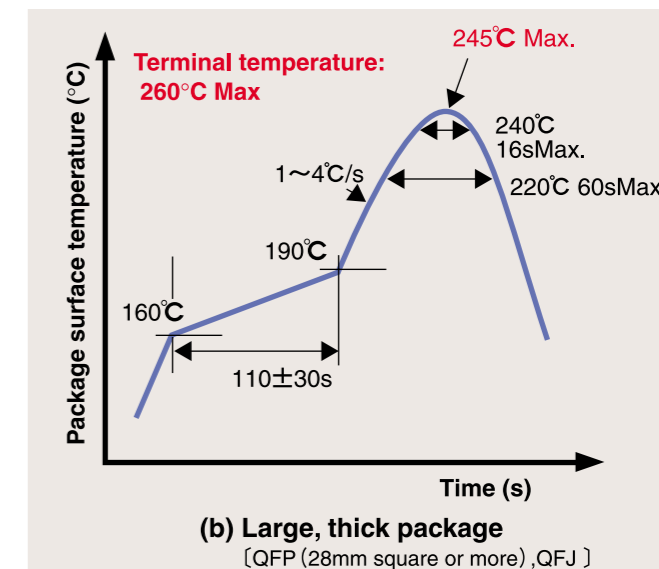
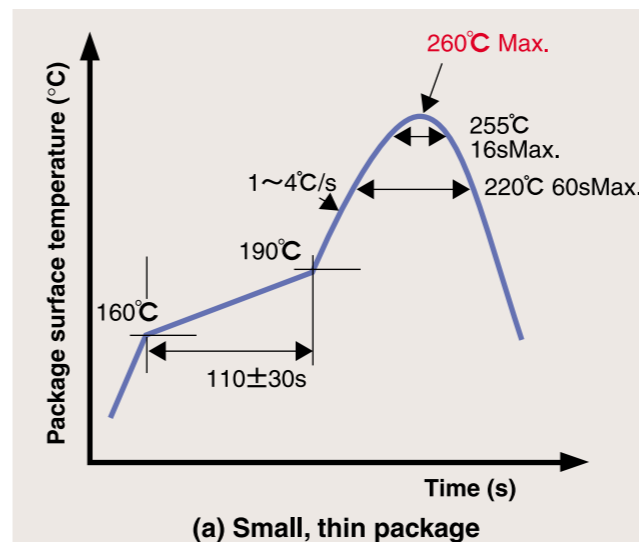
Package	Conventional specifications	Lead-free specifications
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	Ni/Pd/Au plating	Same as conventional specifications
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IR/air reflow profiles of small, thin packages and large, thick packages

Information is available on an individual basis for devices that do not conform to the profiles shown below.



Lead-free specifications for various packages

Package	Package name	Appearance	Sn-Bi plating	Sn-Cu plating	Ni/Pd/Au plating	Sn-Cu dipping	Sn-Ag-Cu ball	Sn plating	Au plating
Surface-mount type (SMD)	IC, LSI package	QFP, TQFP, LQFP, HQFP	○	○	○				
		SOP, TSSOP, TSOP(1), TSOP(2), HSOP	○	○	○				
		QFJ, SOJ	○	○					
		P-VQFN	○	○					
		BGA, TFBGA, HBGA					○		
		LGA							○
Transistor, diode package	UPAK, SOT-89, DPAK(S), MP-3, LDKPAK(S), TO-220S	○	○						
	MPAK, SOT-23mod	○	○						
	URP, UFP	○	○						
Pin insertion type (THD)	IC, LSI package	DIP, SDIP	○	○	○	○			
		G-DIP, C-DIP					○	○	
		ZIP	○	○					
		PGA						○	
Transistor, diode package	TO-92, TO-220, TO-3P					○			
	DO-34, DO-35					○			
	DPAK(L), LDKPAK(L)	○							

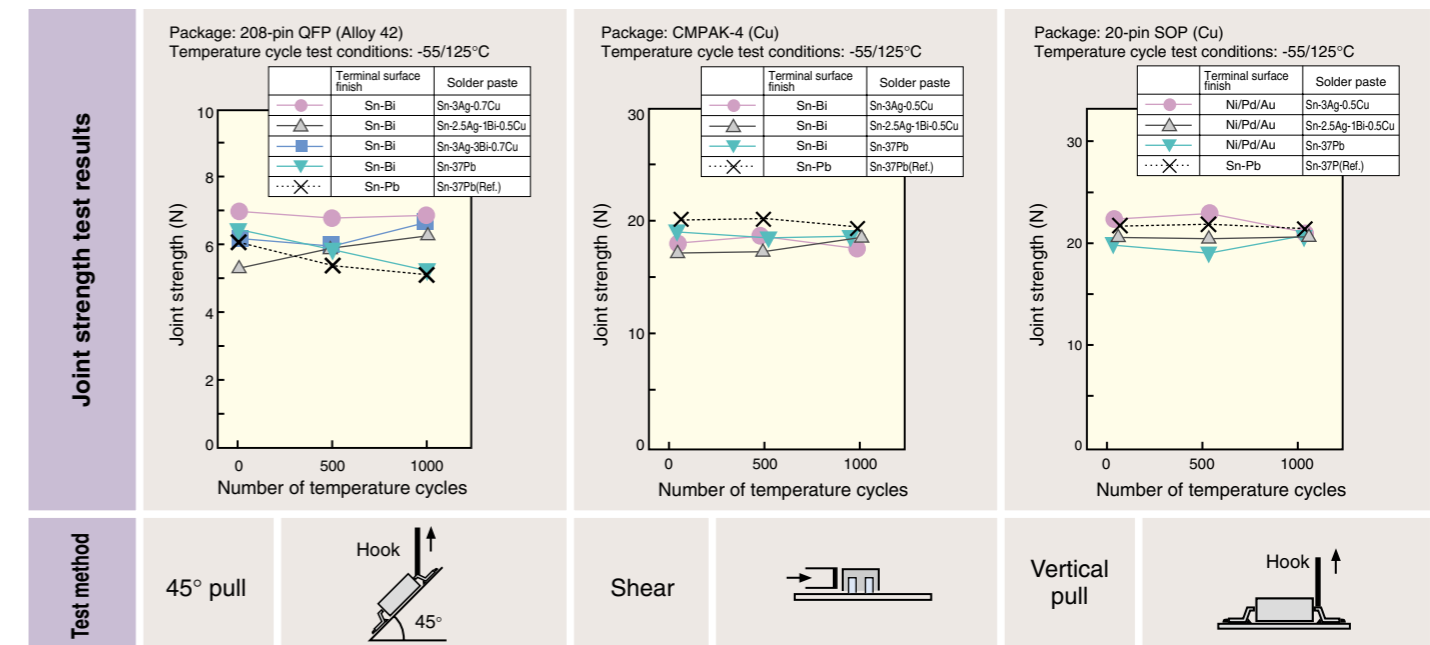
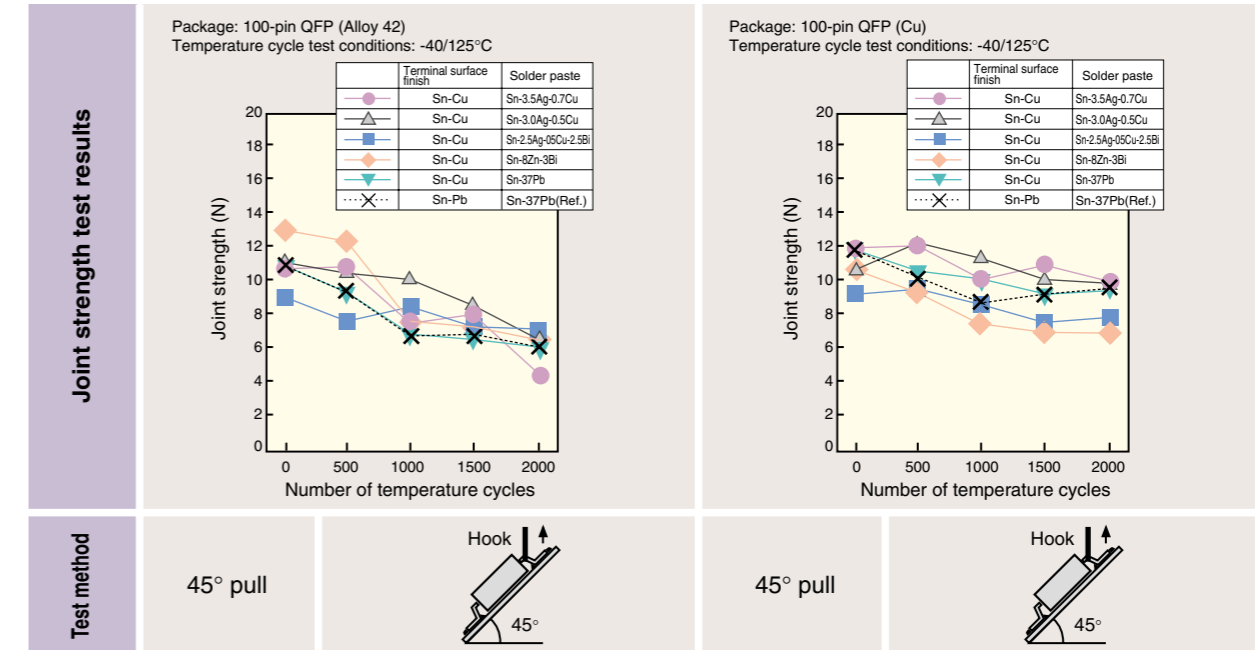
○ :Lead-free specifications ○ :Same as conventional specifications

In the case of packages for which a number of specifications are indicated, the specification is determined by products. Specifications may differ for outsourced products.

Various test results

Joint strength test results of lead-free plating products

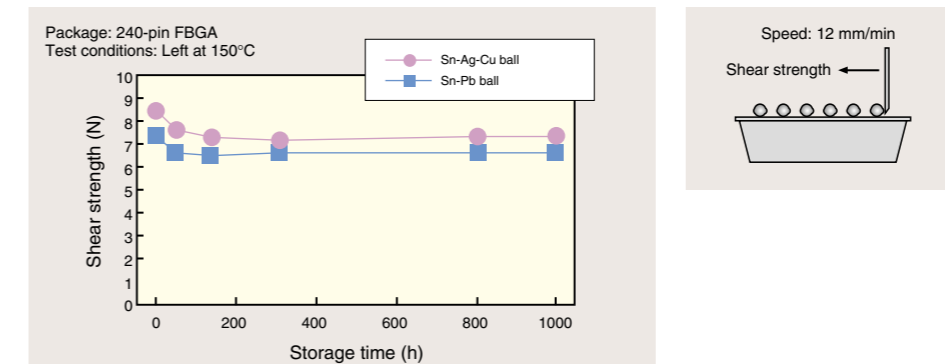
The joint strengths for both Alloy 42 and Cu lead frames are equivalent to conventional products (using Sn-Pb plating and Sn-Pb solder paste).



Joint strength test results of lead-free ball products

Shear strength of ball products

The joint strengths for Sn-Ag-Cu ball products are equivalent to conventional products.



The given data in this chapter "Various test results" cannot be guaranteed.

Lead-free specifications for various packages

Package	Package name	Appearance	Sn-Bi plating	Sn-Cu plating	Ni/Pd/Au plating	Sn-Cu dipping	Sn-Ag-Cu ball	Sn plating	Au plating
Surface-mount type (SMD)	IC, LSI package	QFP, TQFP, LQFP, HQFP	○	○	○				
		SOP, TSSOP, TSOP(1), TSOP(2), HSOP	○	○	○				
		QFJ, SOJ	○	○					
		P-VQFN	○	○					
		BGA, TFBGA, HBGA					○		
		LGA							○
Transistor, diode package	UPAK, SOT-89, DPAK(S), MP-3, LDKPAK(S), TO-220S	○	○						
	MPAK, SOT-23mod	○	○						
	URP, UFP	○	○						
Pin insertion type (THD)	IC, LSI package	DIP, SDIP	○	○	○	○			
		G-DIP, C-DIP						○	○
		ZIP	○	○					
		PGA							○
Transistor, diode package	TO-92, TO-220, TO-3P					○			
	DO-34, DO-35					○			
	DPAK(L), LDKPAK(L)	○							

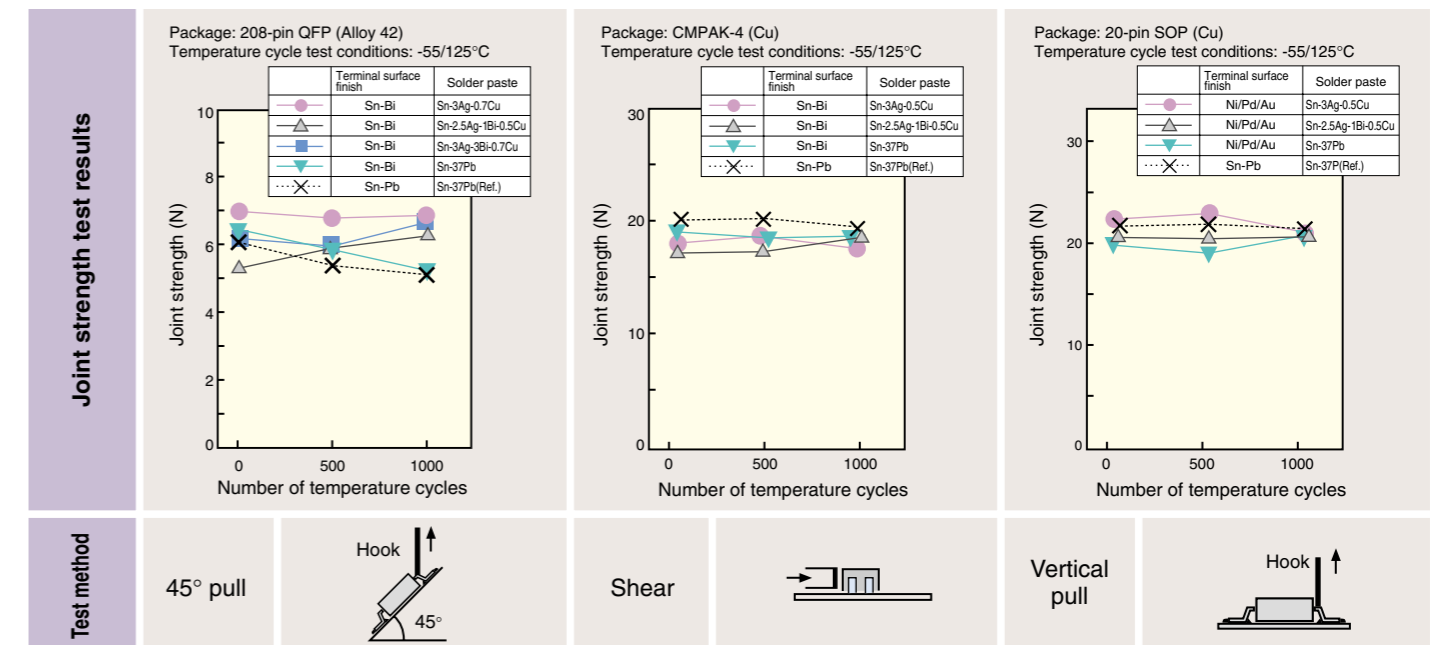
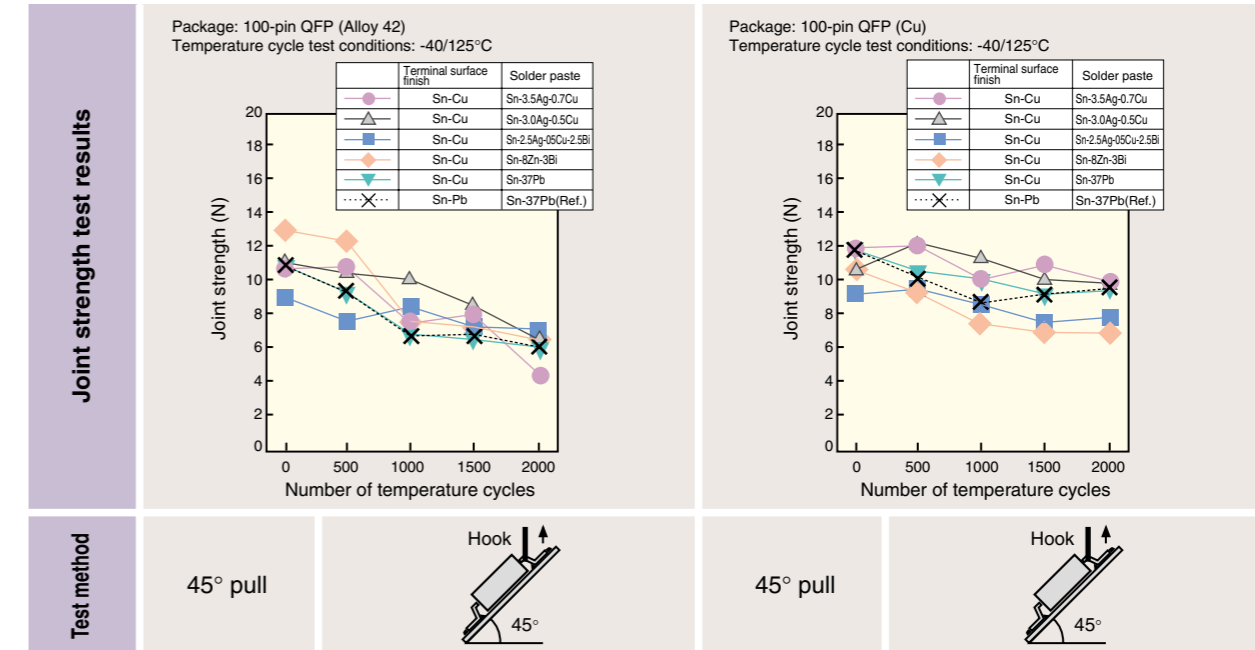
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Various test results

Joint strength test results of lead-free plating products

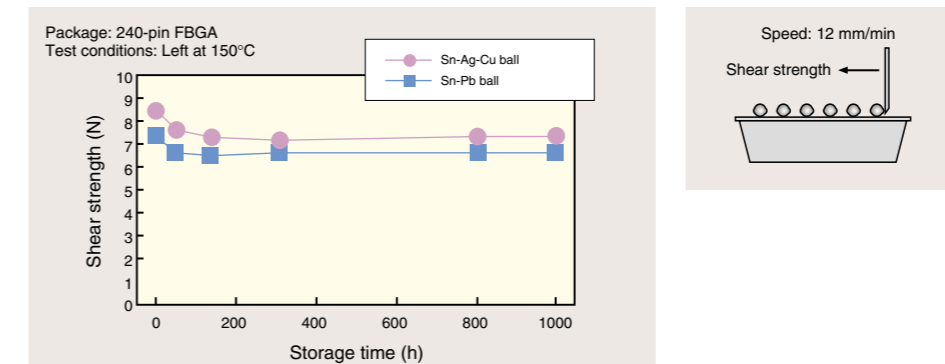
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Joint strength test results of lead-free ball products

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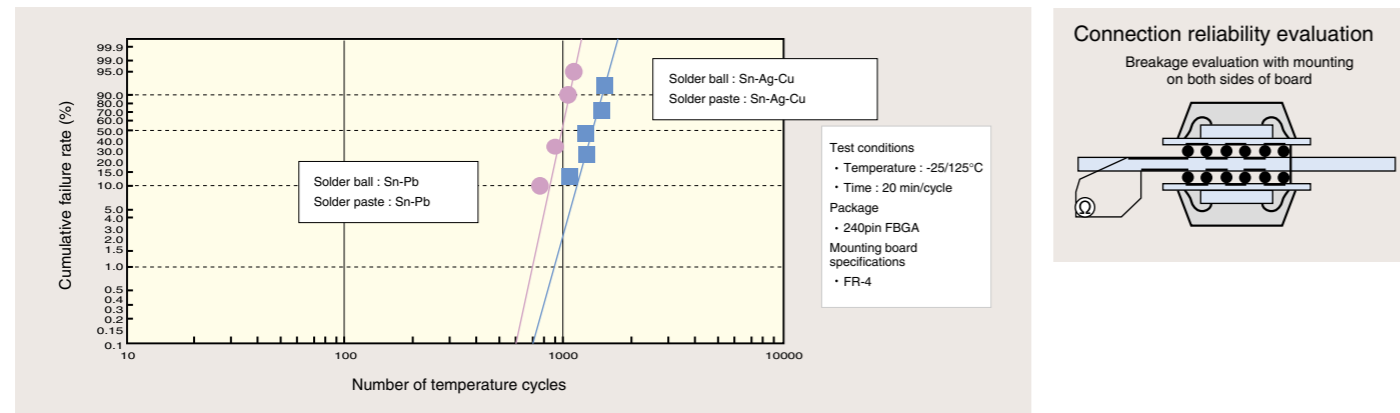
The joint strengths for Sn-Ag-Cu ball products are equivalent to conventional products.



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● Solder ball connection reliability

Connection reliability of Sn-Ag-Cu balls is equivalent to conventional products.



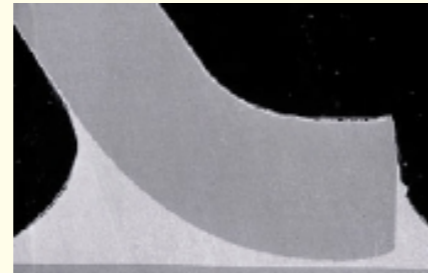
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Cross-sections of fillet shape after mounting on board

Sn-Bi plating vs Sn-Pb plating

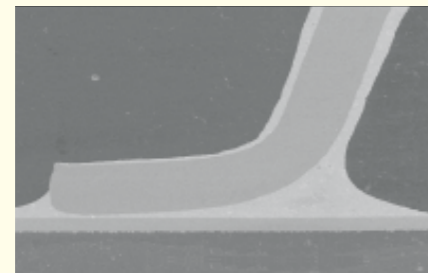


Sn-Bi plating

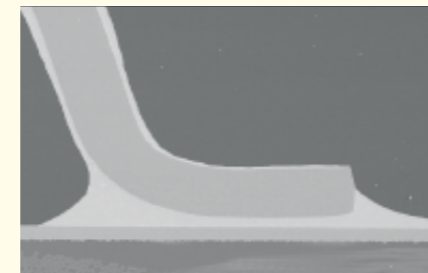


Conventional Sn-Pb plating

Sn-Cu plating vs Sn-Pb plating



Sn-Cu plating



Conventional Sn-Pb plating

Ni/Pd/Au plating vs Sn-Pb plating

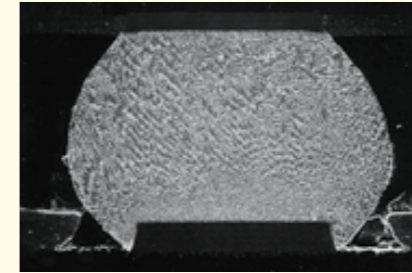


Ni/Pd/Au plating

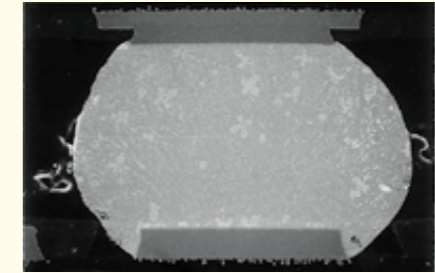


Conventional Sn-Pb plating

Sn-Ag-Cu ball vs Sn-Pb ball

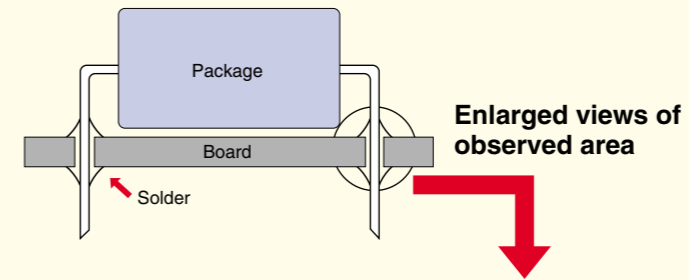


Sn-Ag-Cu ball

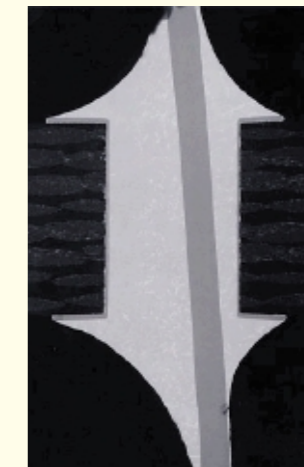


Conventional Sn-Pb ball

Sn-Cu dipping vs Sn-Pb dipping



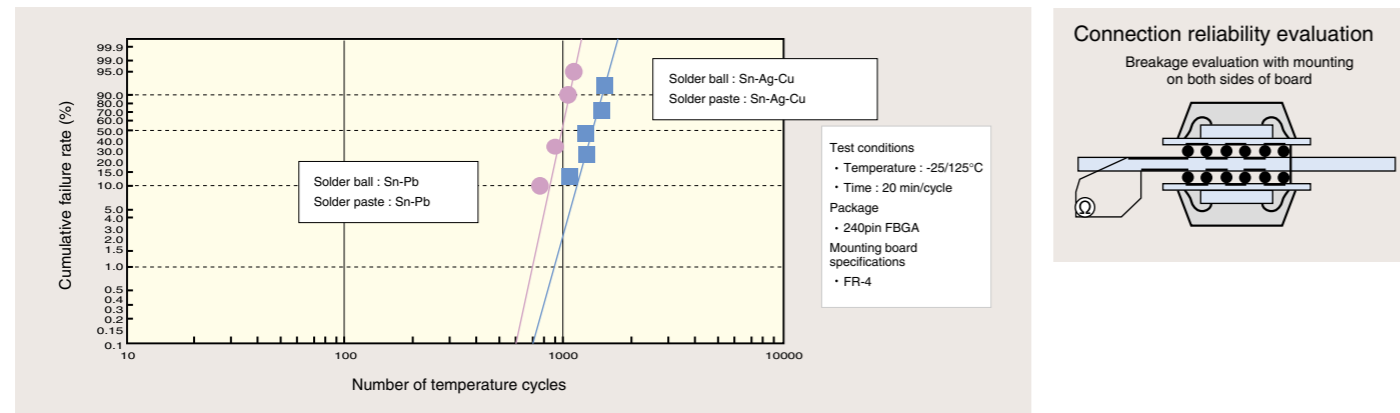
Sn-Cu dipping



Conventional Sn-Pb dipping

● Solder ball connection reliability

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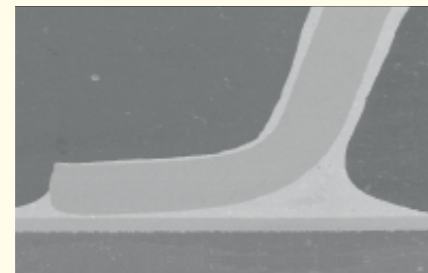


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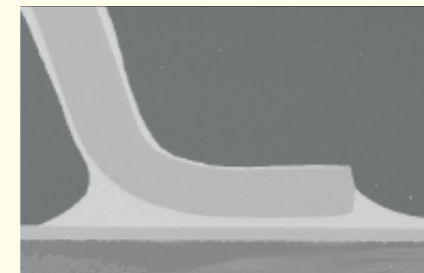


Conventional Sn-Pb plating

Sn-Cu plating vs Sn-Pb plating



Sn-Cu plating



Conventional Sn-Pb plating

Ni/Pd/Au plating vs Sn-Pb plating

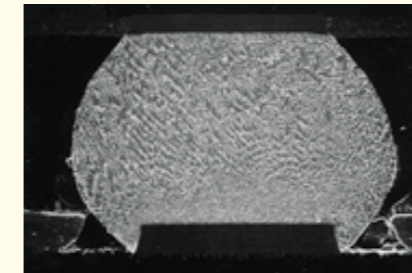


Ni/Pd/Au plating

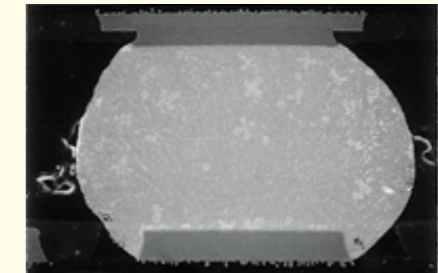


Conventional Sn-Pb plating

Sn-Ag-Cu ball vs Sn-Pb ball

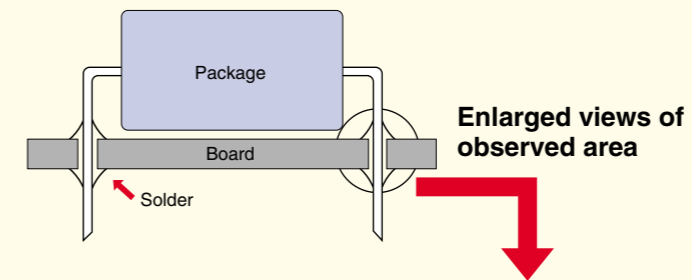


Sn-Ag-Cu ball

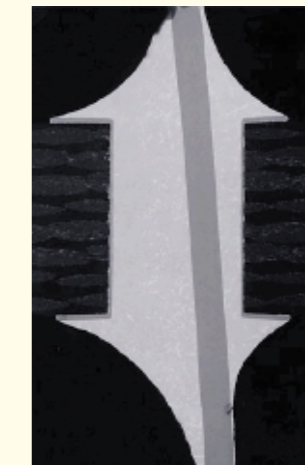


Conventional Sn-Pb ball

Sn-Cu dipping vs Sn-Pb dipping



Sn-Cu dipping



Conventional Sn-Pb dipping



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