Renesas Semiconductor Lead-Free Packages

2003.4

Renesas Technology
www.renesas.com

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 elecironic 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.**

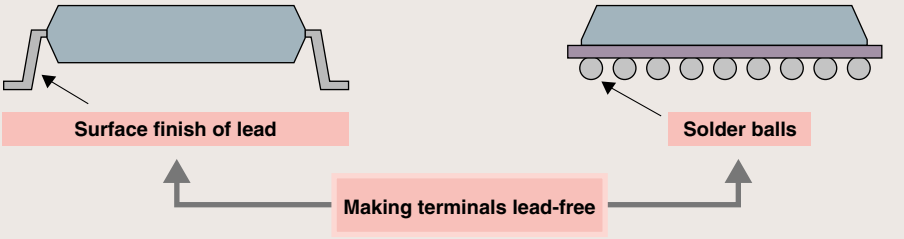
* Technologies are under development for eliminating lead inside packages, including sealing glass, and also die-bonding materials in some products.

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

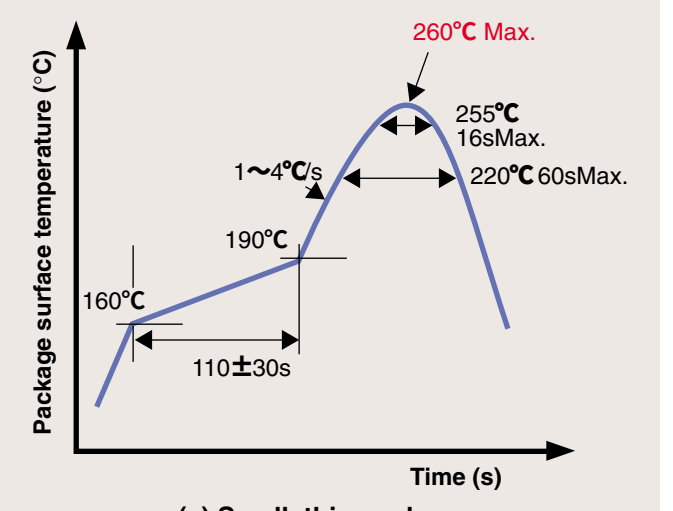
Package	Conventional specifications	Lead-free specifications
Surface-mount type (SMD)	Sn-Pb plating	Sn-Bi plating Sn-Cu plating Ni/Pd/Au plating
	Ni/Pd/Au plating	Same as conventional specifications
	Sn-Pb ball	Sn-Ag-Cu ball
Pin insertion type (THD)	Sn-Pb plating	Sn-Bi plating Sn-Cu plating
	Sn-Pb dipping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

■Improving heat resistance

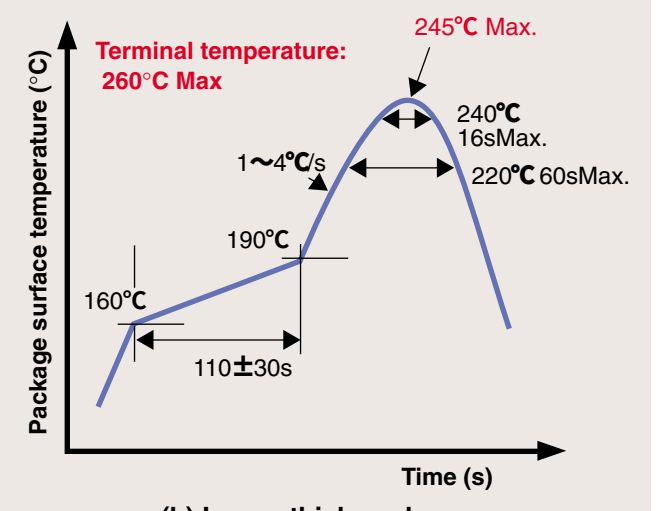
Lead-free soldering generally requires higher reflow temperature. Renesas has set the heat-resisting temperature of a surface-mount type package at 260°C or 245°C to withstand mounting with an Sn-Ag-Cu or similar high-melting-point lead-free solder. Solder heat-resistance is defined by the package surface 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.

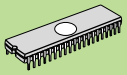
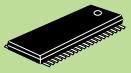
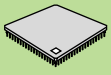


(a) Small, thin package



(b) Large, thick package
(QFP (28mm square or more), QFJ)

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 LDPAK (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) LDPAK (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.

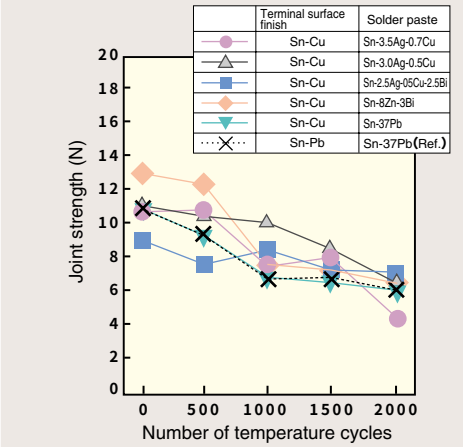
Various test results

■Joint strength test results of lead-free plating products

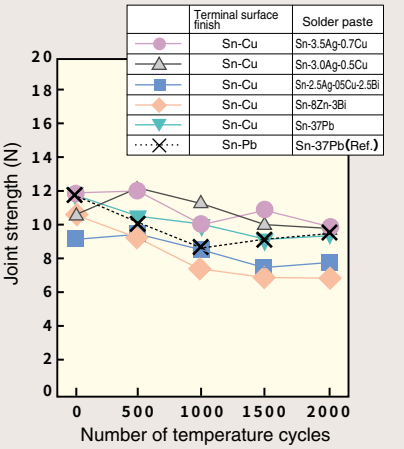
The joint strengths for both Alloy 42 and Cu lead frames are equivalent to conventional products (using Sn-Pb plating and Sn-Pb solder paste).

Joint strength test results

Package: 100-pin QFP (Alloy 42)
Temperature cycle test conditions: -40/125°C

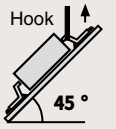


Package: 100-pin QFP (Cu)
Temperature cycle test conditions: -40/125°C



Test method

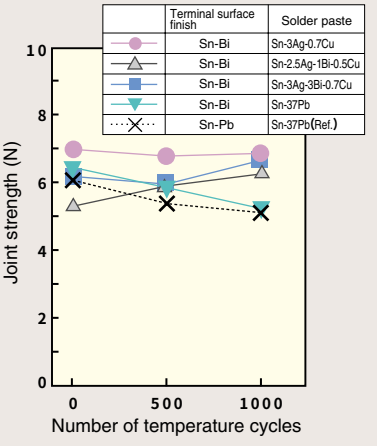
45° pull



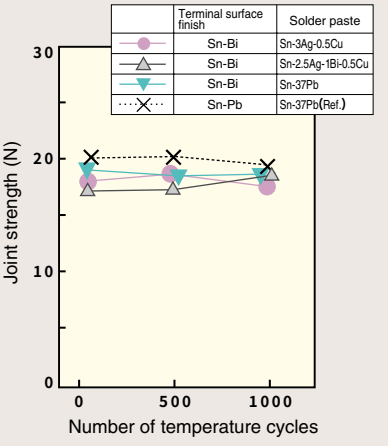
45° pull

Joint strength test results

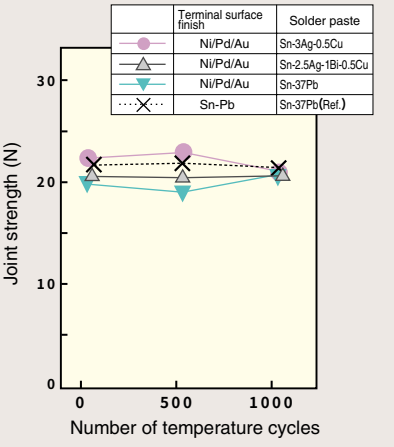
Package: 208-pin QFP (Alloy 42)
Temperature cycle test conditions: -55/125°C



Package: CMPAK-4 (Cu)
Temperature cycle test conditions: -55/125°C

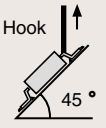


Package: 20-pin SOP (Cu)
Temperature cycle test conditions: -55/125°C



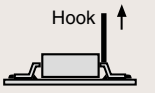
Test method

45° pull



Shear

Vertical pull

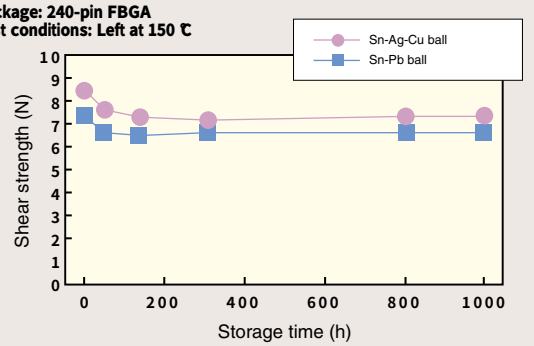


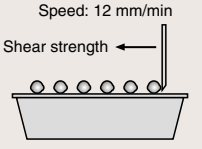
■Joint strength test results of lead-free ball products

●Shear strength of ball products

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

Package: 240-pin FBGA
Test conditions: Left at 150 ℃

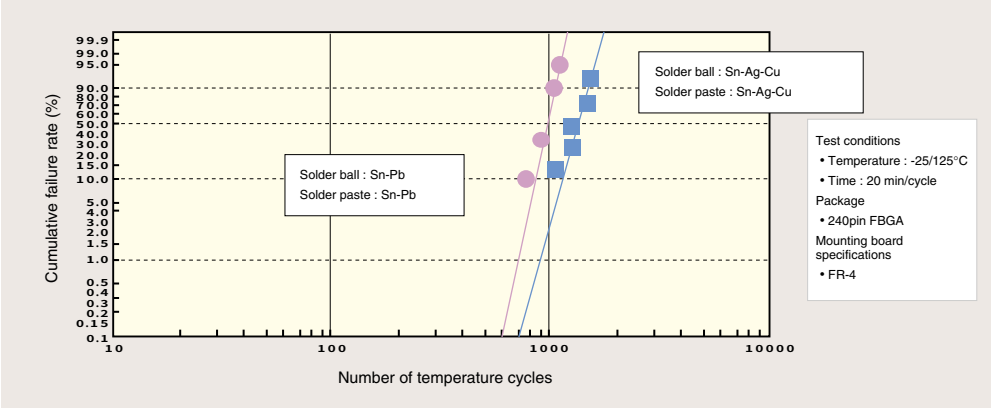




The given data in this chapter“ Various test results ”cannot be guaranteed.

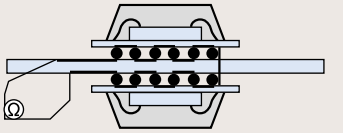
Solder ball connection reliability

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



Connection reliability evaluation

Breakage evaluation with mounting on both sides of board

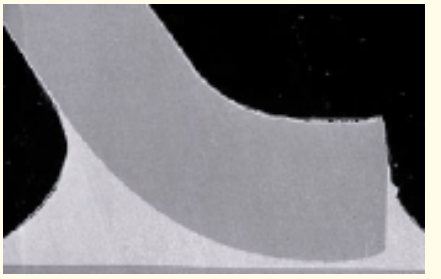


The given data in this chapter“ Various test results ”cannot be guaranteed.

Cross-sections of fillet shape after mounting on board

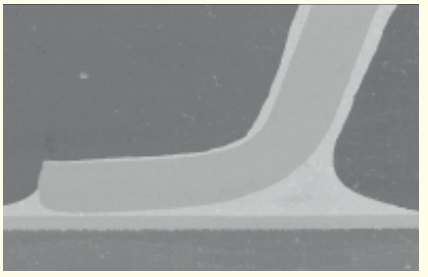
Sn-Bi plating vs Sn-Pb plating

Sn-Bi plating

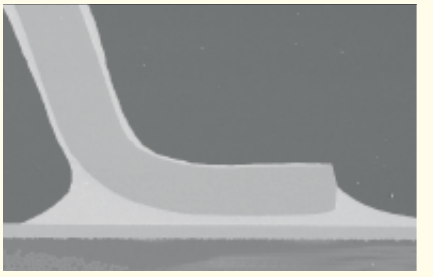


Conventional Sn-Pb plating

Sn-Cu plating vs Sn-Pb plating



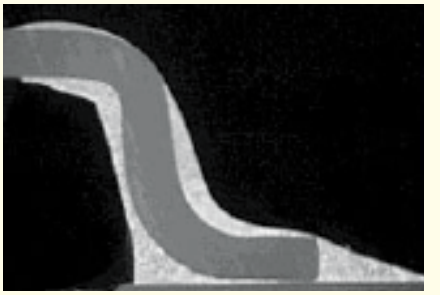
Sn-Cu plating



Conventional Sn-Pb plating

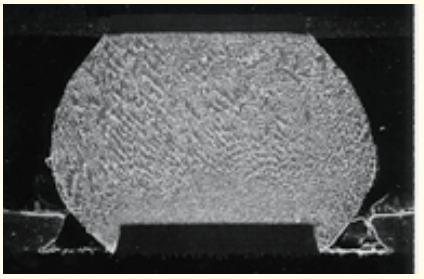
Ni/Pd/Au plating vs Sn-Pb plating

Ni／Pd／Au plating

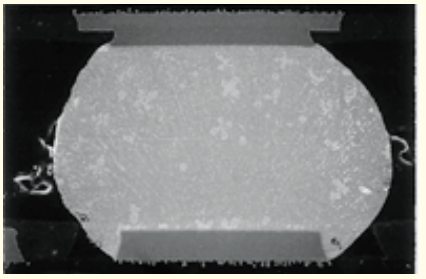


Conventional Sn-Pb plating

Sn-Ag-Cu ball vs Sn-Pb ball

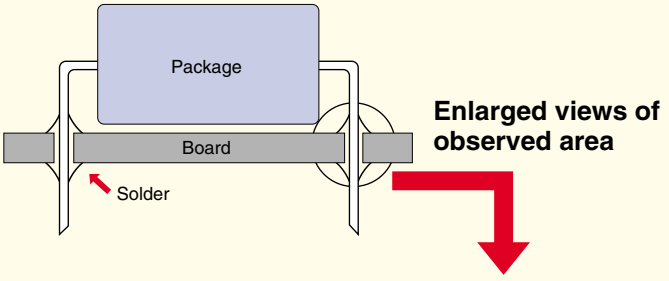


Sn-Ag-Cu ball

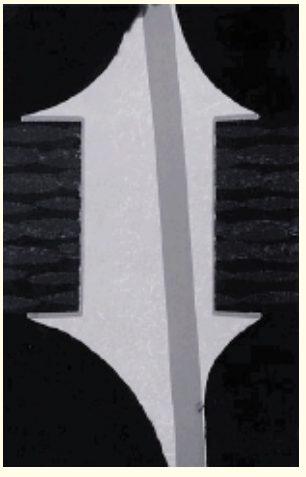


Conventional Sn-Pb ball

Sn-Cu dipping vs Sn-Pb dipping



Sn-Cu dipping



Conventional Sn-Pb dipping

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