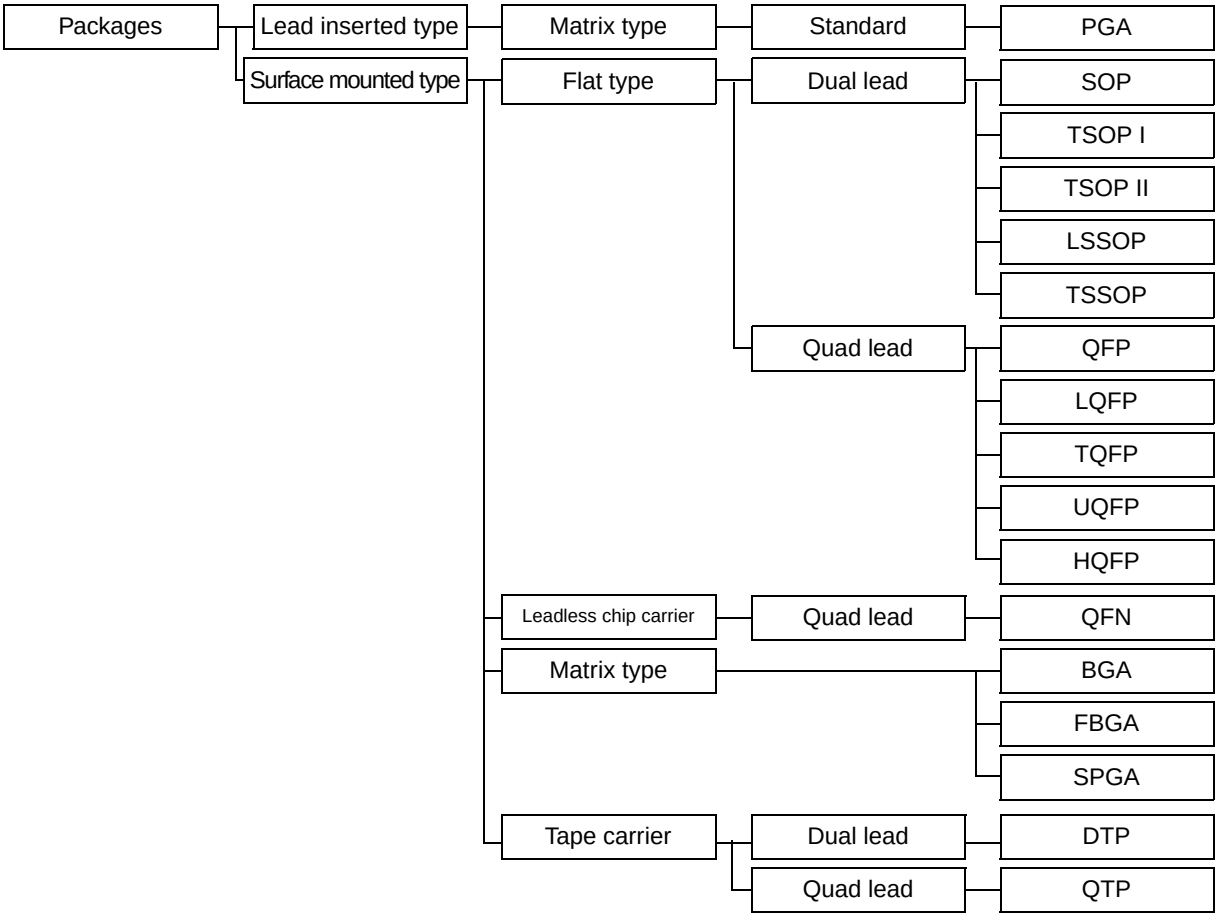
Package Lineup/ Forms/ Structures

1. Package Lineup
2. Package Forms
3. Package Structures

1. Package Lineup

The packages are classified as follows, according to form, material, and the mounting methods for which they are suited.



PACKAGE

Name of package	Description	Lead pitch (mm)
PGA	Pin Grid Array Package	1.27/2.54
SOP	Small Outline Package (straight lead) Small Outline L-Leaded Package	1.27
SSOP	Shrink Small Outline L-Leaded Package	0.65/0.80/1.00
TSOP (1)	Thin Small Outline L-Leaded Package (1)	0.50/0.55/0.60
TSOP (2)	Thin Small Outline L-Leaded Package (2)	0.50/0.80/1.00/1.27
SON	Small Outline Non-Leaded Package	0.50/1.00
QFP	Quad Flat Package (straight lead) Quad Flat L-Leaded Package	0.40/0.50/0.65/0.80/1.00
LQFP*	Low-Profile Quad Flat L-Leaded Package	0.40/0.50/0.65/0.80
TQFP	Thin Quad Flat L-Leaded Package	0.40/0.50
HQFP	QFP with Heat Sink	0.40/0.50/0.65
LCC*	Leadless Chip Carrier	1.016/1.27
QFN	Quad Flat Non-Leaded Package	
BGA	Ball Grid Array	1.27/1.0
FBGA	Fine pitch Ball Grid Array	0.8/0.75/0.65/0.5
DTP	Dual Tape Carrier Package	—
QTP	Quad Tape Carrier Package	—

*: Package name used by Fujitsu Microelectronics Limited

2. Package Forms

Packages can be broadly classified into two types according to the mounting method used:

Lead inserted type: The leads on the package are inserted into through holes in a printed circuit board, etc., and then soldered in place.

Surface mounted type: The device lays flat on surface of the circuit board and the leads are soldered directly to the wires.

In addition, each of the various package forms has its own unique features.

Figure 1 Lead insertion types

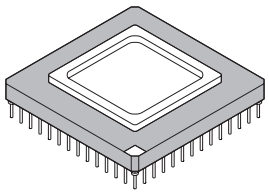
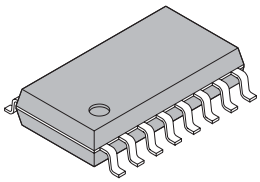
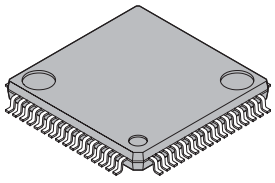
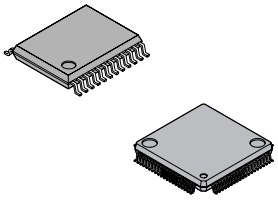
Illustration	Name of package	Features	Lead pitch
	PGA	The leads on this package extend straight down from the bottom of the package in a grid arrangement. This package is suited for high-density mounting of packages with 64 or more pins. A special surface-mount version of this package is available with a lead pitch of 1.27mm.	Standard : 2.54mm

Figure 2 Surface mounted types

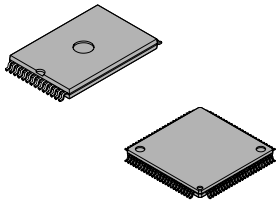
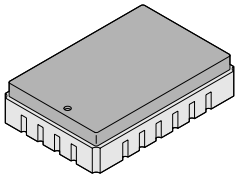
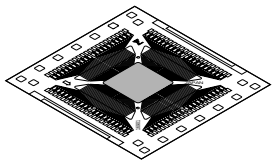
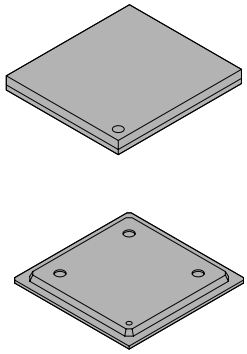
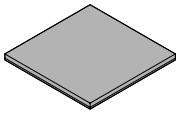
Illustration	Name of package	Features	Lead pitch
	SOP SOL *	The leads on these packages extend out from two edges of the package; the leads are either gullwing (L-shaped) or straight. Packages that conform with JEDEC specifications are called "SOL".	Standard : 1.27mm
	QFP	The leads on this package extend out from four sides of the package; the leads are either gullwing (L-shaped) or straight.	1.00mm 0.80mm 0.65mm
	SSOP LQFP *	These packages are compact versions of the SOP and QFP. (The lead pitch and body size are smaller.)	SSOP : 0.65mm/0.80mm/ 1.00mm LQFP : 0.40mm/0.50mm

Package name used by Fujitsu Microelectronics Limited.

(Continued)

PACKAGE

(continued)

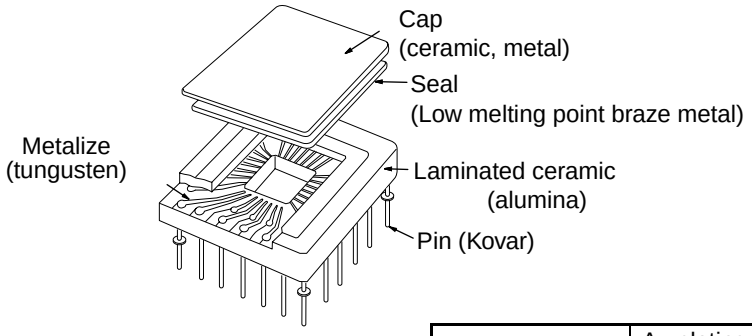
Illustration	Name of package	Features	Lead pitch
	TSOP TQFP	These packages are thinner versions of the SOP and QFP. (Mounted height: 1.27 mm max.)	TSOP : 0.50mm/0.55mm/ 0.60mm TQFP : 0.40mm/0.50mm
	LCC QFN	This package has no leads; instead, it has only electrode pads for soldering. A ceramic leadless chip carrier is a compact, high-reliability representative of this type of package.	Standard: 1.27mm Among LCCs with many pads, 1.016mm, 0.635mm and other fine-pitch packages are currently under development.
	DTP QTP	This type of package, generally called a "TAB package," consists of an IC chip mounted by means of TAB technology on a tape on which the wiring pattern is formed; the chip is then coated with resin. This package is suited for the increasing number of pins required in chips and for high-density mounting. There are three tape widths: 35 mm, 48 mm, and 70 mm.	0.50 to 0.15mm
	BGA	This package has a grid of equally spaced leads (solder ball) on the underside of the package. The BGA package is suitable for high density mounting and includes the following types: E-BGA: The package is die bonded directly to a heat sink for improved heat dissipation. T-BGA: A low-profile package with a metal-rich construction that provides excellent heat-withstanding and thermal resistance characteristics. FC-BGA: A high pin count package that uses flip chip bonding technology.	1.00mm 1.27mm
	FBGA	Same as the BGA package but with a finer lead pitch.	0.5mm 0.65mm 0.75mm 0.8mm

3. Package Structures

3.1 Structure diagrams

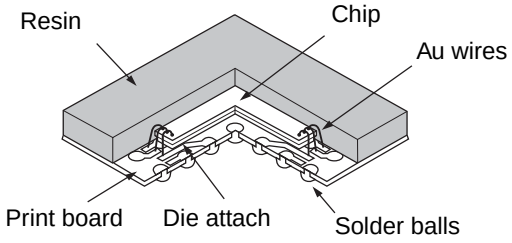
Structure diagrams for typical packages are shown below.

Ceramic PGA (laminated)

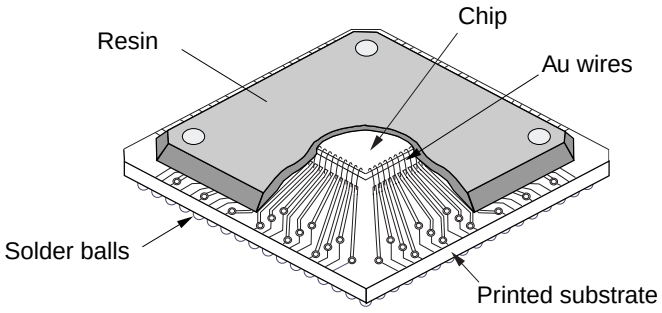


Lead finish	Au plating or solder dip

Plastic FBGA

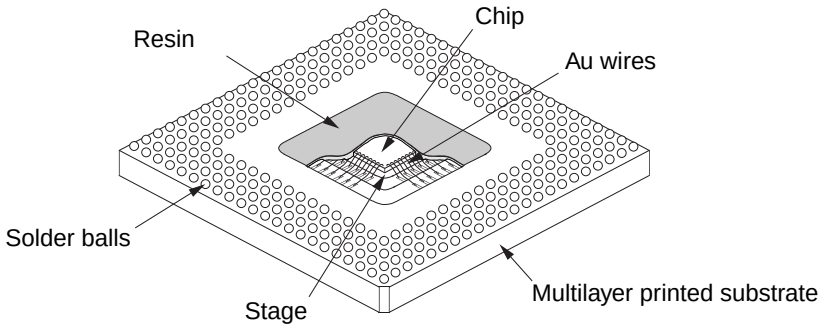


Plastic BGA (mold type)

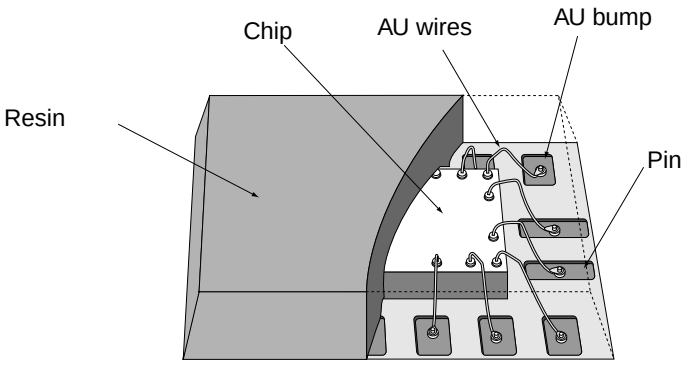


PACKAGE

Plastic BGA (cavity down type)

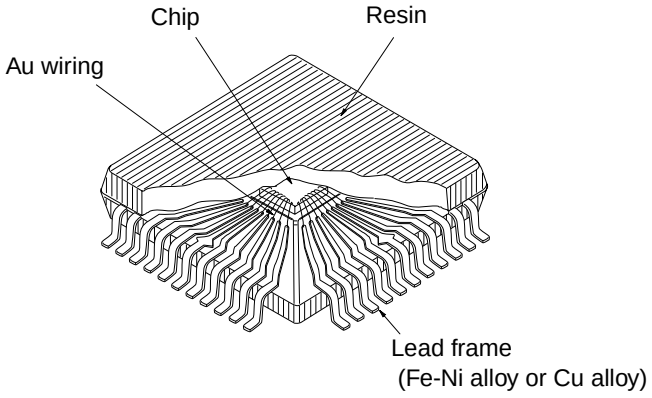


Plastic LCC (BCC type)



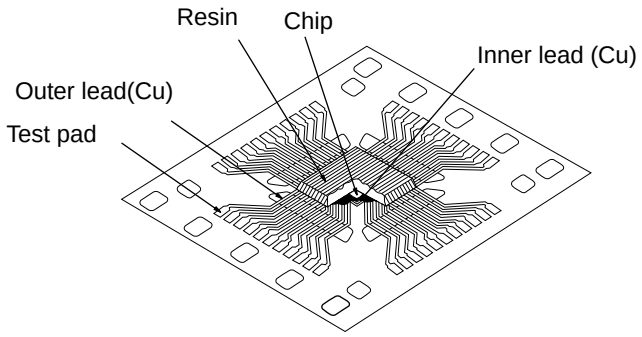
Lead finish	Pd/Ni/Pd plating

Plastic QFP



Lead finish	Solder plating

Tape carrier package



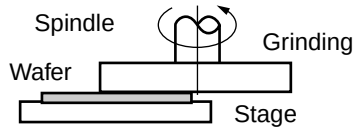
Lead finish	Sn plating

3.2 Sample Assembly Process

Sample assembly process for a Lead frame type IC chip

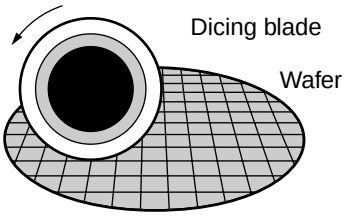
(From primary testing)

Completed wafers are checked electrically before entering the assembly process.



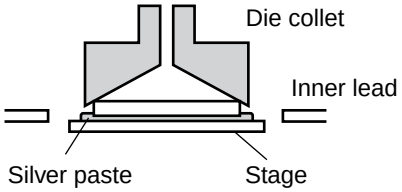
Reverse side grinding

Wafers are ground to an appropriate thickness for packaging.



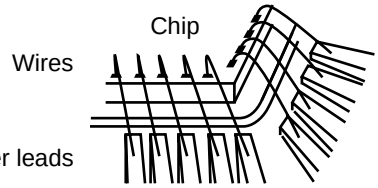
Dicing

Individual chips are separated using a dicer.



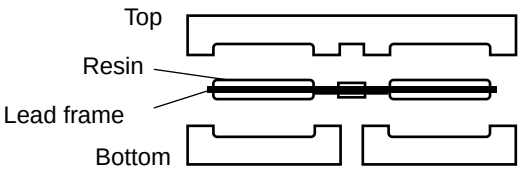
Die bonding

The chip is attached to a lead frame with a silver paste.



Wire bonding

Gold wires are placed between the chip and leads

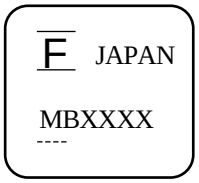


Molding

The package is molded using epoxy resin

External plating

External leads are solder plated to make them easier to solder during mounting

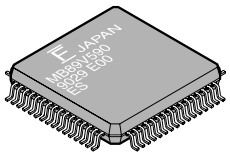


Embossing

The manufacturer's name, country of origin, model and lot number are embossed on the package

External lead formation

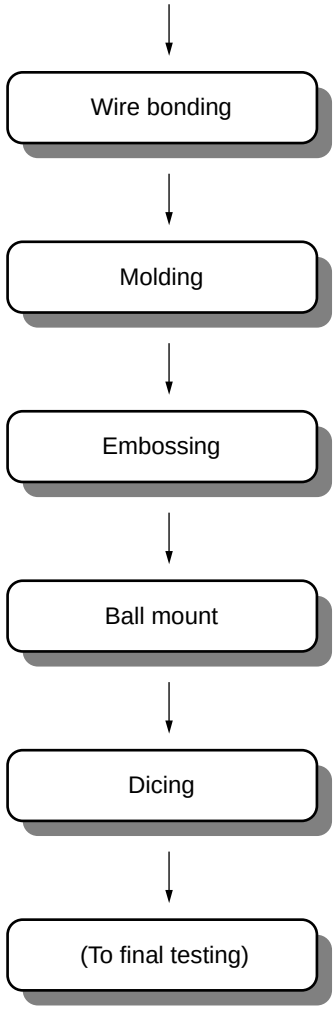
The LSI is separated from the lead frame and external leads are formed, completing the assembly process



(To final testing)

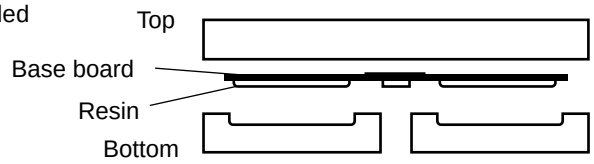
Products are electrically tested before shipment

Sample assembly process for a BGA type IC chip



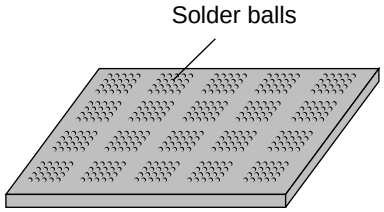
Up to the wire bonding stage, the process is the same as for a lead frame type IC

Only the top side is molded

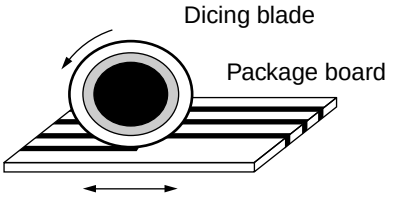


The manufacturer, model and lot number are embossed on the package

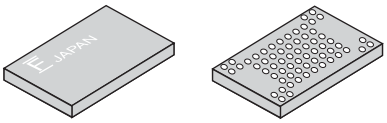
Solder balls are mounted on the terminals of the package board



Package boards are diced to separate IC's, and the assembly process is finished.



Products are electrically tested before shipment



3.3 Structural materials

Some of the materials of which packages are composed are described below.

Alumina	Al_2O_3 90 to 95%. Used as a substrate material in typical ceramic packages. Substrates are divided into several different types according to the percentage content of Al_2O_3, with each demonstrating slightly different physical properties.
Low melting point glass	Primary components include PbO, B_2O_3 , SiO_2 , and Al_2O_3 . Primarily used for seal between the ceramic substrate and the lead frame in cerdip packages, or for sealing the ceramic cap on a laminated ceramic package.
Epoxy resin	Raw material for plastic packages; phenol-hardened epoxy resin is primarily used.
Kovar	An iron-nickel-copper alloy. Because it has a coefficient of thermal expansion near that of ceramics, it is used primarily for metal caps and external leads in laminated ceramic packages.
42 alloy	Iron-nickel alloy (42% nickel). Generally used as the lead frame material in cerdip packages and plastic packages. Also used as external lead material in laminated ceramic packages.
Copper (Cu)	A copper alloy (a copper-nickel-tin alloy) is used as the lead frame material in plastic packages. Also used as a structural material in ceramic packages. When lowering thermal resistance is an objective, a copper film, a copper-molybdenum compound or a copper alloy may be used as the intermediate metallic material between the bottom of the chip and the heat dissipation fins. Copper has also recently gained attention for use in bonding wires.
Tungsten (W)	Raw material for metallized paste used in the wiring patterns (internal wiring) of laminated ceramic packages. The paste is screen printed on the unsintered ceramic substrate and is then sintered simultaneously with the ceramic.
Silver (Ag)	There are partially silver-plated inner pattern tips and portions of the stage with chip in the lead frame of a plastic package. Silver is also used in the metallized paste used in the chip mount in a cerdip package. A silver paste is also used as an adhesive between the chip and substrate.
Aluminum (Al)	Used as a wire material for wire bonding (ultrasonic type). In addition, aluminum is sometimes vapor deposited or pressed onto the tips of the inner pattern of the lead frame in a cerdip package for its bonding characteristics. Aluminum is also often used for heat dissipation fins.
Gold (Au)	Used as a wire material for wire bonding (nailhead type). Gold plating is also often used for the metallized pattern and external leads in a laminated ceramic package.
Tin (Sn)	The external leads of most cerdip packages are often tin-plated. A gold-tin alloy (20% tin) is also used as a sealing solder for the metal cap on a ceramic package.
Lead-tin (solder)	A variety of solders with differing characteristics can be obtained by changing the ratio of lead-tin composition. At present, lead-tin amalgam solders (normally called solder plating) are used for external lead processing of plastic packages. Also used for sealing metal caps on ceramic packages. In addition, used for solder dip processes for external leads.
Tin-bismuth (solder)	A lead-free solder, used for external lead processing of plastic packages in lead-free mounting operation.
Tin-silver-copper (solder)	A lead-free solder, used for solder balls on BGA packages.
Polyimide tape	This is the primary material in the tape used for TCP. This tape is generally made from pyromellitic dianhydride and aromatic diamine. In addition to the ability to withstand high temperatures, this tape also possesses excellent mechanical, electrical, and chemical characteristics.

■ Lead-Free Packages

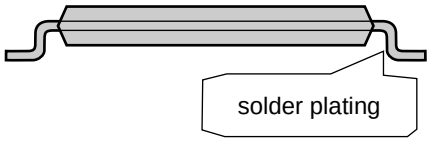
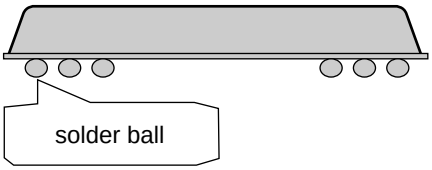
The use of lead-free electronic components is mentioned as a significant issue in global environment assessments.

Lead is a harmful heavy metal, which if absorbed and accumulated in the body is reported to cause damage including inhibited growth in children and psychological damage in adults.

In particular, lead can leach from electronic products that have been disposed of in land fills, from contact with acid rainwater. This can lead to contamination of rivers and ground water, and can thereby enter the body through drinking water.

At Fujitsu, we have actively addressed this problem by starting the production of lead-free products with semiconductor packages completely free of lead as of October, 2000.

(1) Lead-free Products

QFP package 	Tin-bismuth solder used in solder plating for external lead treatment
BGA package 	Tin-silver-copper balls used in solder balls for external leads

Caution

Lead-free materials are still under development for other applications including die bonding materials for power devices, and sealing materials for ceramic packages.

(2) Heat Resistance in Lead Free Packages

In general, lead-free solder has a higher melting point than eutectic solders, requiring the mounting temperature to be increased by 10 to 20 °C. For this reason Fujitsu has addressed improvement of package heat resistance as part of the development of lead-free packaging.

(3) Differentiation from Previous Products

Lead-free products are distinguished from previous products in the following ways :

1. The classification code “E1” is added to the end of the product name.
2. The letters “E1” are added to the embossed code on the product (excluding some products on which there is no space available) .
3. Packaging material is labeled to indicate that the product is lead-free.