

# Moving from Environmental Protection to a Sustainable Society

## Sony's Environmental Efforts in the Core Technology & Network Company

At Sony, we are engaged in a wide range of environmental protection activities based on our environment action plan.

Our technology development efforts, such as polystyrene foam recycling using limonene, macromolecular polymer flocculants, and longer life batteries, are but one part of these efforts.

In this CX-EYE, we present three such technologies.

- Pb-free solder mounting technology
- Halogen-free circuit board technology
- Reuse of IC packing containers

Sony is committed to these technologies, both to protect the earth's environment, and to return to the earth as a small token of our appreciation.



**Takaaki Koizumi**  
General Manager  
Environmental Promotion Department  
Core Technology & Network Company  
Sony Corporation

In these last few years, or rather, perhaps it has just been in the last year, our way of thinking about the environment has changed radically. To put it simply, what is now required is a social structure based on recycling and reuse.

The earth's resources are limited. While it is, of course, important to conserve those resources and to not extract harmful materials, what is now required is to actually create resources within a cycle of reuse and develop energies. Much of this must be handled by technological development. The earth's environment has already reached such a perilous state that this is necessary.

The other night on the bus as I was gazing at the bright lights of Yokohama, it crossed my mind that a large amount of energy was being consumed in creating the spectacle. Wouldn't it be possible to blank the screen, or reduce

the size of the image, to reduce the energy consumed by TV sets? What is required here is both the creation of the energy and technological development in large-screen low-power displays.

We are now studying the "life cycle assessment" approach. This consists of not only checking the obvious items, such as those in the product assessments used up to the present, such as the environmental burden of the power consumed by the products themselves and the chemicals used in factories, but also checking, in detail, the whole life cycle of the product to the very end.

For example, what sort of influences on the environment are associated with a TV set, from design, manufacture, and use, through the end of its lifetime. The TV set is transported by truck to the store where it is sold. Exhaust gas is created in that process. The

TV set will consume energy when it is used in the home. What sort of influence will this have on the environment if it is used for some number of hours every day for its operating lifetime? Our idea, then, is to only deliver a TV set to the market once we have determined the burden on the environment of its whole life cycle. The issue is how to incorporate this kind of thinking into devices from the start.

There are still swans in the rivers in the vicinity of Sony Shiroishi Semiconductor Inc. just as there used to be years ago. The water in the river near Sony Kokubu Corp. is extremely clean, and fish can be seen swimming in it. However, we must not allow this to reassure us. The argument that we must do more to save the earth will grow stronger, and we are now at the point where we ourselves must change and become more aware of these issues.

### Core Technology & Network Company Efforts in the Environmental Technology Area to Create a Sustainable Society

<p><b>Energy Saving Measures</b></p> <p><i>A 15% reduction from 1997 levels by 2002</i></p>	<p>Introducing energy saving equipment Saving energy in manufacturing processes</p>
<p><b>Measures to Reduce Environmental Pollutants</b></p> <p><i>Achieving zero emissions</i></p>	<p>Promotion of MEK recycling Promotion of toluene recycling Investigation of IPA recycling technology</p>
<p><b>Measures to Reduce Waste</b></p> <p><i>Achieving zero waste production</i></p>	<p>Promotion of reduction and reuse Recycling and volume reduction technologies</p>
<p><b>Measures Applied to End Products</b></p> <p><i>Reduction or elimination of toxic and harmful materials</i></p>	<p>Pb-free solder Halogen free PVC free</p>

Towards a Sustainable Society. Sony Environmental Technology I

# Pb-free Solder Mounting

Commercialization of Semiconductor Products that Support Pb-free Solder by Achieving the Heat Resistance of 260°C

## Pb-free Solder Will Be Introduced in Sony Models

As part of our group environmental action program, Sony is in the direction of introducing Pb-free solder in Sony products manufactured in Japan by March 2001. Sony is also aiming at using Pb-free solder in Sony products manufactured in outside of Japan by March 2002. These are but two of Sony's environmental efforts.

As part of Sony's semiconductor related environmental efforts, Sony has led the industry since 1995 by adopting Pb-free lead frame (S-PdPPF: Palladium Pre-Plating Lead Frame)\*1 technology and releasing products incorporating that technology. By the end of the year 2000, Sony plans to switch to environmentally friendly products that have achieved at the same time both improved heat resistance and Pb-free leads at all domestic Japanese and overseas semiconductor plants.

\*1 This is the name for Sony lead frames that use no lead in the surface plating of the copper, which is the external lead pin material, but that use nickel, palladium, and gold instead.

## From 235°C to 260°C, and Improving Component Mounting Reliability

Sony succeeded in developing Pb-free soldering semiconductor packages that can resist the component mounting temperatures (reflow peak: 260°C) associated with the use of Pb-free solder. Since December 1999 we have been gradually switching over to and shipping products based on this new technology.

Generally speaking, Pb-free solder has a higher melting point than lead-based solder, and during mounting it is necessary to increase the temperature by 10°C to 20°C above that temperature. During high-temperature mounting, any moisture that has penetrated into the semiconductor device package vaporizes, and depending on the resin used, this may result in destruction of the package. Thus the heat resistance of semiconductor device packages has been a serious technological problem.

To improve resistance to heat over conventional products, Sony has improved the fabrication process and modified the lead frame structure in certain products, and has released to the market products with superlative heat resistance properties. Furthermore,

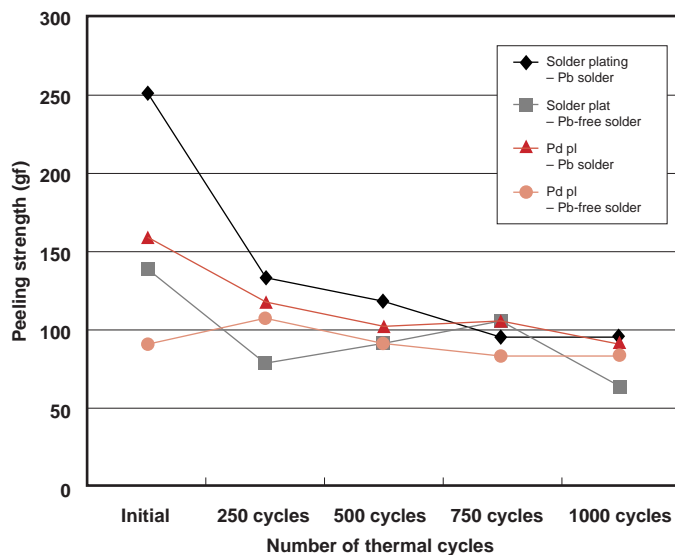
by adopting, in stages, package materials with superlative resistance to package cracking in all semiconductor products, Sony is making it possible to raise the allowable soldering temperature from 235°C to 260°C. This means that it will be possible to adopt Pb-free solder without concern for problems in the heat resistance.

## Sony Semiconductor Pb-free Lead Mounting

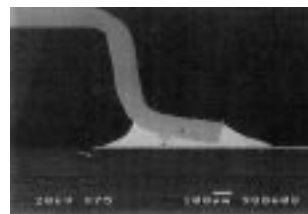
In February 1995, Sony introduced the Palladium PPF (Pre-Plating Lead Frame) in insertion-type ICs in DIP and SDIP packages. The Palladium PPF completely abolishes the use of lead containing plating materials. Furthermore, based on research on the soldering mechanism, Sony has continued to achieve improvements in solder wetting and reliability characteristics, and in October of that year, Sony began mass production of Palladium PPF products in surface mounting ICs as well.

The Sony Palladium PPF adds gold plating to the palladium surface (S-PdPPF) to improve solderability. Currently Pb-free lead products amount to one third of Sony's total production.

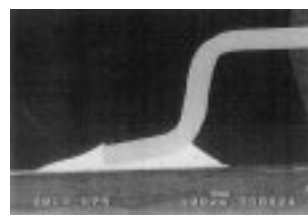
Peeling Strength



Pb Solder

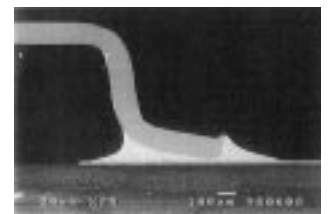


Initial

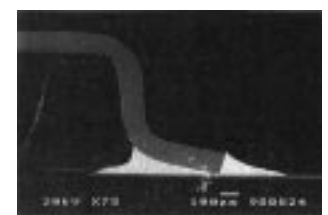


1000 cycles

Pb-free Solder



Initial



1000 cycles

Towards a Sustainable Society. Sony Environmental Technology II

# Halogen-free Circuit Boards

Halogen-free Products, That Do Not Generate Dioxin, Used on Practical Multilayer Circuit Boards

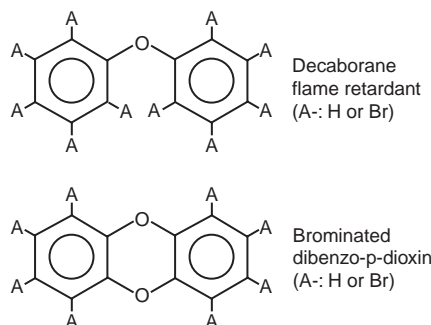
## Why Is Halogen-free Importance Illuminating?

Currently, most electric products and components are treated with a chemical compound called a flame retardant. The UL standard provides a basis for indicating the degree of flame retardance provided. A flame-retardant level of V-0 is required normally for materials used in products and parts. Many of the currently used flame retardants use halogen-based flame retardant chemicals. These include phenyl compounds containing bromine (Br) as shown in the upper section of figure 1. If no changes occur in these compounds after they are applied to the materials used in the products, no problems will occur. However, if they are subjected to high temperatures or incinerated inappropriately, these compounds will be oxidized and chemically converted to the "infamous" brominated dibenzo-p-dioxin shown in the lower part of figure 1.

Since many of the halogen-based flame retardants closely resemble the chemical structure of dibenzo-p-dioxin shown in figure 1, the chemical reaction transforming them to dioxin can occur easily at high temperatures. On a per unit weight basis, dioxin is about 1000 times as toxic as cyanide, and is said to be the most toxic carcinogen.

Flame retardants that use nitrogen and/or phosphorous have been developed to resolve these problems, and recent progress has been made on making more products halogen free. While it goes without saying that we require the maintenance of sufficient flame-retardant properties and material quality as well as the absence of harmful chemicals in the alternative products, the alternatives can meet these requirements at this moment.

Figure 1



## Dioxin Regulation Started in Europe

The German dioxin ordinance (Phase I) of July 1994 was the world's first such directive regarding dioxines, and the use of the decaborane flame retardant resins was limited in the European market. This law stipulated that after a five year period of gradual reduction, stricter limitations would then be enforced. Thus starting in July 1999, limits ten times stricter than the Phase I limitations were enforced as Phase II. Furthermore, halogen-based flame retardants have been pointed out by the toxic materials regulations in the EU Directive WEEE, which is, however, still in draft form, to be enforced for electric products. Thus electronics companies who sell in the European market are being forced to respond to these requirements.

## Creating Practical Halogen-free Multilayer Circuit Boards and Product Deployment

The trend towards halogen-free products in circuit boards is the focus of attention, and much progress has been made in this area in Europe, even before the enactment of the German dioxin ordinance (Phase I). However, practical application has been delayed due to a wide range of problems, including sufficient flame retardant property, quality, cost performance, and the ability to mass produce products. However, Sony succeeded in developing both single sided and double sided practical halogen-free paper phenol circuit boards and is using these boards in color TV sets and VCR decks manufactured in Europe. Sony has now also developed practical glass-epoxy halogen-free multilayer circuit boards that can fully meet the UL

standard flame retardant grades.

These boards will soon be deployed in all types of portable equipment, and include the four-layer circuit board used in DVD players shown in photograph 1. The HF mark printed on the circuit board is the Sony registered trademark for halogen-free PWB, and is standardized as a de facto standard by the JPCA. Since these circuit boards must be made completely with halogen free, we switched from phthalocyanine green, which contains chlorine, to phthalocyanine blue as the photoresist pigment that covers the board surface. Thus by thoroughly removing all bromine and chlorine from these circuit boards, we have assured that no dioxin will be generated at incineration.

These new circuit boards were developed jointly by Circuit Board Business Center and the Sony PWB Technology Committee and Sony Neagari handled mass production, including the development of mass production technology. Currently, we have succeeded in developing high multilayer halogen-free double built-up boards, and have established mass production technology. We hope to deploy these boards in high value-added products in the near future.

Photographs 2-1 and 2-2 show the lineup of halogen-free multilayer circuit boards and a DVD player that uses these boards as presented at the IFA '99 (Berlin show). Sony also exhibited TVs, VCR decks and other products that use halogen-free circuit boards. These products created much interest as environmentally conscious products. Furthermore halogen-free TV and DVD products, and the circuit boards used in them, are now on permanent display at the Fraunhofer Institute in Berlin.



Photograph 1  
Halogen-free Multilayer DVD Circuit Board (4 layers)  
and the Sony Halogen-free Mark, Which Is a Registered  
Trademark



Photograph 2-1  
Halogen-free Multilayer Circuit Board Product Line



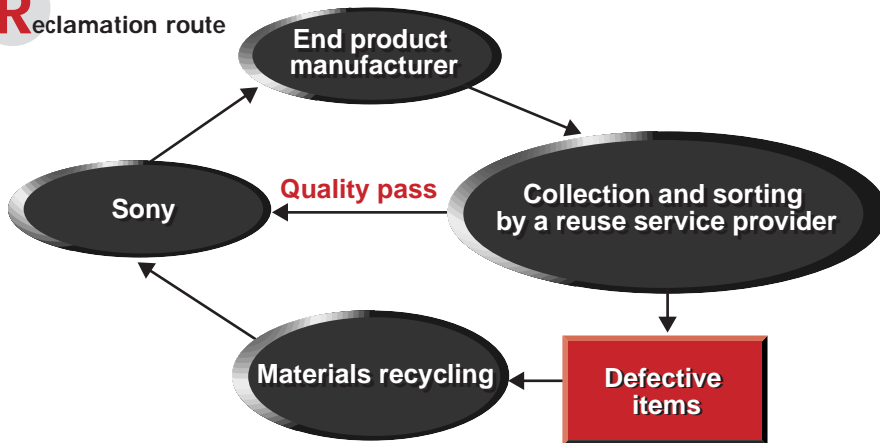
Photograph 2-2  
Halogen-free Multilayer Circuit Board DVD Player

Towards a Sustainable Society. Sony Environmental Technology III

# Reuse of Semiconductor (IC, CCD, LCD, and LD) Packing Containers

Efforts Towards Reuse, Recycling, and No Use of PVCs for Environment-friendly Packing Materials

## Reclamation route



Sony Semiconductor Company is one step ahead in

- Reuse of all packing material items, and
- Increased percentage of reusable items.

### Reusable Items

- (1) Magazines, (2) Trays, (3) Reels, (4) Cardboard boxes,
- (5) Cushioning materials

### New Efforts

- (1) Humidity indicators, (2) Desiccants

## Aiming for a Society with Zero Solid Waste

--- Efforts of the Semiconductor Company's Reuse Committee

In November 1991, Sony proposed reusing semiconductor containers, and in 1992 started a program of study and evaluation of collection methods and quality in reusable products in conjunction with both packing container manufacturers and customers. This program culminated in the determination of the basic specifications for these containers. After first introducing reusable magazines in March 1993, Sony went on to introduce reusable trays for some trays in September 1993. Since 1994 Sony has been gradually expanding the use of reusable trays, and we have synchronized our activities with the reuse and recycling efforts of Sony's internal Procurement Center.

At the same time as switching to reusable reels in 1997, we achieved reusability in the soft trays used for CCD and LCD products for the first time in the semiconductor industry, and are currently developing a program of customer site visits to actively promote collection of these reusable containers. Furthermore, since 1998 we have adopted reusable cardboard boxes and cushioning materials in some cases, and our efforts towards reusability in desiccants and humidity indicators allow us to begin to reuse some of those materials in 2000.

## Avoidance of Polyvinyl Chloride -- To Ease Handling of Solid Waste

- We have succeeded in avoiding the use of Polyvinyl chloride materials in embossed carrier tape and soft trays.
- We have stopped using Polyvinyl chloride materials in all packing materials except for magazines. (In magazines, we are aiming for full reusability.)

## An Appeal to Our Customers -- Let's Reuse Reusable Items

1. Send reusable items directly to the reuse service provider for the item.
2. Avoid areas subject to direct sunlight or rain as storage areas.
3. Consult with your Sony representative concerning direct collection or direct shipment, depending on the volume of items to be collected.



Photograph provided by Narimoto Container Co., Ltd.



Inspection and final cleaning operation using tray automation