

Infineon

European Distribution Sales Conference
Innsbruck October 13th-15th, 2003

green product

Jürgen Winterer



Green Products are being taken in support of government regulations and the world-wide customer requirements to supply environmentally friendly products.

Restriction for the use of Hazardous Substances (RoHS) to prohibit lead (Pb),

Enforcement date for Lead-free materials: 01. 07. 2006

Waste of Electrical and Electronic Equipment (WEEE): A directive to recycle 'plastic containing brominated flame retardant (halogen) in the electro- and electronic equipment.

Enforcement date for halogen-free materials: 01. 01. 2007

- The market is preparing for a major conversion in 2004.
- The Japanese and European market are in a leading position.

What is green?

green
Product

green (internet-link)
Product

RoHS compliant

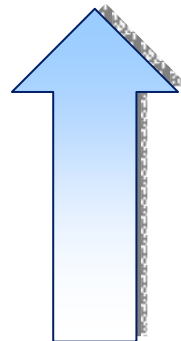
Robust Package

=
+

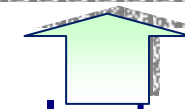
Lead-free **<1000ppm**
Balls, FC bumps, Lead finish

+

Halogen-free **<900ppm**
Substrate materials,
Mold compound
If technically / economically beneficial

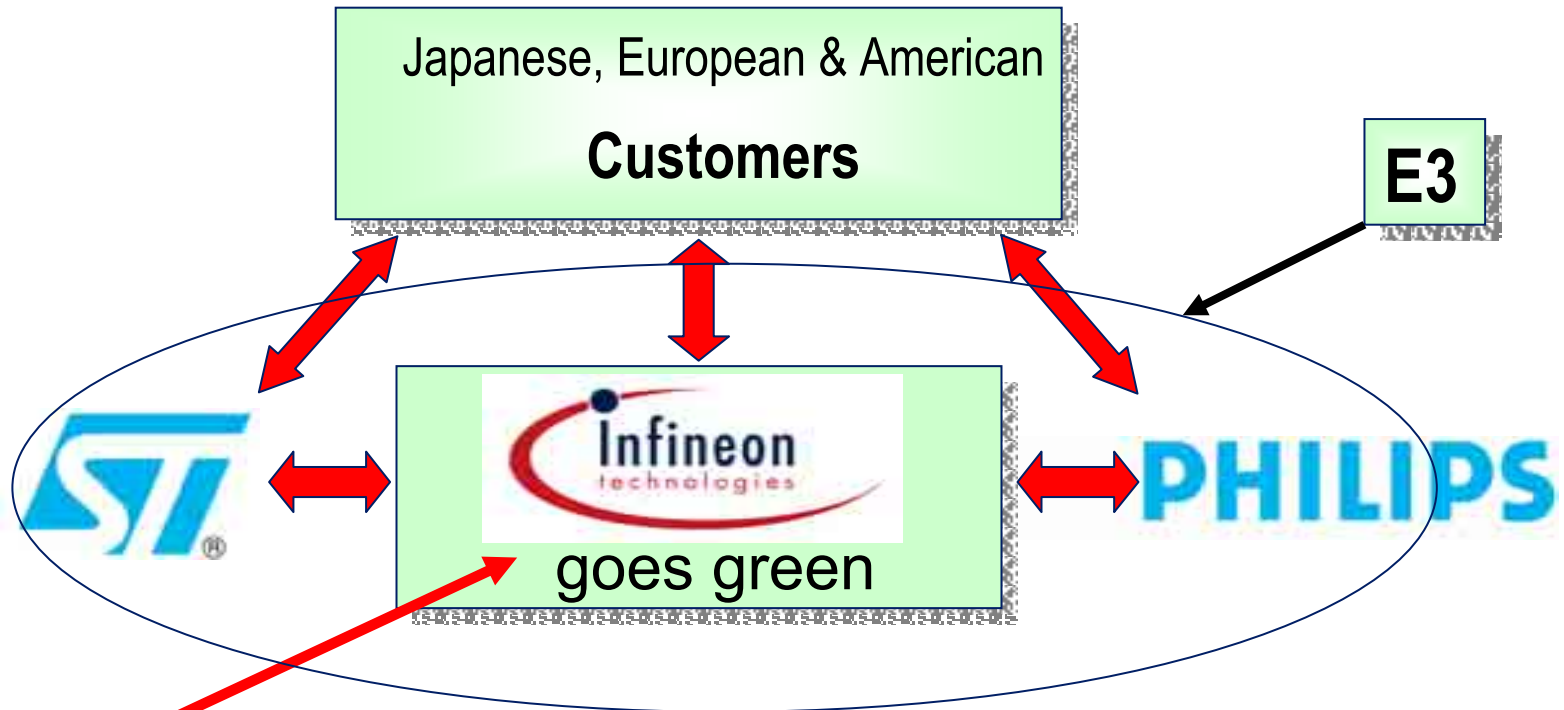


To fulfil the solder conditions for lead-free board assembly



To fulfil legal and market demands

The Fast Track to Success



- NEMI** National **E**lectronics **M**anufacturing **I**nitiative
- JEDEC** Joint **E**lectronic **D**evice **E**ngineering **C**ouncil
- AEC** Automotive **E**lectronics **C**ouncil



Standardisation

IPC/JEDEC J-STD-020B



- Infineon procedures are conform with the J-STD-020B
- Existing results are compliant to J-STD-020B
- Enhanced conditions for small packages:
Infineon introduced an additional profile with 260°C -5°C/+0°C for testing MSL of small devices at higher temperature. The additional profile is obtained by extrapolating the 250°C JEDEC profile with the same set of tolerance and a peak temperature of 260°C -5°C/+0°C

Consolidated lead free solutions:

For lead frame based packages

- Post plate of matte tin

For Ball Grid Array (BGA) packages

- SnAgCu

Technology

Postplate of matte tin (Sn)



Main characteristics

- Material availability is good
- Closest to SnPb in cost and process
- Good solderability with PbSn and Pb free solders
- Good solderjoint reliability
- “Whisker free” process available ¹⁾

¹⁾ See whisker presentation

Technology

SnAgCu Spheres in Ball Grid Array

Main characteristics

- SnAg3.0-4.0Cu0.5-1.0 is the most applied range
- Good solderability with Pb free solders
- Offered by all major suppliers
- Limited backward compatibility with SnPb solders (board apply process to be adopted)

L/F packages Compatibility

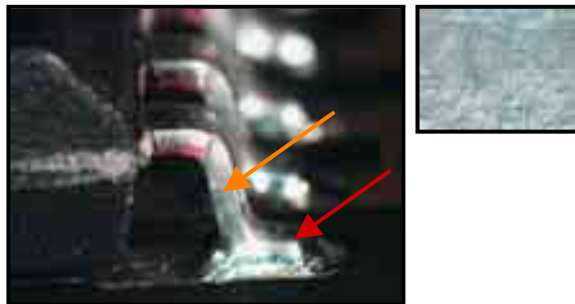
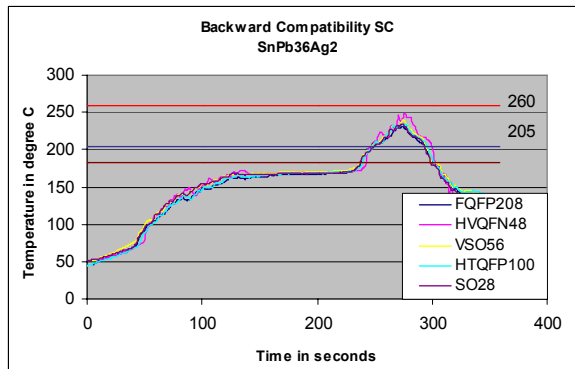
| customer supplier | | Pb - solder | Pb - solder |
|----------------------|--|------------------|--|
| | | component finish | Pb Today Experience of some decades of board assembly |
| Pb | Processability: o.k. Solderability: o.k. Reliability: o.k. | | Processability: o.k. Solderability: o.k. Reliability: o.k. |

(NCMS-, IDEALS-report, internal evaluations)

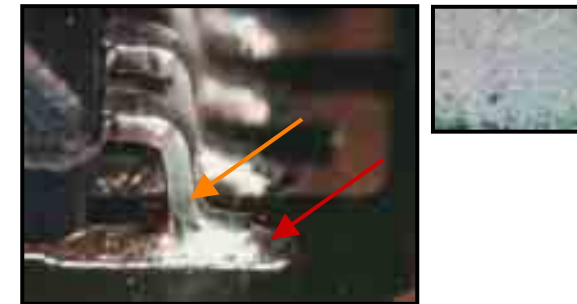
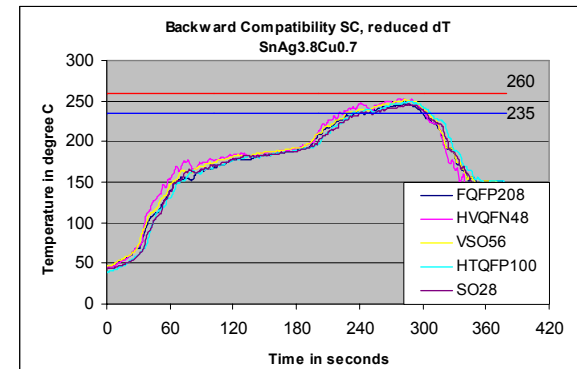
L/F packages Processability

Reflow solder joints

Lead containing solder



Lead-free solder

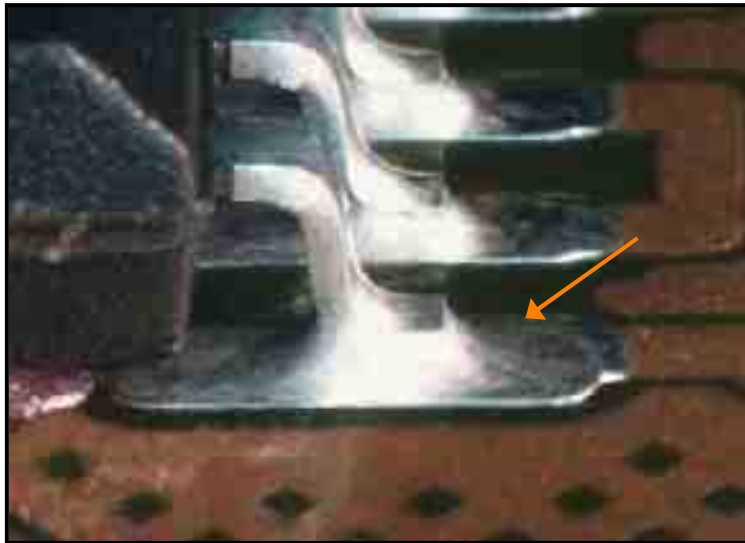


Only slight differences of wetting (←→), fillet (←→)
 Surface: less shiny for lead-free (see inserts)

L/F packages Processability

Wave solder joints

Lead containing solder



Lead-free solder



| Process | Process speed [m/min] | Total soldering time/temp | Pre-heat temperature |
|-----------|-----------------------|---------------------------|----------------------|
| Leaded | 1.25 | 2.75±0.25s / 250°C | 120±10°C |
| Lead-free | 1.2 | 3.75±0.25s / 265°C | 120±10°C |

Only difference:
somewhat less shiny with lead-free

L/F packages Processability

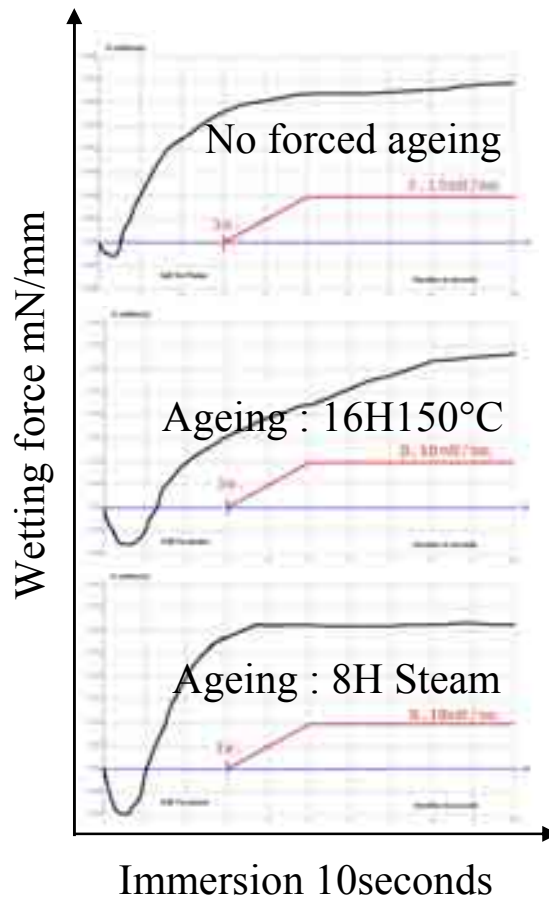
Processability in lead containing vs. lead-free process



- For reflow soldering: paste application, component placement do not require special measures
- For wave soldering: glue application, component placement, glue cure do not require special measures
- Differences in soldering process are time and temperature
- SnPb plating and Sn plating do not show a different behavior in the soldering processes (more than a decade of experience!)

L/F packages Solderability

SO 8



Good solderability of Sn coated components in SnPb

Wetting balance test

- 235°C
- Zero cross time << 3 seconds
- Wetting force >> 0.10mN/mm

Temperature Cycling as reliability test for solder joint

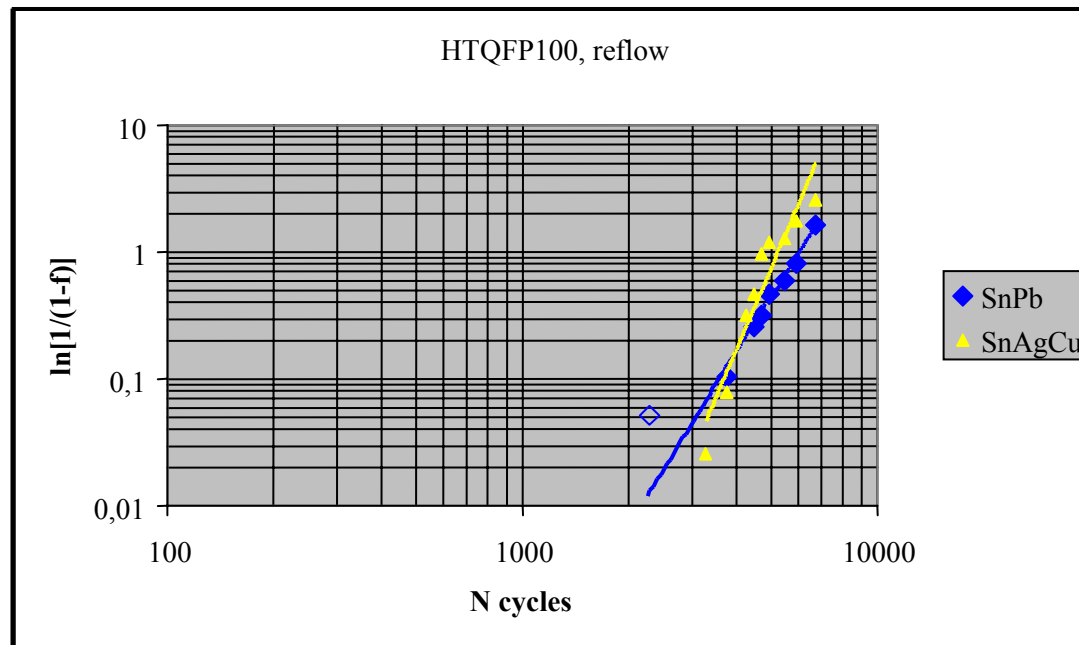
- Temperature cycling causes thermo-mechanical solder fatigue

- Degradation/failure goes along the following path:
 - Diffusion and re-crystallization
 - Crack initiation and growth
 - Failure by macroscopic solder fracture

- Solder fatigue failure is visualized and analyzed according Weibull statistics

L/F packages Reliability

Weibull analysis of failure in temperature cycle test
 (-40/+125 °C) lead-free and lead-containing reflow solder
 Sn plated HTQFP100 components (Cu-based leadframe)

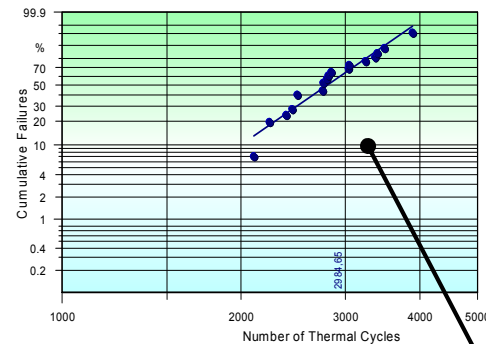


L/F packages Reliability

A trial was done at 'Fraunhofer Institute' to evaluate reliability result for solder joints with lead-free (matt Sn) components metallization



P-TQFP-100-1 on Au/Ni
(SnAg3.8Cu0.7-after
4000 Cycles)



Failure statistics for
P-TQFP-100-1
Alloy42-leadframe
Sn-plated
SnAgCu-paste on AuNi

| | SnPb36Ag2 | | | | SnAg3.8Cu0.7 | | | |
|--------------|-------------------------------------|-------------------------------------|-------------------------------------|-------------------------------------|-------------------------------------|-------------------------------------|-------------------------------------|-------------------------------------|
| | Cu/OSP | | Au/Ni | | Cu/OSP | | Au/Ni | |
| | Cumulated Failures (4000 Cycles) | Characteristic Lifetime (cycles) | Cumulated Failures (4000 Cycles) | Characteristic Lifetime (cycles) | Cumulated Failures (4000 Cycles) | Characteristic Lifetime (cycles) | Cumulated Failures (4000 Cycles) | Characteristic Lifetime (cycles) |
| P-DSO-12-2 | (11) | n.e. | (10) | n.e. | (6) | n.e. | (2) | n.e. |
| P-VQFN-48-4 | 8 | 5233 | 12 | 4134 | 17 | 3704 | 17 | 3891 |
| P-TQFP-100-1 | 24 | 2281 | 24 | 2480 | 24 | 2208 | 24 | 2985 |
| P-TQFP-100-5 | 0 | n.e. | 2 | n.e. | 0 | n.e. | 0 | n.e. |

(x) = package internal contact failure

Source: Infineon - IZM report UB.412.DL.2003.01

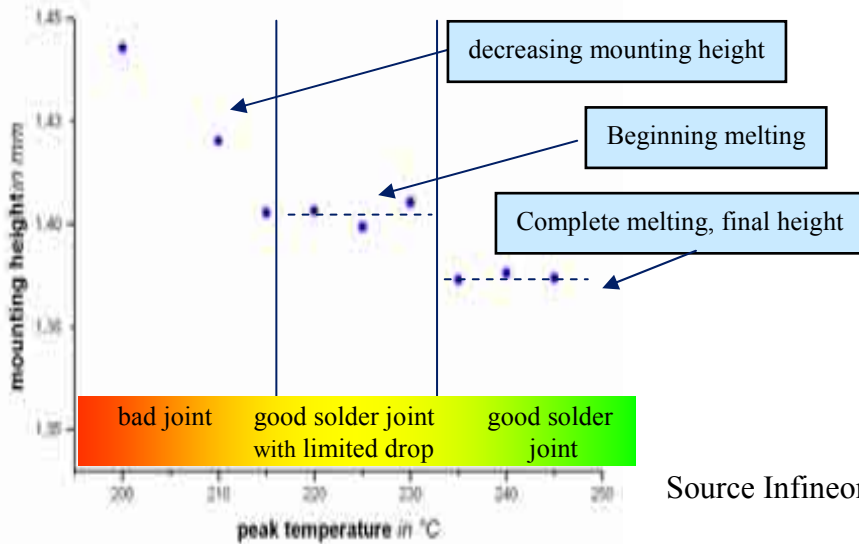
BGA packages Compatibility

| customer supplier | | Pb - solder | Pb - solder |
|--|---|------------------------|--|
| | | Pb component finish | Today Experience of some decades of board assembly |
| Processability below 230°C critical Reliability: o.k. (improved to SnPb) <div style="border: 1px solid orange; padding: 2px; display: inline-block; margin-top: 5px;">For low temperatures critical</div> | Processability: o.k. } Reliability: o.k. } | | Processability: o.k. } Reliability: o.k. } |

BGA Processability

Motivation:

For array-package the processability has been tested. Different temperature at the ball result in different mounting height.



Source Infineon

Conclusion:

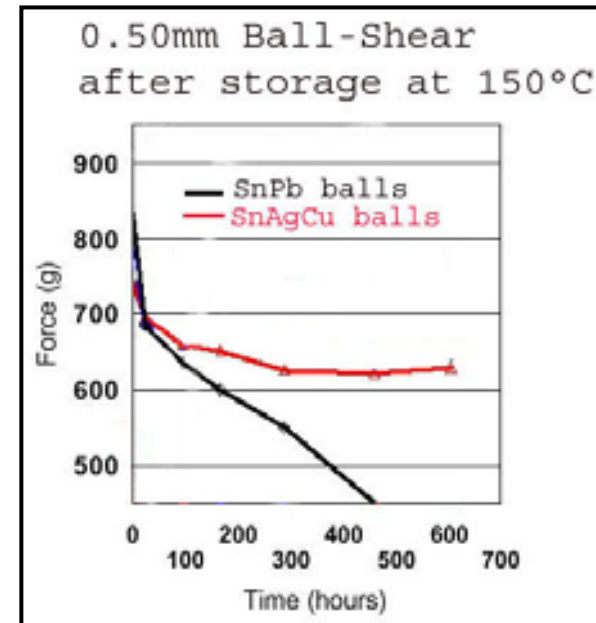
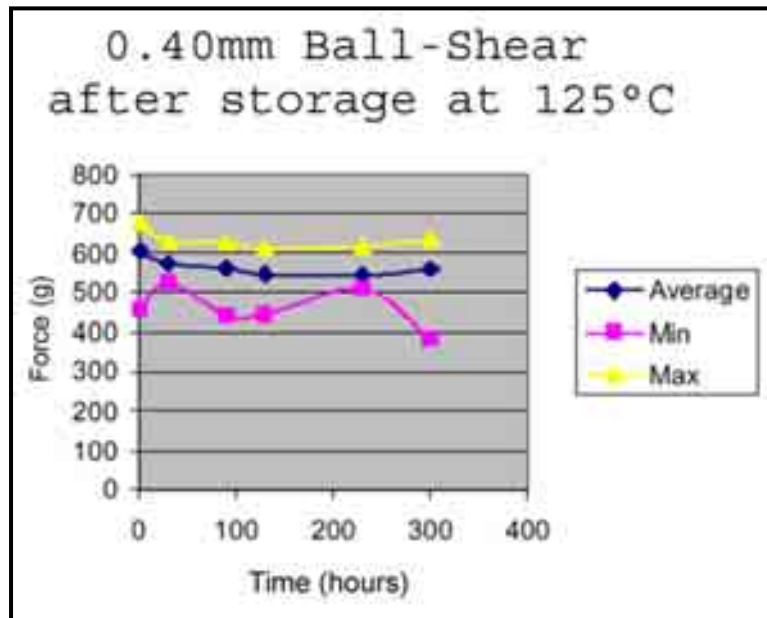
The combination lead-free BGA/SnPb-paste can be processed with a minimum temperature of 230°C (at the ball).

Due to restricted self-alignment, a peak temperature at 220°C should only be chosen in exceptional cases

Peak temperatures over 230°C are recommended



Lead Free solder balls shear test



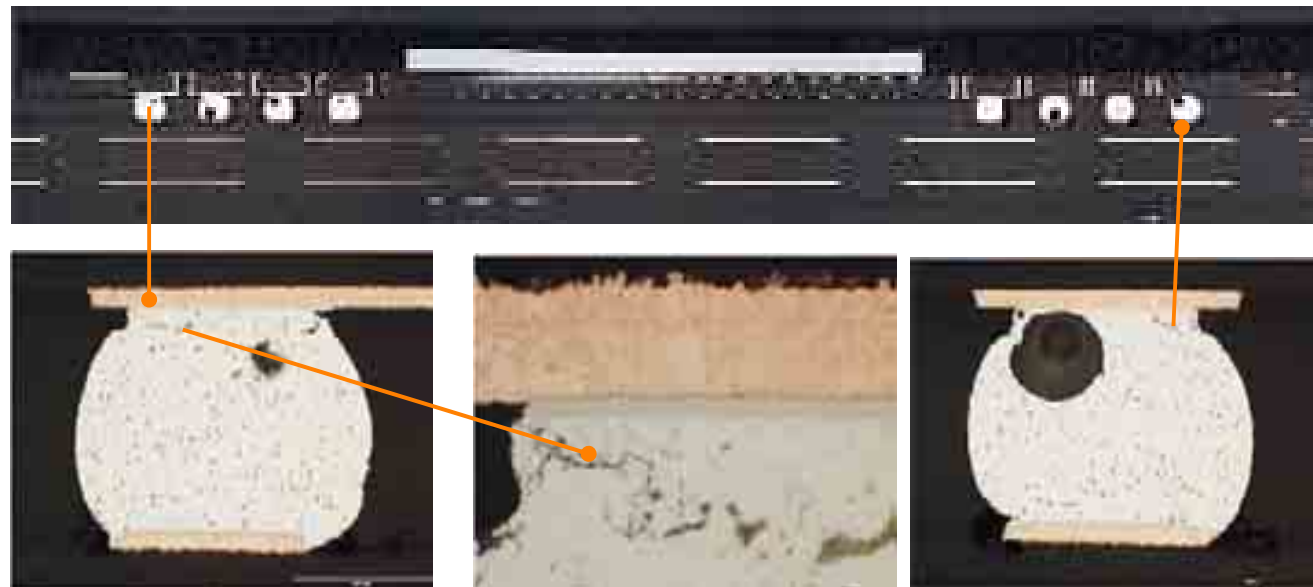
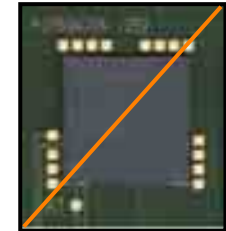
Leadfree solder balls are showing same initial shear strength than SnPb balls but shear values remain more stable during ageing

BGA Reliability

LFBGA-208, Ball SnAgCu, solder SnPbAg

-40°C/+125°C, 2000 cycles

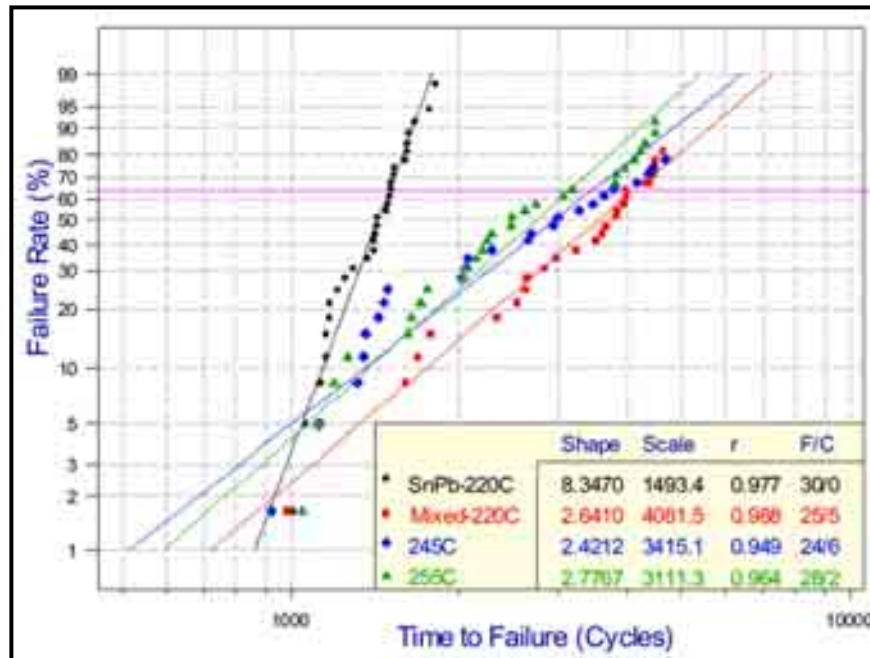
Results positive



Further reference: for large BGA's (35x35mm) positive results shown by:
"Thermal Fatigue Resistance of Pb-free Second Level Interconnect"; Patrick Roubaud; SMTA 2001

BGA Reliability

Weibull analysis of failure in temperature cycle test lead-free and lead-containing reflow solder TFBGA6x6-46 with 0.4mm solder balls (both SnPb-SnAgCu)



4 tested processes

- SnPb balls + SnPb paste (220C)
- SnAgCu balls + SnPb paste (220C)
- SnAgCu balls + SnAgCu paste (245C)
- SnAgCu balls + SnAgCu paste (250C)

-40°C/+125°C cycles

Compatibility

Conclusion for compatibility



Leadframe-package

- Processability: Sn plated products show identical behaviour as SnPb plated products
- Solderability: Sn- and NiPdAu surfaces are solderable with SnPb and Pb-free solder paste
- Solder joint reliability tested at >> 2000 TC does show no failure

BGA-package

- Processability: good processability for temperature over 230°C
- Solder joint reliability is improved compared to SnPb-balls



Roadmap

Package Conversion Roadmap



www.infineon.com/greenproduct

Infineon technologies logo and navigation menu (Products, Company Information, Investor Information, Careers). Breadcrumbs: Home > Products > Green Products > Conversion Roadmap.

Green Conversion* Roadmap

*1) Introduction of green materials into IFX in-house and sub-contractor productions
Status: June 2003

| Package Family | Planned PCN Date | Planned Conversion Date |
|-----------------------------------|---------------------------------|----------------------------|
| IC Packages | | |
| P-BGA | 1st quarter 2004 | 4th quarter 2004 |
| P-DSO | Min. 6 months before conversion | Soonest Early 2005 |
| P-LBGA | Min. 6 months before conversion | Soonest Early 2005 |
| P-LFBGA | 1st quarter 2004 | 4th quarter 2004 |
| P-QFP - Family (TQFP, LQFP, MQFP) | 1st quarter 2004 | 4th quarter 2004 |
| P-TSSOP (without P-TSSOP-10) | 4th quarter 2003 | 2nd quarter 2004 |
| P-TSSOP-10 | 3rd quarter 2003 | 1st quarter 2004 |
| P-PLCC | Min. 6 months before conversion | Soonest Early 2005 |
| P-VQFN | 4th quarter 2003 | 2nd quarter 2004 |
| Memory Packages | | |
| P-TSOP, P-BSP | Will be provided in | It is intended to coincide |

MyInfineon Login form with fields for Username and Password, and a LOGIN button.

European Distribution Sales Conference
October 13th-15th 2003

green product
J. Winterer

conclusion

Leadframe packages

- Sn-plating will be introduced as lead-free technology's
- For leadframe packages there is a full compatibility to SnPb- and Pb-free solder process

BGA packages

- For BGA packages SnAgCu is the chosen metallurgy
- On board reliability is proven
- In the case of BGA-packages the soldering temperature must be above 230°C for processability

The major conversion will take place in 2004



communication



Presenter: J. Winterer
Infineon Technologies AG
Wernerwerkstr. 2
93049 Regensburg
(49) 0941 202 3879

Internet: <http://www.infineon.com/greenproduct/index.htm>

roadmap
technical papers
contacts
MSL information

European Distribution Sales
Conference
October 13th-15th 2003

green product
J. Winterer