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Interflux, bringing chemistry to electronics for over 36 years

EDM Workshop

Interflux Electronics

18-05-2021

Low melting point solder technology for advanced processor components

introduction to Interflux Electronics nv

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- Belgian company, privately owned by Mr. Daniel Werkhoven
- Founded in 1985
- Development and production of soldering chemicals and solder alloys
- HQ and main production site located in Ghent, Belgium
- 7 IF sister companies worldwide
- ISO9001:2015 certified

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introduction to low melting point solder alloys

Melting Point

- **solder alloy composition with a melting point between 120°C and 180°C**
- **40°C-80°C lower melting point than SAC-based solder alloys (217°C-227°C)**
- **eutectic or non-eutectic**

Composition

- **SnBi+x (Bi 35% to 58%) or SnIn+x.**
- **SnBi(+x) solders are more common due to lower cost in comparison with SnIn(+x).**

Generations

- **Gen1** : SnBi : Poor drop shock and thermal cycling performance
- **Gen2 :** SnBiAg : improved performance over Gen1, addition of Ag
- **Gen3 :** SnBi+"ductility enhancing dopands" : Further improvement over Gen2

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introduction to low melting point solder alloys

Processability

- Current Low Melting Point soldering products are used in **reflow soldering, wave soldering, selective soldering, dip soldering and hand soldering**

Field of application

- modern low melting point solder alloys are used in a wide range of applications **: Railway, Automotive, Lighting, … where Tpeak does not exceed 125°C.**

processing a low melting point alloy : process temperatures

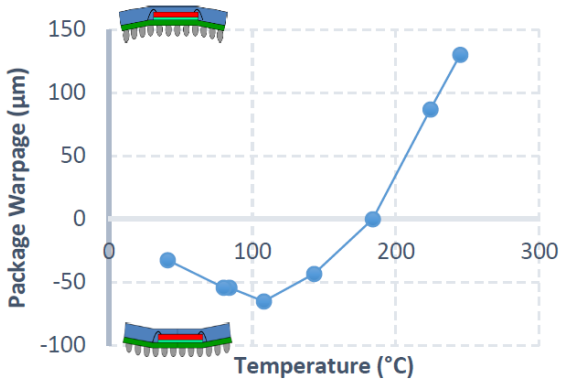
- Overview of typical temperatures used in various soldering processes

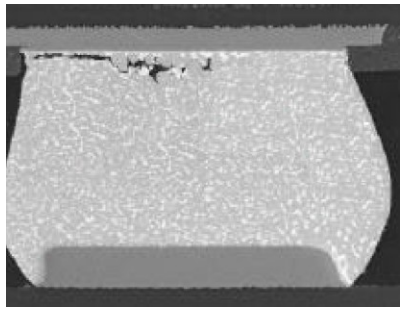
Process	T°-settings (°C) SAC Solder	T°-settings (°C) LMPA™-Q
Wave soldering	250 - 280	210-230
Selective soldering	260 - 330	230-250
Reflow soldering convection	235 – 250 (peak)	190-210 (peak)
Reflow soldering vapour phase	230	200
Hand soldering	320 - 400	300-350

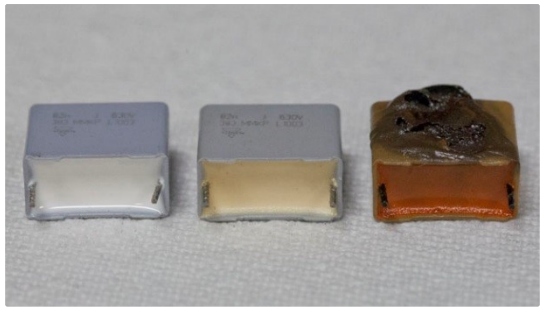
component damage

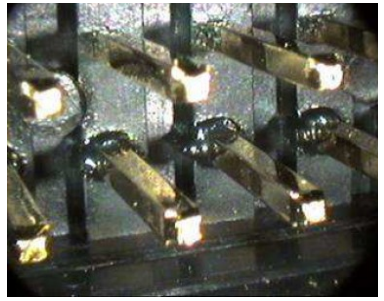
Lower process temperatures lead to lower thermal and thermo-mechanical stress on temperature sensitive components

- Warping of BGA, LGA, QFN,… components
- Elco's, capacitors, LED's…
- Plastic body components
- Soldering defects : Hot-tear, HiP,…









- **Lower process temperatures lead to lower defect rate and lower energy consumption**

low melting point alloy : BGA component study

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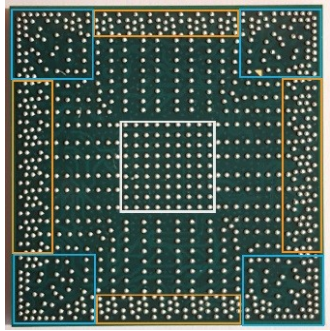
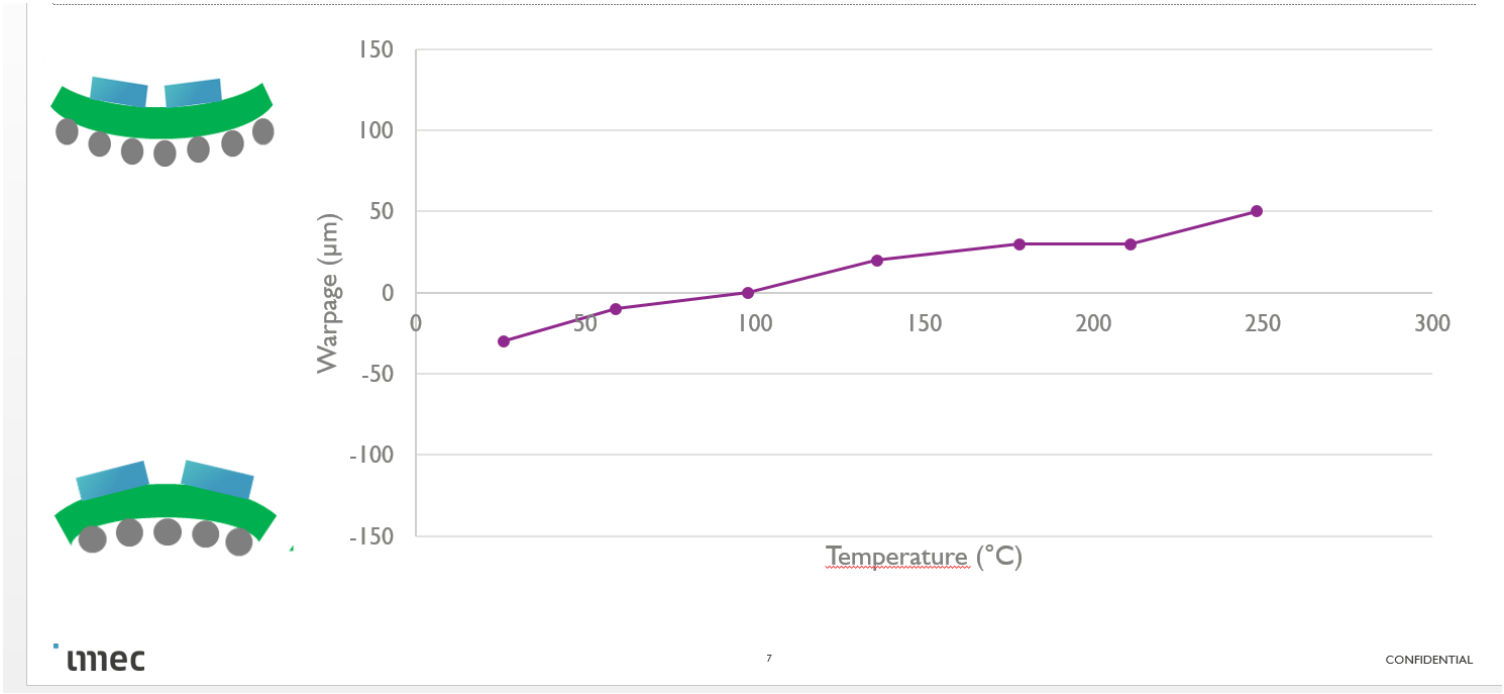
- **Component warping and hot-tear analysis**
  - Advanced PC processor
  - FCBGA with 885 solder ball connections (SAC305)
  - Ball size : Ø 0,305mm
  - Size : 24x23mm
  - Sensitive to T >200°C
    - Warping
    - Hot tear defects / HiP defects



component warping

- **Component warping analysis**
  - 25° → 250°C
  - Concave at low temperature
  - Convex at high temperature



Hot tear / HiP defect

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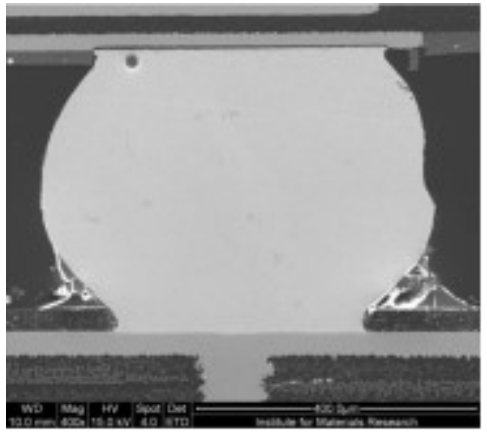
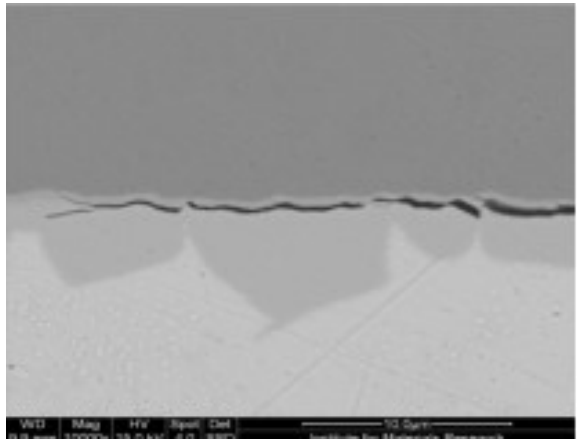
Hot tear defect

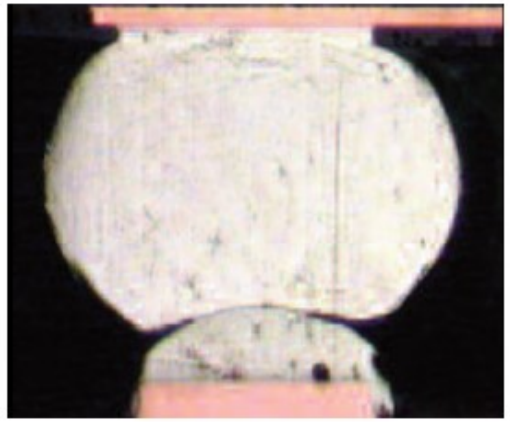
- Crack formation after soldering process
- Bulk solder / solder-PCB interface / solder-component interface
- **Cause**
  - CTE differences
  - Component /PCB warping
  - Solder alloy schrinkage
  - Reflow temperature

HiP defect

- No metallic connection
- **Cause**
  - Warping
  - Flux exhaustion
  - Reflow temperature







Hot tear / HiP defect

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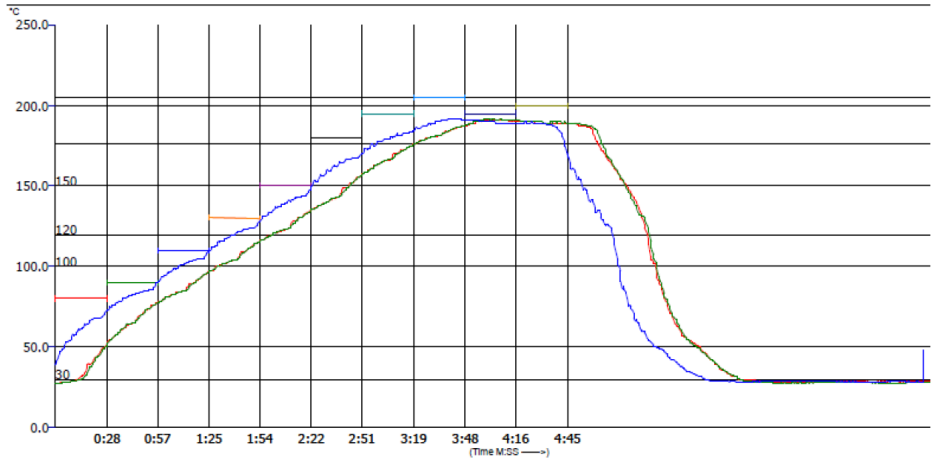
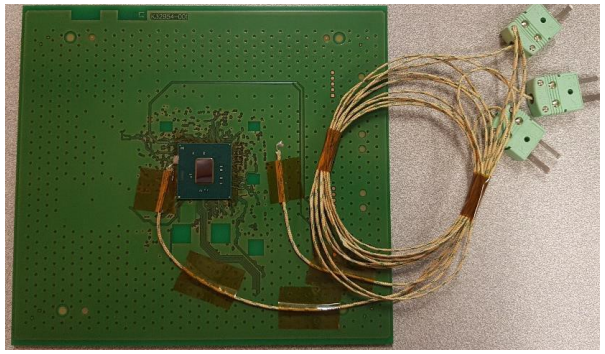
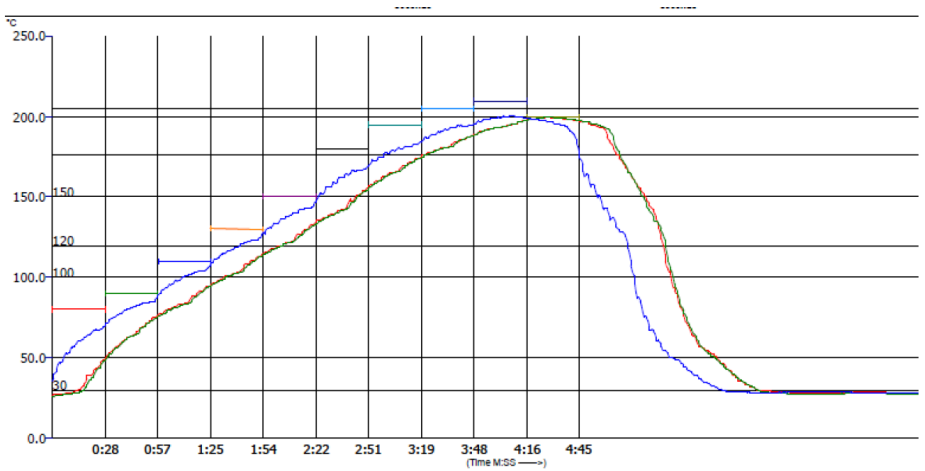
- **Soldering on FR4 OSP-Cu PCB substrate**
  - Different soldering reflow profiles

190°C "Long Peak" Profile

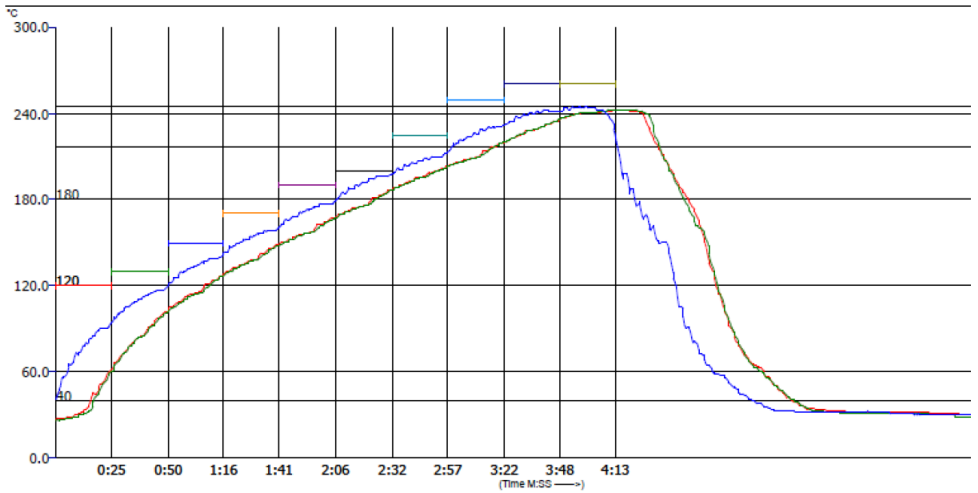




200°C Peak Linear Profile



Lead-Free Linear Profile



Hot tear /HiP defect analysis

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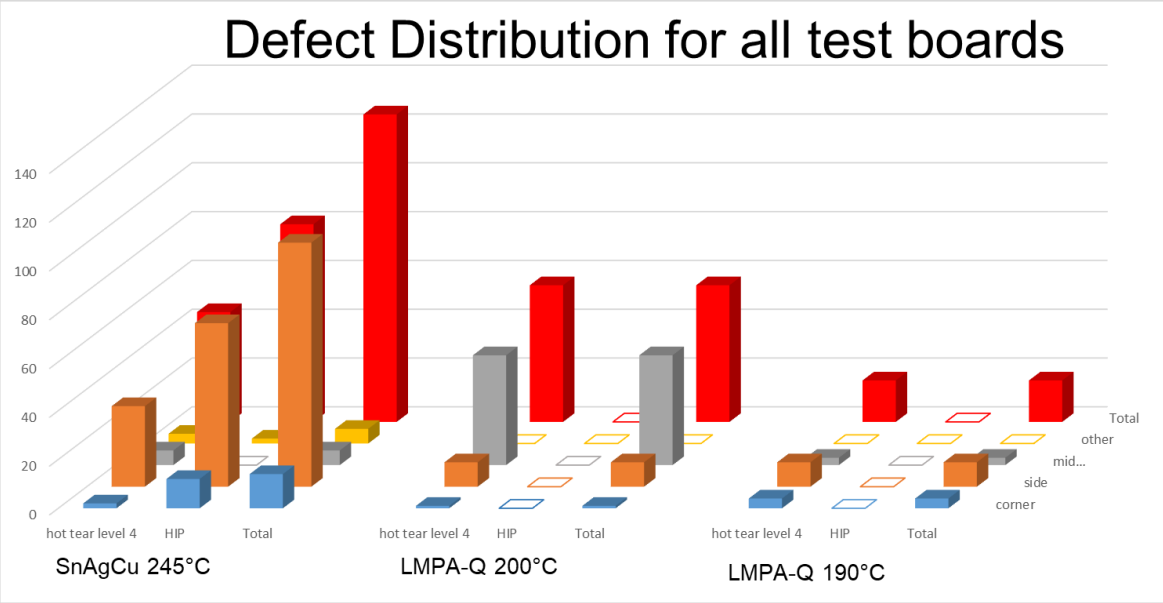
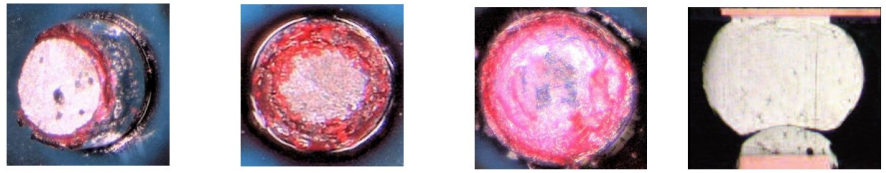
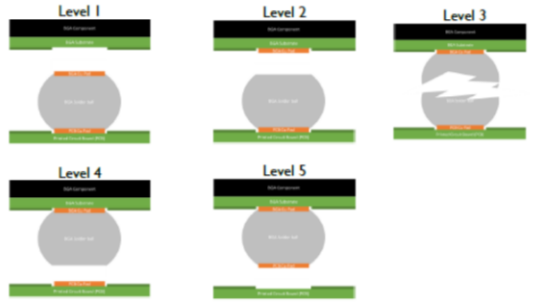
- Dye-and-pry analysis results





OK | Hot tear | HiP/ HoP



Fracture level 1: The Cu pad of the component is pulled out of the BGA substrate.

Fracture level 2: Fracture at the component pad to BGA ball interface.

Fracture level 3: Facture in the bulk solder of the BGA ball.

Fracture level 4: Fracture at the BGA ball to PCB pad interface.

Fracture level 5: The Cu pad of the PCB is pulled out of the PCB laminate.

- Mainly hot tear “level 4” defects, and head-in pillow defects.
- Lowest failure rate obtained with LMPA™-Q, soldered at 190°C

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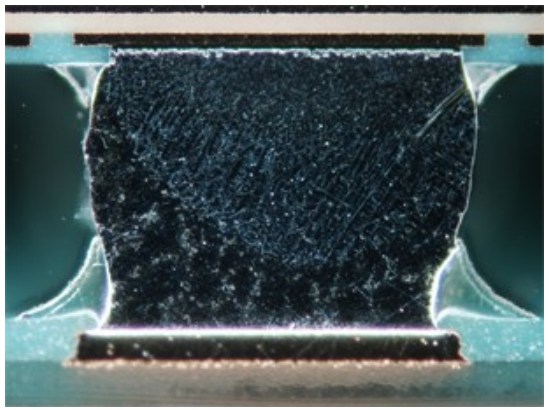
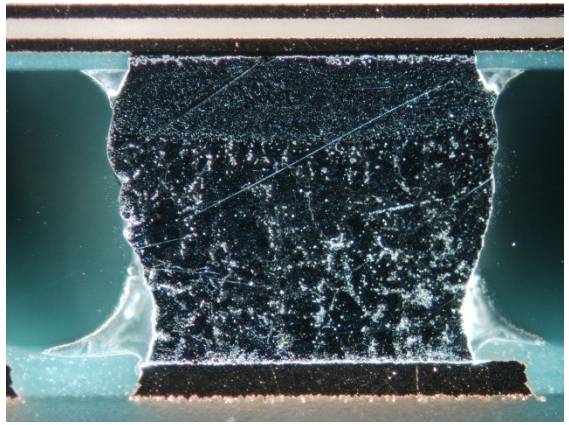
BGA cross section

Compatibility between Low Melting Point Solder (LMPA™-Q) and SAC BGA

- Low Melting Point solder makes a hybrid joint with SAC BGA
- Very low voiding
- Good mechanical strength



Hybrid joint – 190°C



Hybrid joint – 200°C

drop shock test

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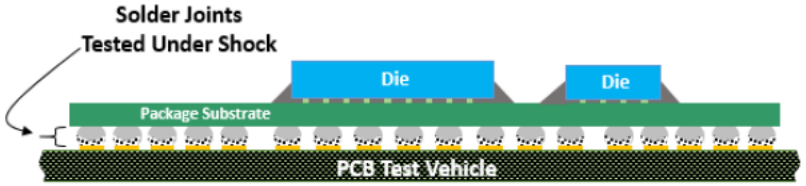
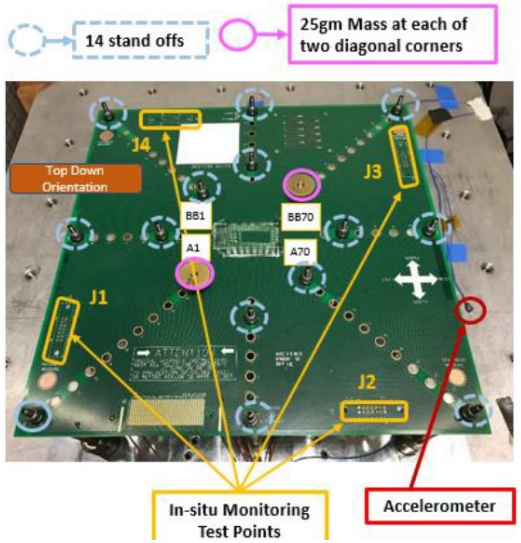
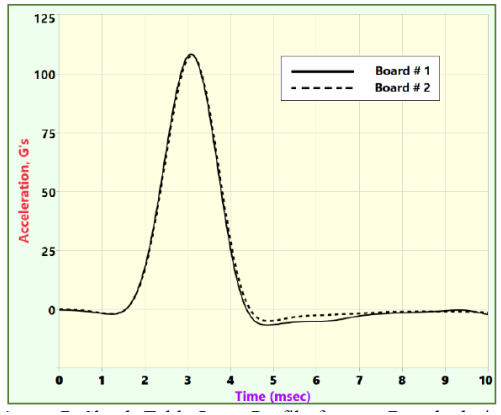
Drop shock test information

- PC Processor
- FCBGA component , size : 42mm x 28mm
- 1515 solder balls, SAC1205+Ni
- 100G – +-3ms
- Extra 25gm mass at diagonal corners
- In-Situ monitoring
- SAC + SnBi-based alloys





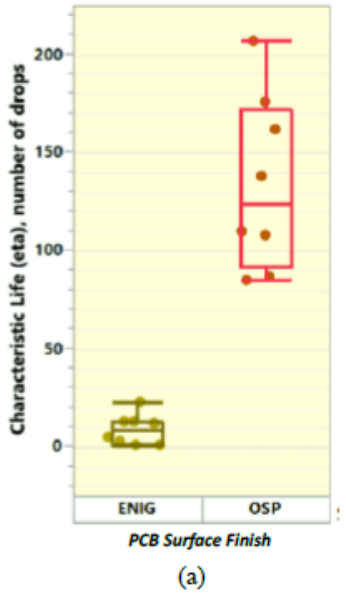


Images and data courtesy of iNEMI

drop shock test

Drop shock results with hybrid solder joints

- Typically lower drop shock resistance compared to SAC
- OSP-Cu PCB finish yields better results



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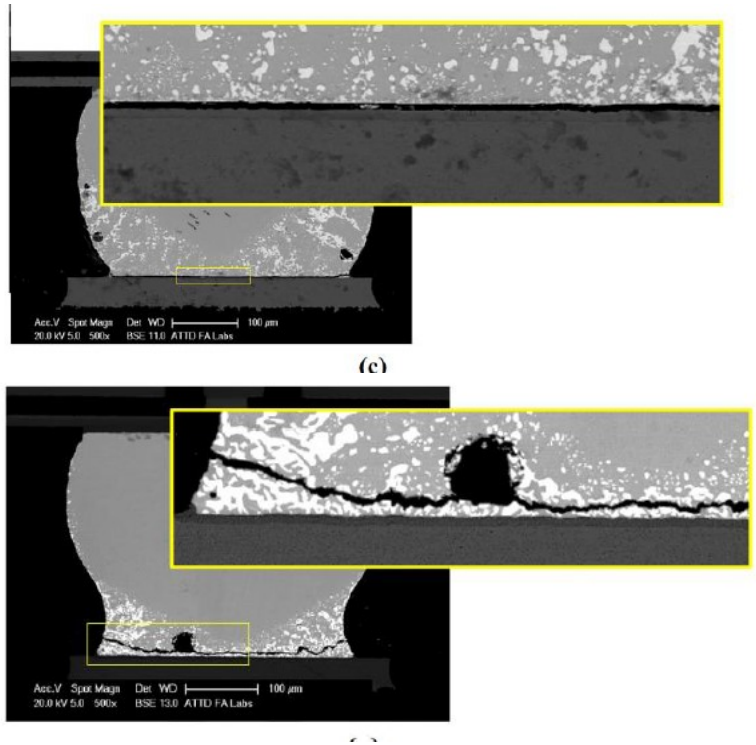

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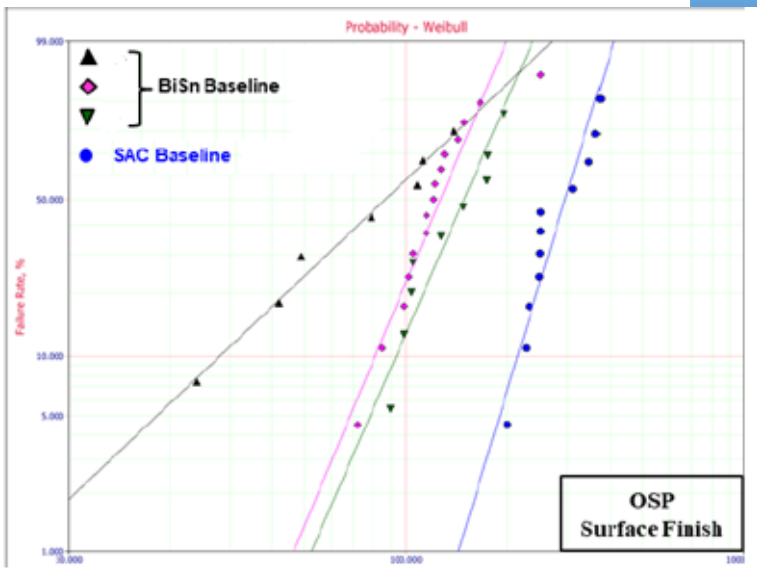
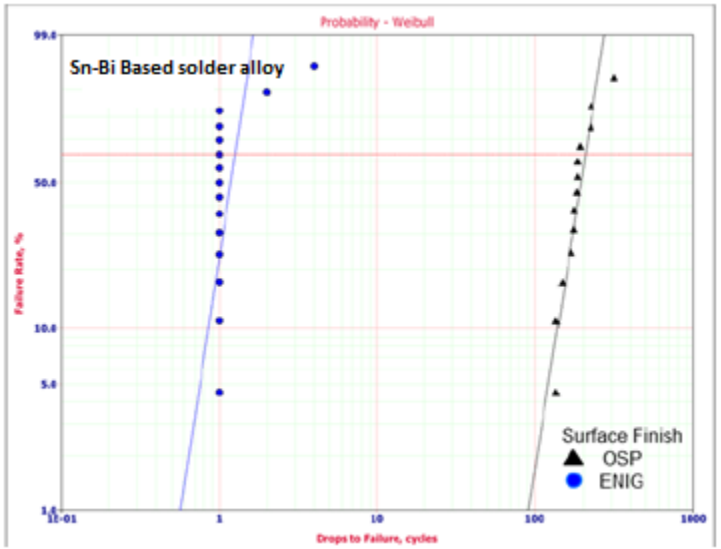
Images and data courtesy of iNEMI





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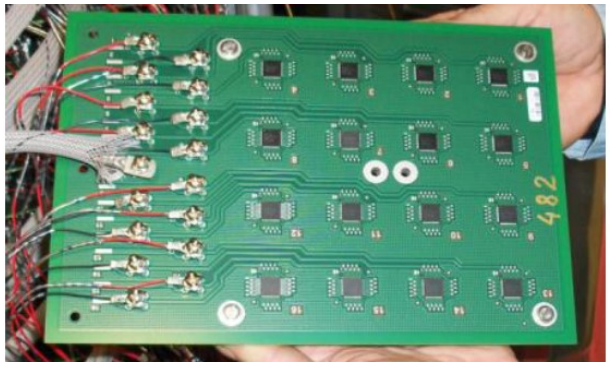
thermal cycling

- Thermal cycling test conducted on Interflux LMPA™-Q Low Melting Point solder alloy and SAC(X) solders

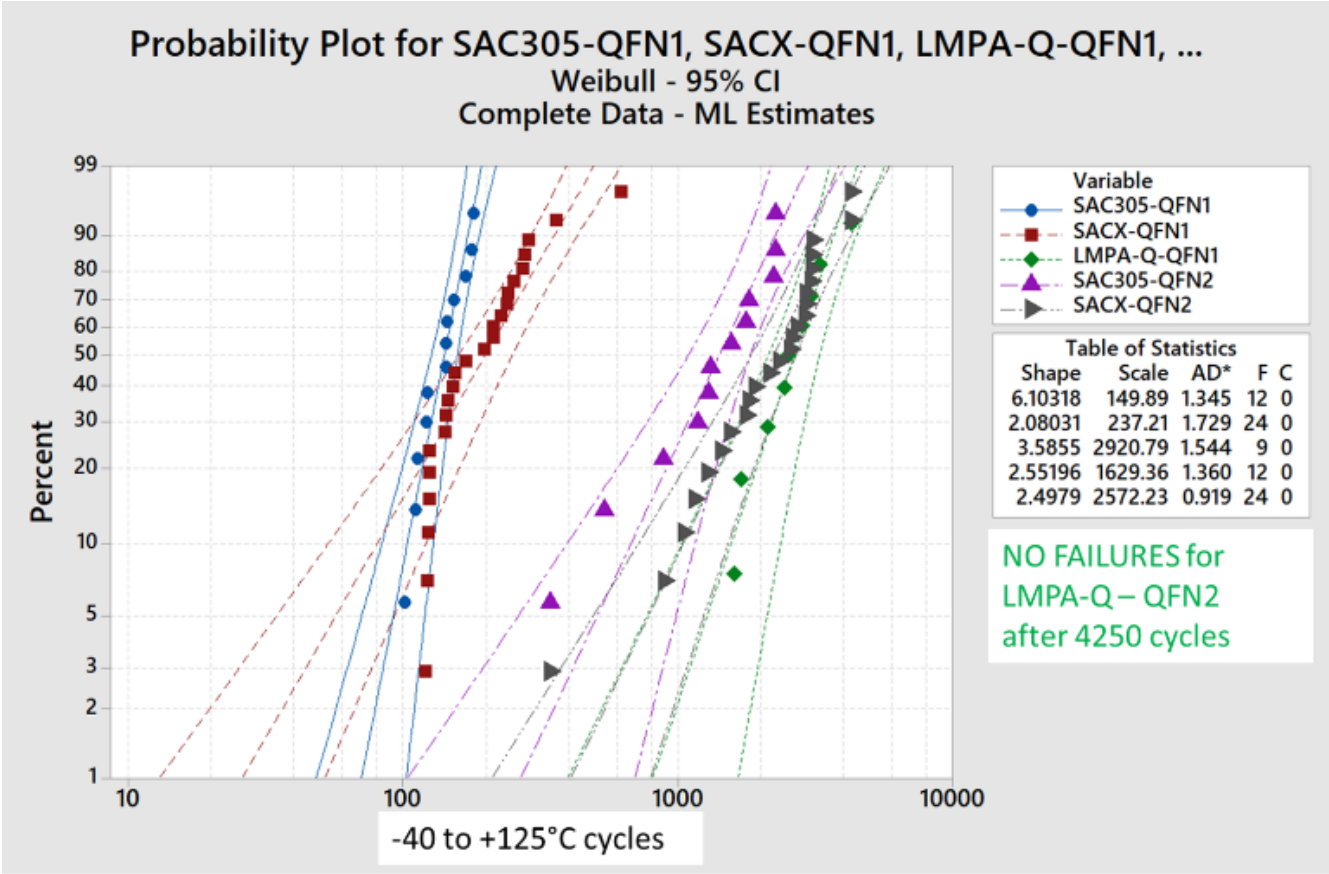


Images and data courtesy of REVUP project

Components: • QFN1: 9x9mm size, mold CTE = 7 ppm/°C • QFN2: 9x9mm size, mold CTE = 15 ppm/°C
PCB: 1.6 mm thick 6-layer board
Solder paste: • SAC305: 3% Ag, 0.5% Cu • SACX: 0.3% Ag, 0.7% Cu • LMPA-Q: SnBi based
Test condition: • Thermal cycling: -40 to +125°C air-to-air • ramp rate of 10°C/minute, dwell time of 10 minutes • Test stopped after 4250 cycles

thermal cycling

- A significant increase of solder joint lifetime was obtained with the Low Melting Point solder alloy LMPA™-Q when compared to SAC(X) solder on QFN components



Images and data courtesy of REVUP project

thermal cycling

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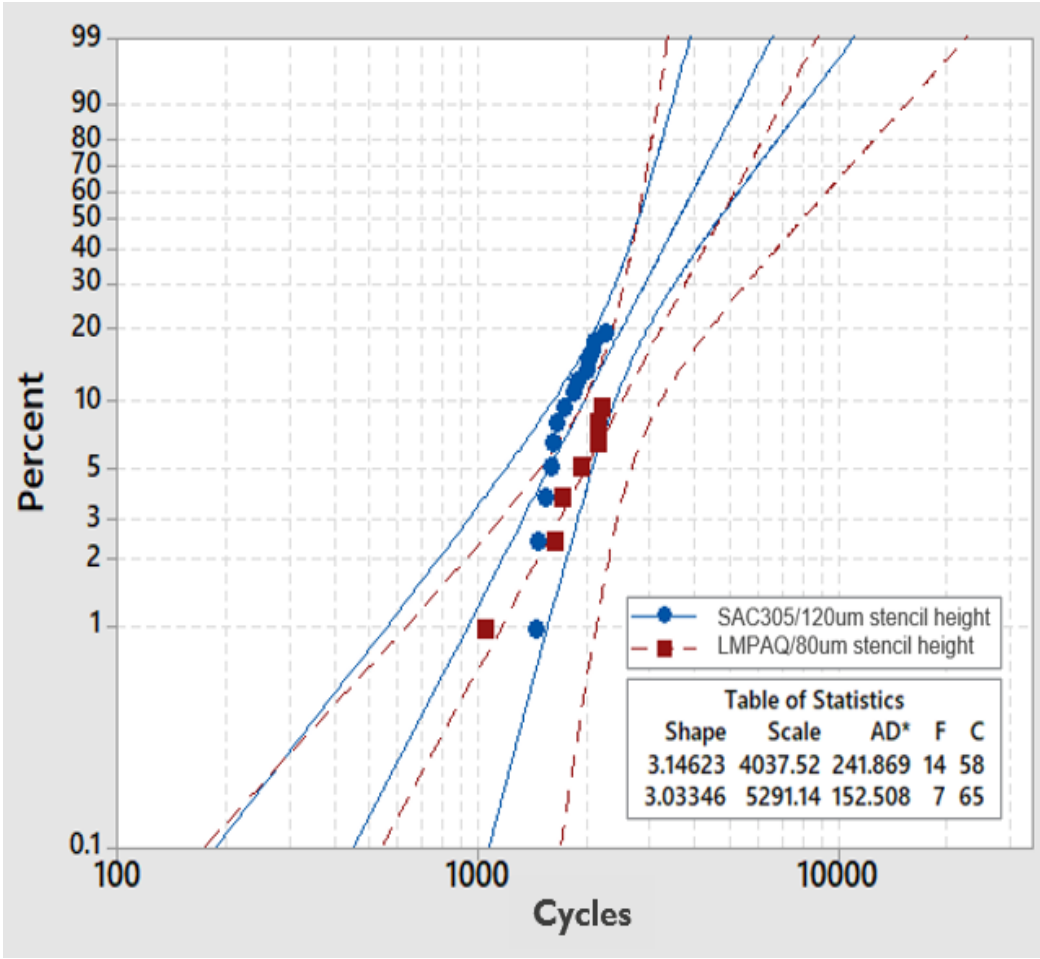
Components: • 2512 resistor
PCB: 1.6 mm thick
Solder paste: • SAC305: 3% Ag, 0.5% Cu • LMPA™-Q: SnBi based • Stencil thickness 120µm for SAC and LMPA™-Q • Stencil thickness 80µm for LMPA™-Q
Test condition: • Thermal cycling: 0°C to 100°C air-to-air • ramp rate of 10°C/minute, dwell time of 10 minutes • Test stopped after 2800 cycles

LMPA™-Q outperforms SAC305, even with lower solder deposit.
No failures were detected with LMPA™-Q with 120µm stencil thickness



Images and data courtesy of IMEC

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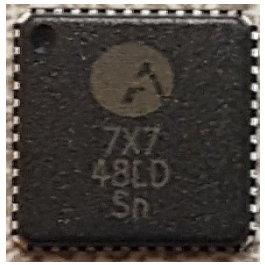
void formation

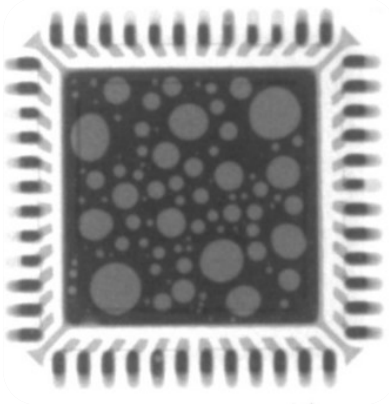
Void formation test

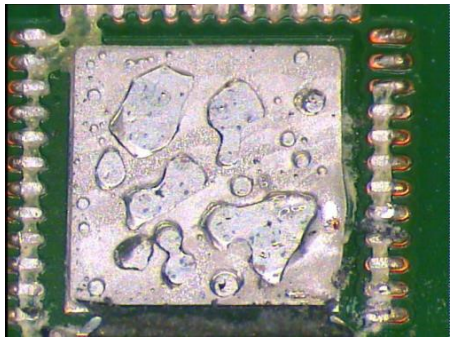
- QFN component , size : 7mm x 7mm
- Sn-finished
- 100% paste print (no reduction)
  - SAC305
  - Sn42Bi57Ag1
  - LMPA™-Q
- Fr4 substrate with OSP-Cu and ENIG finish
- X-Ray analysis



Void formation

- Outgassing of flux medium
- Mitigation
  - reflow profile
  - PCB finish
  - solder alloy
  - stencil design
  - Process
    - vacuum / overpressure





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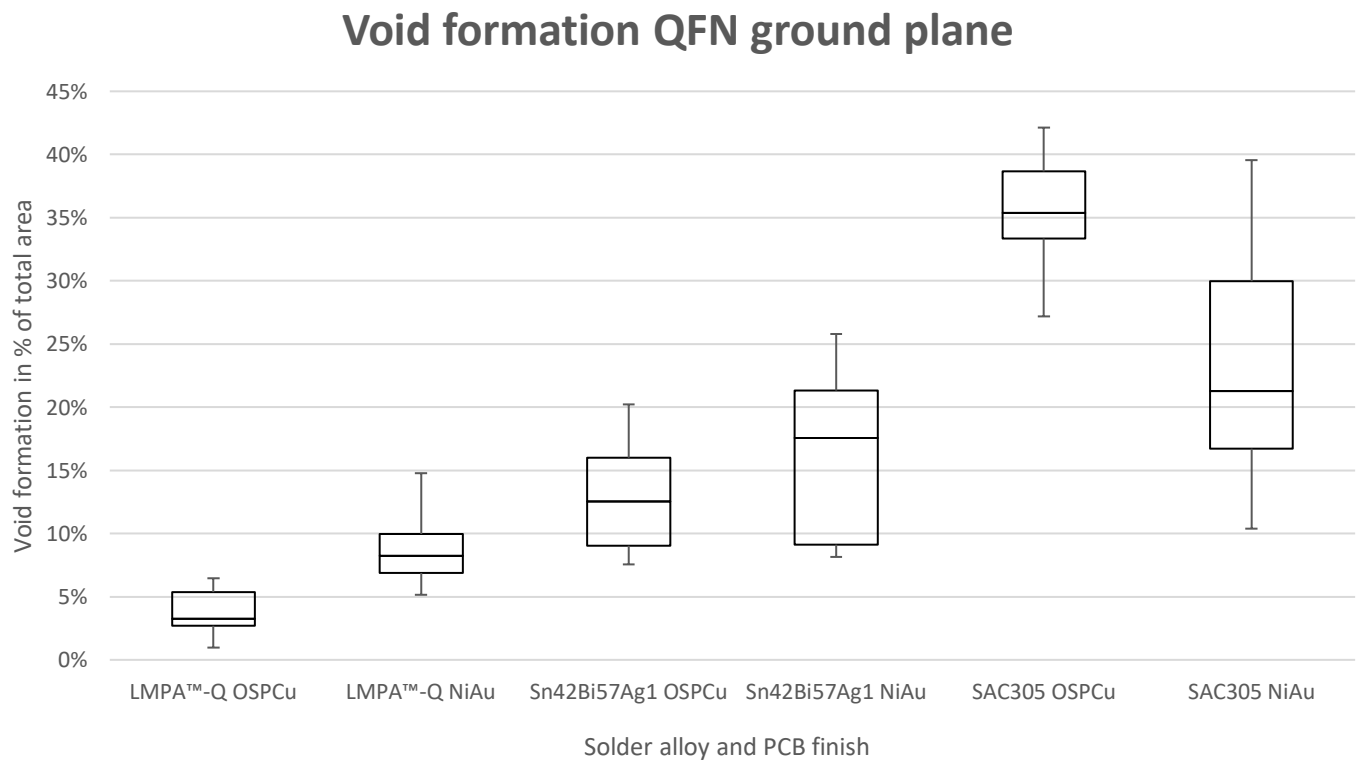
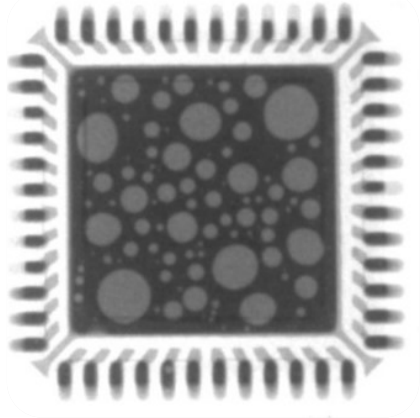
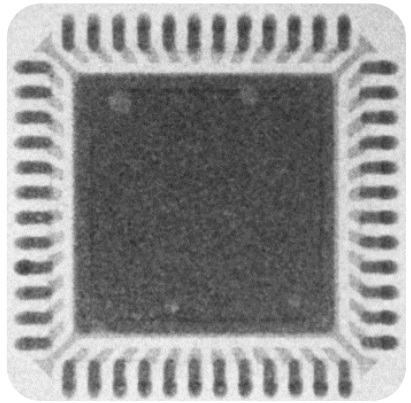
void formation

- **Lower level of voids for LMPA™-Q and Sn42Bi57Ag1 in comparison to SAC305**





SAC305 void formation



LMPA™-Q void formation

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Thank you!

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