FIFTEENTH ANNUAL BiTS 2014
Burn-in & Test Strategies Workshop

Session 3

Tuesday 3/11/14 8:00am

SHOW THEM WHAT WE'RE MADE OF

Microelectronics continually tests the limits and ingenuity of test and burn-in strategies. So, more and more, the onus falls on materials solutions for sockets. This session kicks off with an examination of available socket materials to foster a better understanding of their relative merits for various applications, plus there's a sneak preview of coming material trends. The continuing trend of tighter pitches, higher temperatures and higher density contacts places heavy demands on test probes and equipment, particularly the materials used to manufacture them. As these materials continuously evolve, finite element modeling can help designers demonstrate the effects of material properties and performance as you'll learn in the second paper. The third presentation focuses on high temperature burn-in for automotive applications, emphasizing advancements in contact pin plating and surface finishing technologies to address the thermal challenges being faced. Wrapping up this session is a case study comparing three types of palladium alloys for spring pin contactors to determine what the best material is for test.

The Stuff We're Made Of
An Examination of the State of the Art in Socket Materials
Jon Diller—Smiths Connectors | IDI

Rising to the Challenge: Material Evolution to Enable Reliable Performance at Tighter Pitches and Higher Temperature
Mike Gedeon—Materion

This Paper

180 Deg. C BGA Burn-in, Is It Doable?
Kenji Ichihara, Masaru Sato, Noriyuki Matsuoka—Yamaichi Electronics Co., Ltd.
Jec Sangalang—Yamaichi Electronics USA

Palladium Alloy Hardening and Wear Away Characteristics
Takuto Yoshida, Craig Hudson—Test Tooling Solutions Group

180 Deg. C BGA Burn-in, Is It Doable?

Kenji Ichihara, Masaru Sato, Noriyuki Matsuoka
Yamaichi Electronics Co., Ltd.
Jec Sangalang – Yamaichi Electronics USA

2014 BiTS Workshop
March 9 - 12, 2014

Contents

Background & Previous BiTS Work
Discuss present socket data at 150 Deg. C
Examination of Multiple Plating option at 180 Deg. C
Examination of Increase in Contact Force at 180 Deg. C
Examination of New Plating at 180 Deg. C and 200 Deg. C
Examination of New Plating at 200 Deg. C with QFP device
Summary
Conclusions
Next Steps

Background

We've heard customer's demand to raise burn-in temperature several times over the last 30 years

To shorten burn-in time and reduce cost

The push to raise burn-in temperature is being heard from customers, once again

For Higher Reliability, especially for automotive

Not only QFP, but also BGA

Previous BiTS Work

High Temperature Burn-in (Up to 200 Deg. C): Are We Ready Yet?

Noriyuki Matsuoka, Kazumi Uratsuji
Yamaichi Electronics Co., Ltd.
Jec Sangalang – Yamaichi Electronics USA
Ryota Takeuchi – NGK Insulators, Ltd.

2013 BiTS Workshop
March 3 - 6, 2013

Previous BiTS Work

Conclusions

QFP Open Top Socket with combination of Newly Developed BeCu, Edged Contact Tip and Present Mold can be used for 200°C Burn-in.

The same level of

Contact Resistance,
Contact Mechanical Life,
Contact Electrical Conductivity,
Socket Outline,
Operation Force

as 150°C Burn-in can be achieved.

3/2013 High Temperature Burn-in (Up to 200 Deg. C): Are We Ready Yet? 27

BiTS 2014 180 Deg. C BGA Burn-in, Is It Doable? 5

Previous BiTS Work

Next Steps

- More Field trials with customers.
- Try with BGA Tweezers style contact Open Top Socket.
- Try to improve mold material for better stability.

3/2013 High Temperature Burn-in (Up to 200 Deg. C): Are We Ready Yet? 28

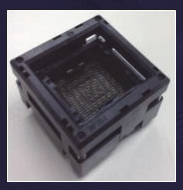
BiTS 2014 180 Deg. C BGA Burn-in, Is It Doable? 6

Evaluation Socket

- Utilize Existing BGA Open Top Socket

Key Features:

- Socket Size : 32.00mm Sq. ht=19.40mm
- Style : Open Top, PTH socket
- Pin style : Tweezers style pin
- Pitch : 0.80mm
- Pin tip design : High Edge type
- Contact Force : 12.0gf
- Pin material : BeCu
- Plating : Au



Test Method @ 150 Deg. C
(Existing Socket)

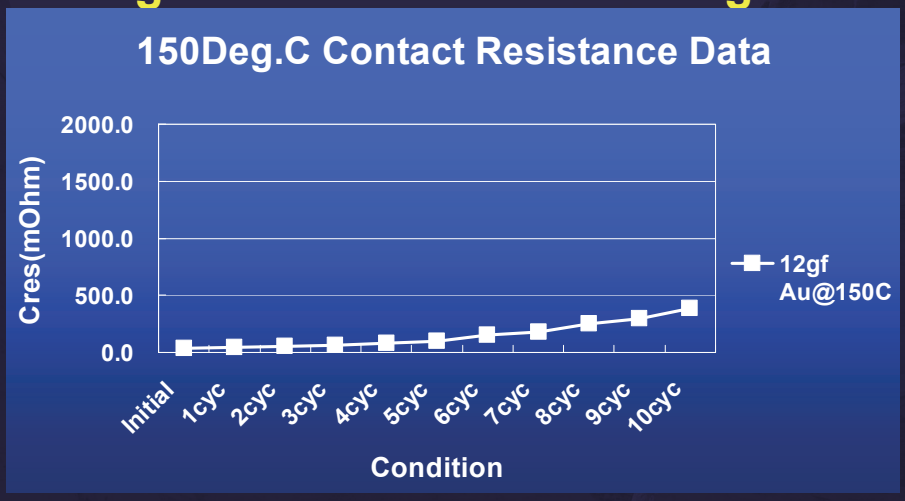
- Test Description

1. Check the contact resistance
2. Set "heat soak at 150 Deg. C for 24hrs as 1 cycle.
3. Repeat up to 10 cycles.
4. Measure Contact resistance at "initial" and every cycle.
5. Contact resistance : Resistance between 2 contacts
8. Solder Ball Composition : Sn-Ag-Cu (Pb Free)
9. Test sample : 1 Socket

Initial → 1cyc 180C24hr → Measure Cres → 2cyc 180C24hr → Measure Cres → · · ·10cyc

- Pin Force : 12.0gf
- Pin Plating : Au

150 Deg. C Evaluation on Existing Socket



Result shows the contact resistance of the current socket at 150 Deg. C

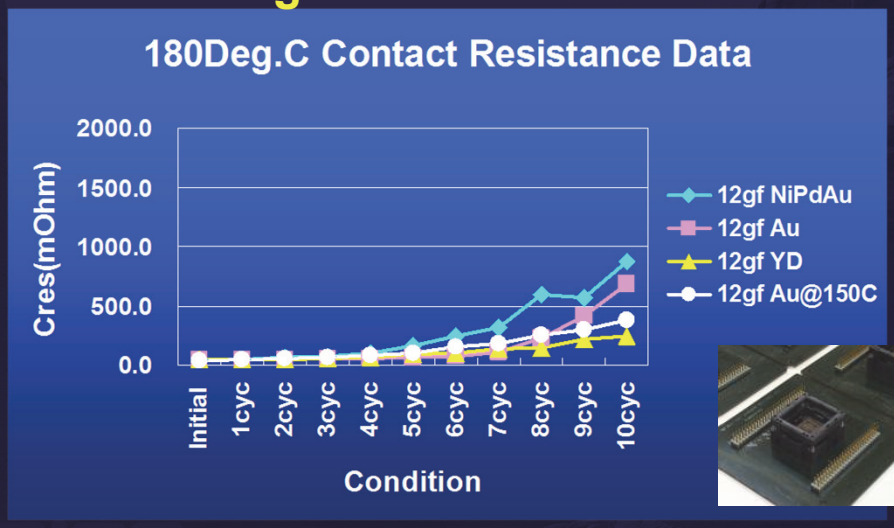
Test Method @ 180 Deg. C
(Existing Socket with Plating Option)

- **Test Description**
  1. Check the contact resistance
  2. Set "heat soak at 180 Deg. C for 24hrs as 1 cycle.
  3. Repeat up to 10 cycles.
  4. Measure Contact resistance at "initial" and every cycle.
  5. Contact resistance : resistance between 2 contacts
  8. Solder Ball Composition : Sn-Ag-Cu (Pb Free)
  9. Test sample : 1 socket per option

Initial → 1cyc 180C24hr → Measure Cres → 2cyc 180C24hr → Measure Cres · · ·10cyc

- **Pin Force : 12.0gf**
- **Pin Plating :**
  - Au Plating
  - NiPdAu Plating
  - YD Plating

180 Deg. C Evaluation Result



YD plating performed excellent at 180 Deg. C Burn-in, YD plating is a solution for 180 Deg. C environment

BiTS 2014 180 Deg. C BGA Burn-in, Is It Doable? 11

Can We Increase Force Per Unit Area !?

- Contact Design for QFP IC Lead
  - Pin tip design can be optimized to sharp edge and increase force per unit

- Contact Design for BGA
  - BGA pin tip is already optimized to have high edge design

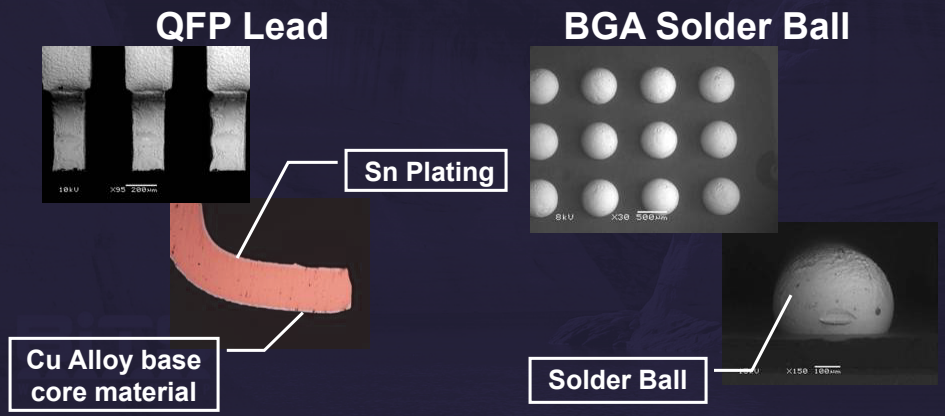
Can we increase the contact force itself ?

BiTS 2014 180 Deg. C BGA Burn-in, Is It Doable? 12

QFP vs BGA Device

- 180 Deg. C Testing on BGA Device

  - BGA Solder ball can easily deform under elevated temperature.



Test Method @180Deg.C
(Existing Socket With 15gf)

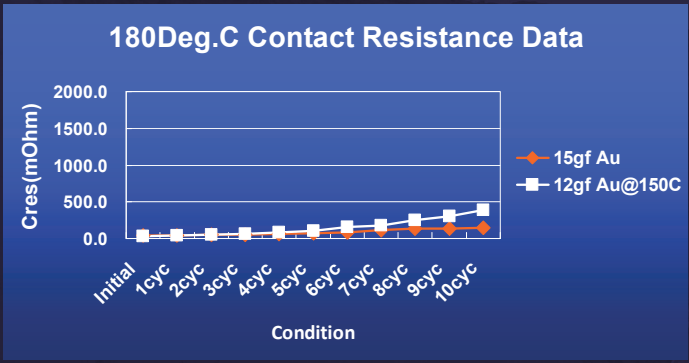
- Test Description
  1. Check the contact resistance
  2. Set "heat soak at 180 Deg. C for 24hrs as 1 cycle.
  3. Repeat up to 10 cycles.
  4. Measure Contact resistance at "initial" and every cycle.
  5. Contact resistance : resistance between 2 contacts
  8. Solder Ball Composition : Sn-Ag-Cu (Pb Free)
  9. Test sample : 1 socket

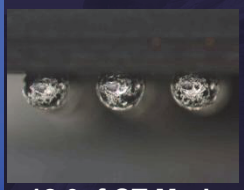
Initial → 1cyc 180C24hr → Measure Cres → 2cyc 180C24hr → Measure Cres · · ·10cyc

- Pin Force : 15.0gf
- Pin Plating : Au Plating

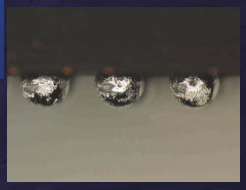
180 Deg. C Evaluation Result With 15gf Pin

- Increase contact force from 12.0gf to 15.0gf





12.0gf CT Mark



15.0gf CT Mark

15.0gf with Au plating had excellent performance at 180 Deg. C Burn-in, increased contact force is a solution for 180 Deg. C environment.

Further Research

- Increase in pin force had excellent result to stabilizing Cres at 180 Deg. C, but high pin force could result to ….
  - Increase in Contact mark
  - High stress to Contact pin element
  - High stress to Mold component
  - Increase in operation force of the socket

Can we research on New Plating capable for high temperature burn-in ?

Research for New Plating

- Expectation for New Plating
  - Minimize solder migration
  - Minimize Pin tip wear
  - Plating which will withstand up to 200 Deg. C
  - Plating which will not require increasing contact force.

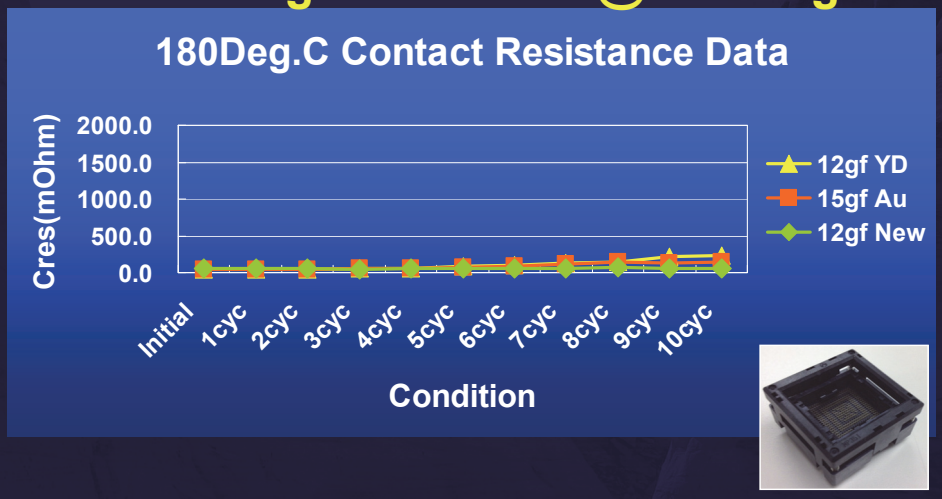
Test Method @ 180 Deg. C
(Existing Socket With New Plating)

- Test Description
  1. Check the contact resistance
  2. Set "heat soak at 180 Deg. C for 24hrs as 1 cycle.
  3. Repeat up to 10 cycles.
  4. Measure Contact resistance at "initial" and every cycle.
  5. Contact resistance : resistance between 2 contacts
  8. Solder Ball Composition : Sn-Ag-Cu (Pb Free)
  9. Test sample : 1 Socket

Initial → 1cyc 180C24hr → Measure Cres → 2cyc 180C24hr → Measure Cres ···10cyc

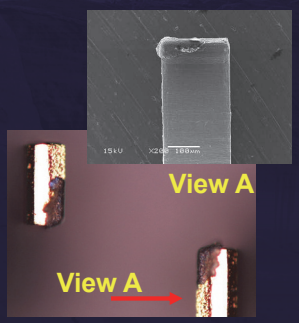
- Pin Force : 12.0gf
- Pin Plating : New Plating

New Plating Test Result @ 180 Deg. C

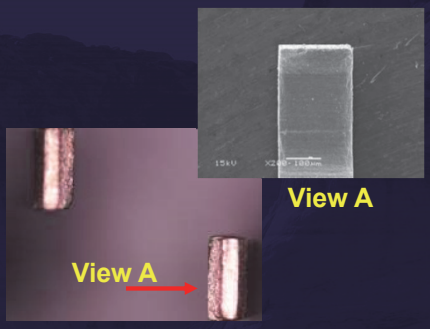


Excellent result on New plating with current 12.0gf at 180 Deg. C Burn-in

Contact Pin Tip Condition @ 180 Deg. C
(After 10 Cycles)



VS

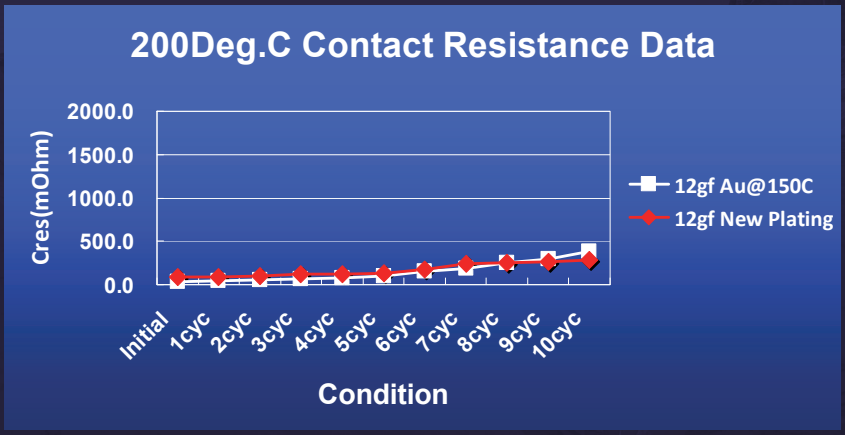


12gf Au @ 180 Deg. C

12gf New Plating @ 180 Deg. C

The new plating showed minimal wear and minimal accumulation of solder to the pin tip, which resulted to stable contact resistance throughout the test.

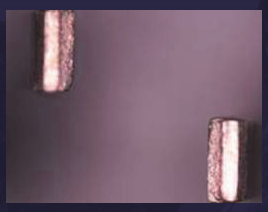
New Plating Test Result @ 200 Deg. C



Additional test performed to check the Cres at 200 Deg. C. Result showed Cres at similar level to 150 Deg. C burn-in, which means the New plating is capable up to 200 Deg. C

Contact Pin Tip Condition @ 200 Deg. C (After 10 Cycles)

12gf Au @ 180 Deg. C

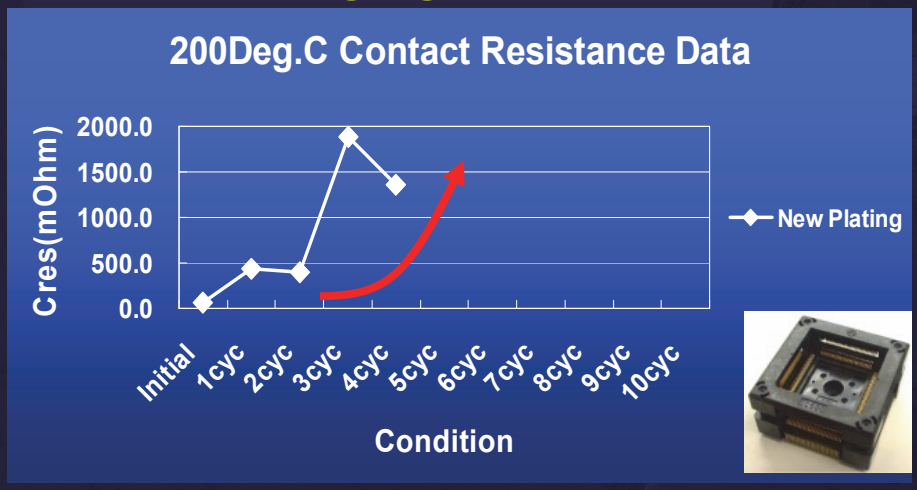


12gf New Plating @ 180 Deg. C

Pin tip condition remained healthy even at 200 Deg. C

12gf New Plating @ 200 Deg. C

New Plating Against QFP Device

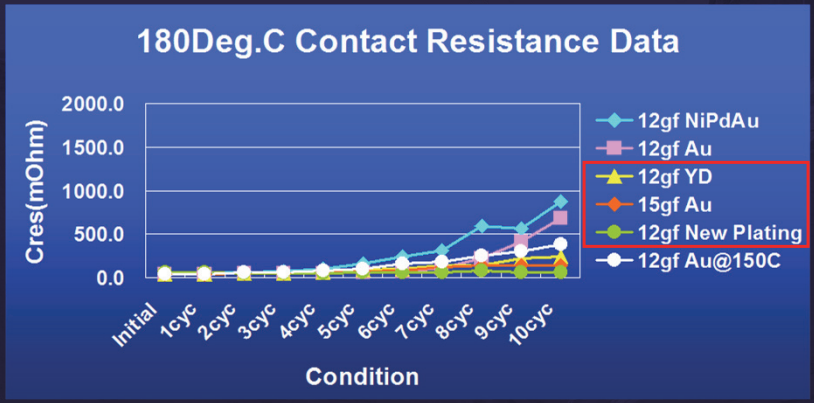


The new plating was tested with existing QFP socket but did not show the same result as the BGA socket.

Summary of New Plating

- Result to have stable Cres at 180 Deg. C against BGA Solder Ball
- Minimal Solder Migration
- Minimal pin tip wear
- Capable up to 200 Deg. C environment against BGA solder Ball
- Cres did not stabilize with QFP device, need further study.
- New Plating high possibility for 180, 200 Deg. C environment but need more study

Summary of Cres @ 180 Deg. C



What can we use for 180 Deg. C Burn-in

POR	Force	Plating		
12gf Au	15gf Au	12gf NiPdAu	12gf YD	12gf New plating
NG	OK	NG	OK	OK

Conclusion

- For the 180 Deg. C burn-in with BGA device
  - Excellent result by using YD plating at 180 Deg. C testing.
  - Excellent result with 15gf Au plating at 180 Deg. C testing

180 Deg. C Burn-in is doable ! !

- Additional test with the New plating showed capability up to 200 Deg. C with BGA device.
- But result with QFP socket did not perform as expected which will require further research.

Next Steps

- Further technical analysis on mechanism of the new plating
- For the New plating further research will be needed to check what made difference on contact resistance between BGA and QFP device.
- Can we expect a better result for YD plating with higher contact force ?
- Any opportunity for decreasing contact force.
- Check result under actual burn-in environment.
- Check with other type of Socket