

**Monday 3/10/14 10:30am**

## **A CLEAN START**

There's no doubt about it, clean contacts in contactors and sockets work a lot better than dirty ones. So what better place to start looking at burn-in and test strategies than with a close look at contamination control and cleaning processes to improve yields, test time and re-test reduction? This session begins with three hypotheses of the causes for contact contamination, Along with guidance on procedural changes for improved performance. The next presentation offers a solution to the havoc high temperature burn-in can wreak on devices under test (DUTs) with a specialized coating process to prevent solder contamination of contacts and deformation of the solder bumps on the DUT. The final two presentations examine online cleaning processes. The first focuses on a characterization tool that determines the effectiveness of online cleaning, while the second is directed at an automatic cleaning solution for a bowl fed handler used with a RF contactor. Hey, it's a dirty job, but somebody's got to do it.



This Paper

### **Contamination Mechanisms of Contact Probes**

Jon Diller, Kevin DeFord—Smiths Connectors | IDI

### **Special Coating Cleans-Up a Mess**

Paul Ruo—Aries Electronics, Inc.  
Erik Orwoll—Contact Coatings, LLC

### **Unique Methodologies for Investigating On-line Cleaning Process Parameters and Recipe Optimization**

Jerry J. Broz, Ph.D., Soheil Khavandi, Bret Humphrey—International Test Solutions

### **Yield and Test Time Improvement via Automated Online Cleaning**

Brent Edington—TriQuint

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# Contamination Mechanisms of Contact Probes

**Jon Diller, Kevin DeFord**  
**Smiths Connectors | IDI**



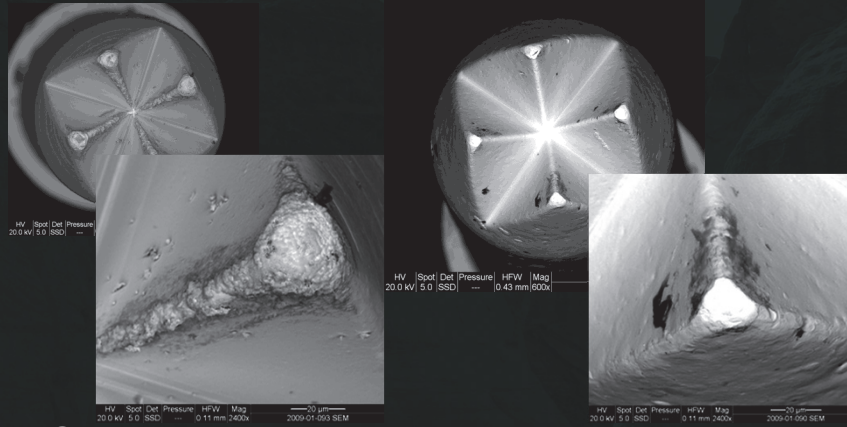
2014 BiTS Workshop  
March 9 - 12, 2014



## Content

- BGA probe contamination today
- Why 'how' matters
- Thermal interdiffusion
- Voltaic transfer
- Fretting transfer
- Further work

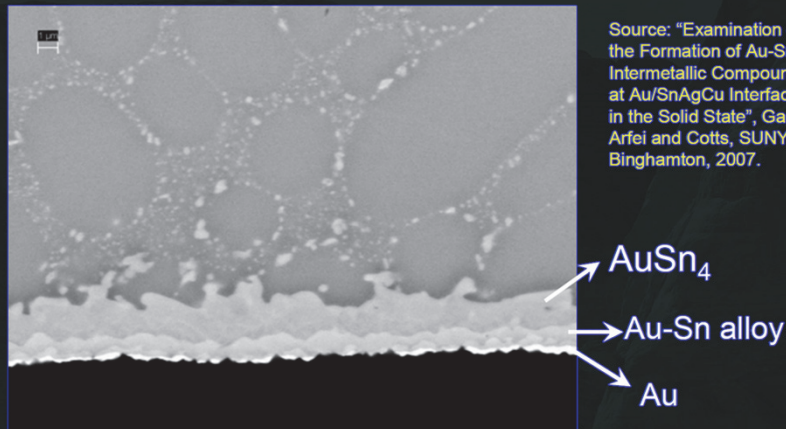
## BGA Contamination



Photos from DeFord 2009

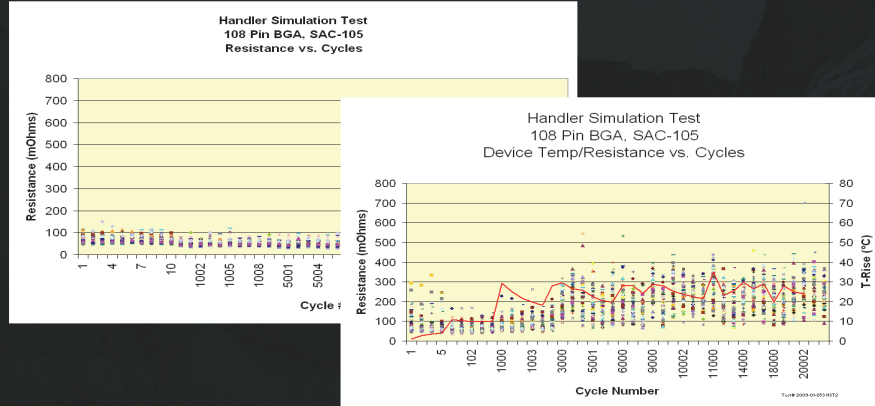
- Organic and metallic
- Externally reducible rise in CRES

## BGA Contamination



- Langston (2008) demonstrates Sn-Au intermetallic layer

## BGA Contamination



**DeFord (2009) correlated rate of contamination with current volume and density**

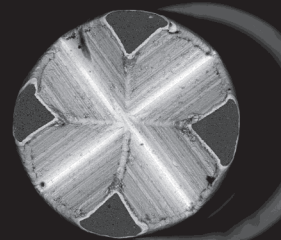
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## Why 'How' Matters

- Homogeneous probes make cleaning effective
- Cleaning is still 'bad'
- Sensitivity of devices can be predicted
- Intermediary layers may be available



HV | Spot | Mag | Sig | WD | Pressure | 50 µm  
 20.0 kV | 5.5 | 661x | BSE | 10.05 mm | --- | 2007-08-148 SEM

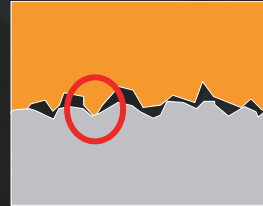
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## Interdiffusion as a Function of Temperature

“The formation of intermetallic layers arises from the inter-diffusion of materials across a bimetallic interface. In electrical contacts, this interdiffusion occurs when the electrical interface is operated in a high-temperature environment or when sufficient electric current is passed through the contact to raise the temperature of the  $\alpha$ -spot to well above the ambient temperature.”  
 -- Timsit (2013)

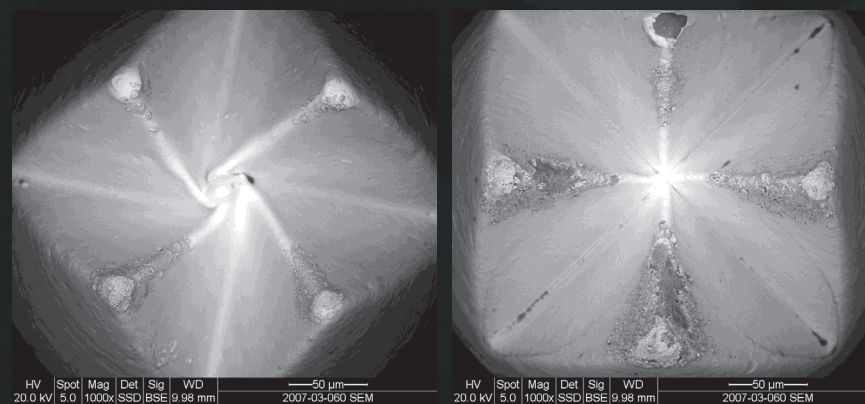


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## Interdiffusion as a Function of Temperature



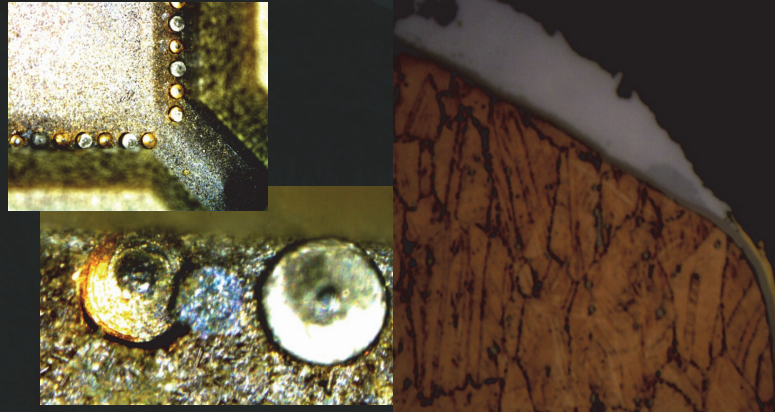
Before and after 24 hours at 125C SAC105

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## Electromigration



- DeFord (2009) demonstrates cathodic – anodic behavior in series with diffusion

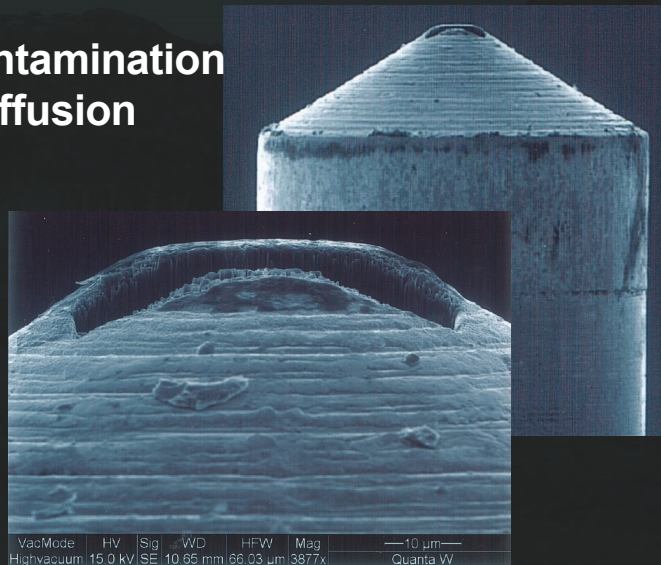
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## Fretting Transfer

- Some contamination has no diffusion

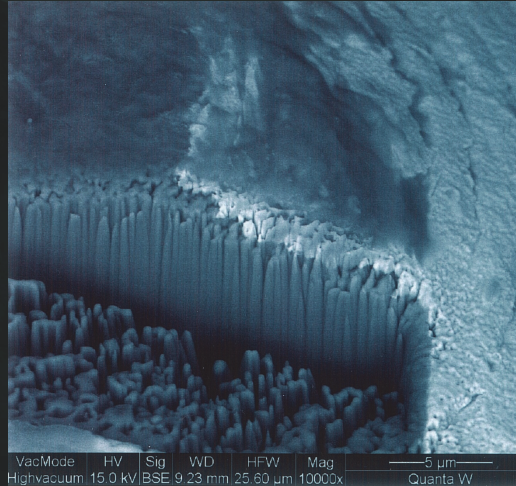
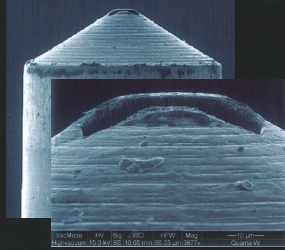


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## Fretting Transfer



- Timsit (2013) describes fretting transfer
- Lubricant affects contamination

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## Summary

Mechanism	Inter-diffusion?	Lubri-cant?	Hardness ?	Smooth-ness?	Force?
Thermal	Yes	No	Negative	Positive	Positive
Galvanic	Maybe	Maybe	Negative	Neutral	Positive
Fretting	No	Yes	Positive	Positive	Positive

- All rely on differing metals
- Suggests further evaluation of:
  - Lubricants
  - Smoothness

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## Acknowledgements

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- Kevin DeFord
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- Rick Westpfahl
- Frank Zhou

## References

- DeFord, Kevin. "Moore or Less: Effects of Higher Current on Socket Life." BiTS Workshop 2009, Hilton East Mesa, Mesa, AZ. March 2, 2009. Presentation.
- Timsit, Roland. "Fundamental Properties of Electrical Contacts." BiTS Workshop 2012, Hilton East Mesa, Mesa, AZ. March 4, 2012. Tutorial presentation.
- Timsit, Roland. "Electrical Contact Resistance: Fundamental Principles." *Electrical Contacts: Principles and Applications*. Paul Slade, ed. CRC Press, Boca Raton, Florida. 2013.
- Langston, Nick. "An Examination of the Causes of CRES Degradation Which Affect the Life of a Test Socket." BiTS Workshop 2008, Hilton East Mesa, Mesa, AZ. March 11, 2008.