SAND2007-3591P

Brazing Optimization of Mechanically-Applied Active Braze Filler Metal Paste

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8th International Conference

Brazing, High Temperature Brazing and Diffusion Bonding

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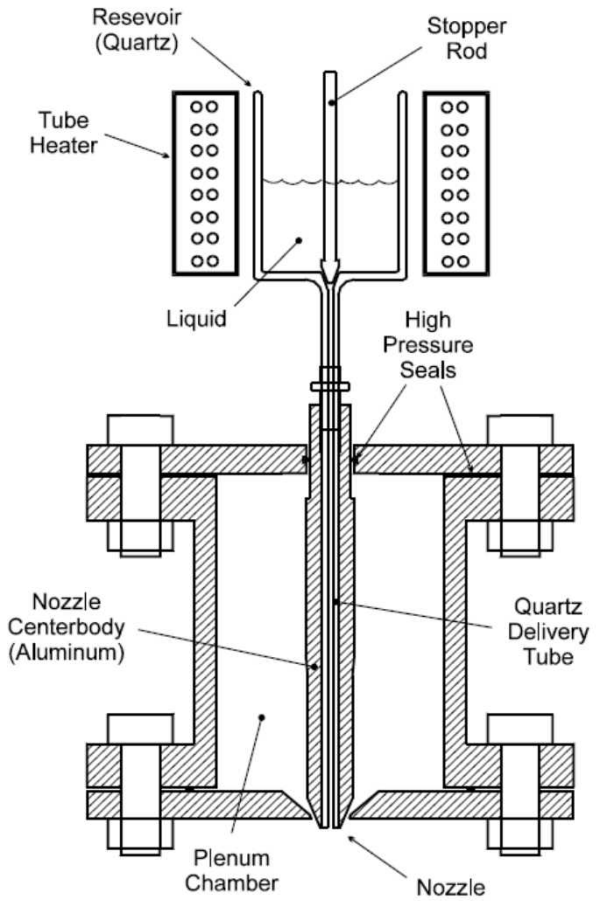
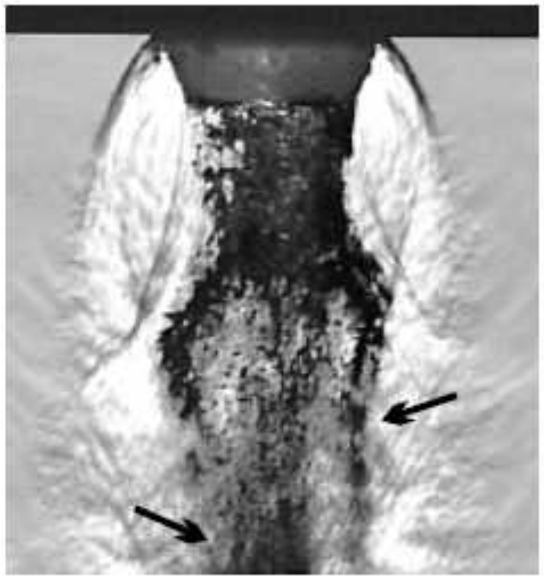
Metal Atomization[1,2]





Powder is produced by the violent disruption of a stream of molten metal with a coaxial, co-directional supersonic gas flow.

1. *HIGH-SPEED IMAGING OF LIQUID METAL ATOMIZATION BY TWO DIFFERENT CLOSE-COUPLED NOZZLES*
S. Mates and G. Settles, The Pennsylvania State University
2. *THE PRODUCTION OF METAL POWDERS BY ATOMIZATON*
John Keith Beddow, The University of Iowa

Braze Paste Shipment & Packaging

Braze Paste Analysis

July 28, 2006

Sample : 97AG-1C-2ZR
Lot No. : MM46001

Department : 211 Lab ID No. : G127
Date Received :July 18, 2006

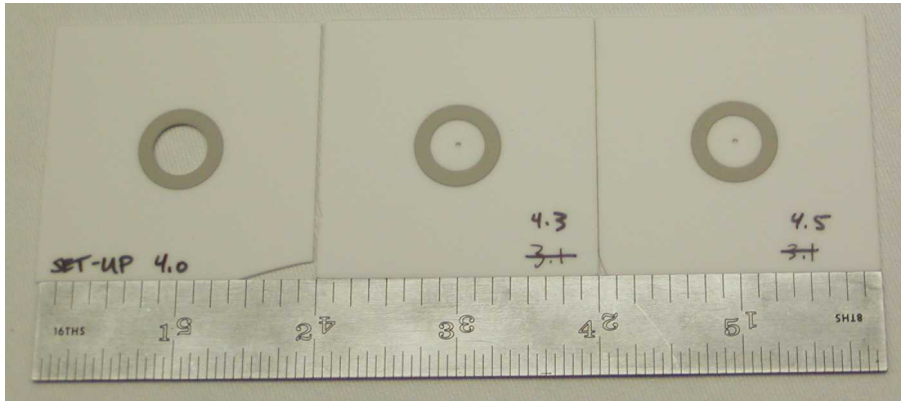
COMPOSITION:

AG:	*	CD:	<.0001	PB:	<.002	ZN:	<.0001
B :	.0002	CO:	.0006	CR:	.0007	CU:	0.99
IN:	.008	FE:	.002	SI:	.001	SN:	.005
TI:	.0002	ZR:	2.31	Y :	.003	P :	<.001
C :	0.0090	N :	0.0000	O :	0.0000	T.Imp.	=0.0229

Material passed thru a -325 mesh, resulting in 44 microns [.0017] max particle size.

Initial Screen-printing Results

- Paste printed in desired pattern with thicknesses of .0040 to .0045
- *Carrier material identified as Propylene Glycol*



- Adhered paste capable of assembly handling operations
- *Binder identified as a polymer (ex. EVA, PVA)*

Paste Printing

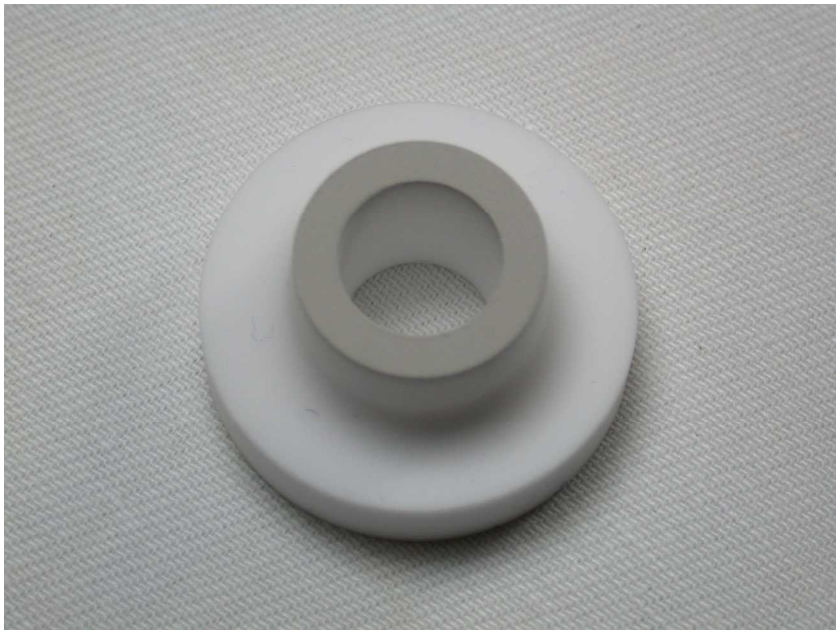
Equipment used

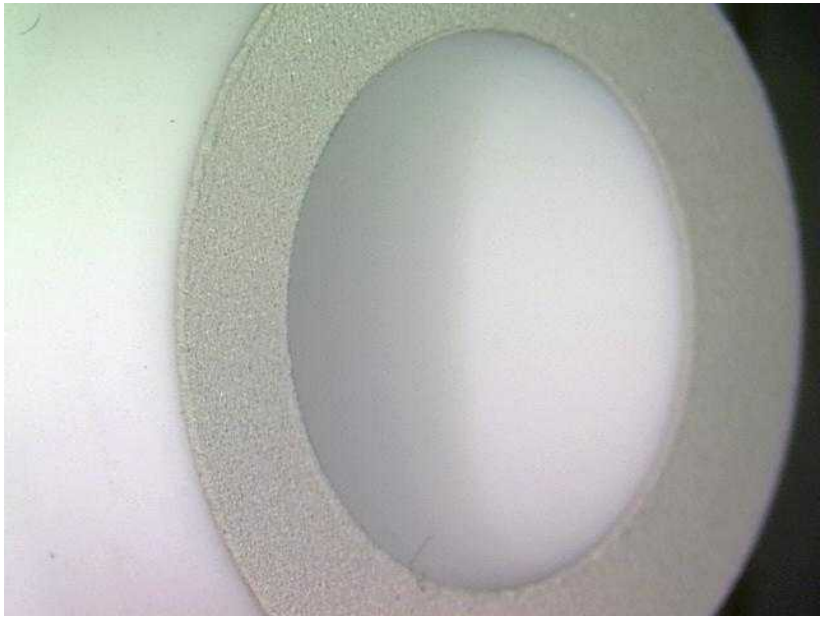
- AMI Screen Printer – adjustable print pressure
- Laser Profilometer
- Masks were made from 325 mesh material.

Details

- 40% reduction in thickness during 1 hour drying.
- Paste used as delivered, no thinning or treatment
- Extra material collected for re-use

Tensile Buttons



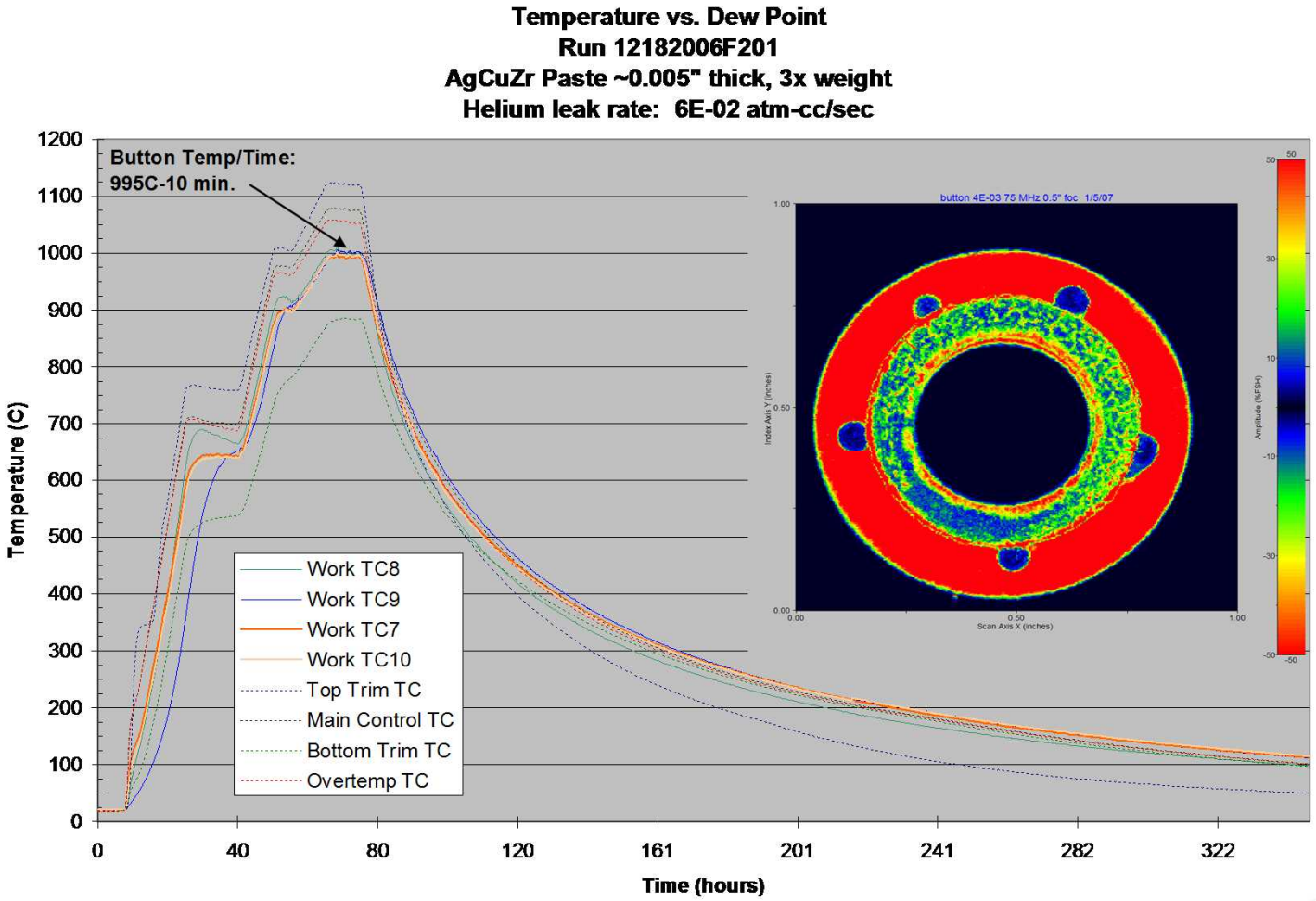


Standard and Half Tensile Button Samples

ASTM F-19 Tensile Buttons were fabricated to measure the leak rate and brazement tensile strength.

Half Tensile Button assemblies were used for ultrasonic inspection test samples.

Trial 2



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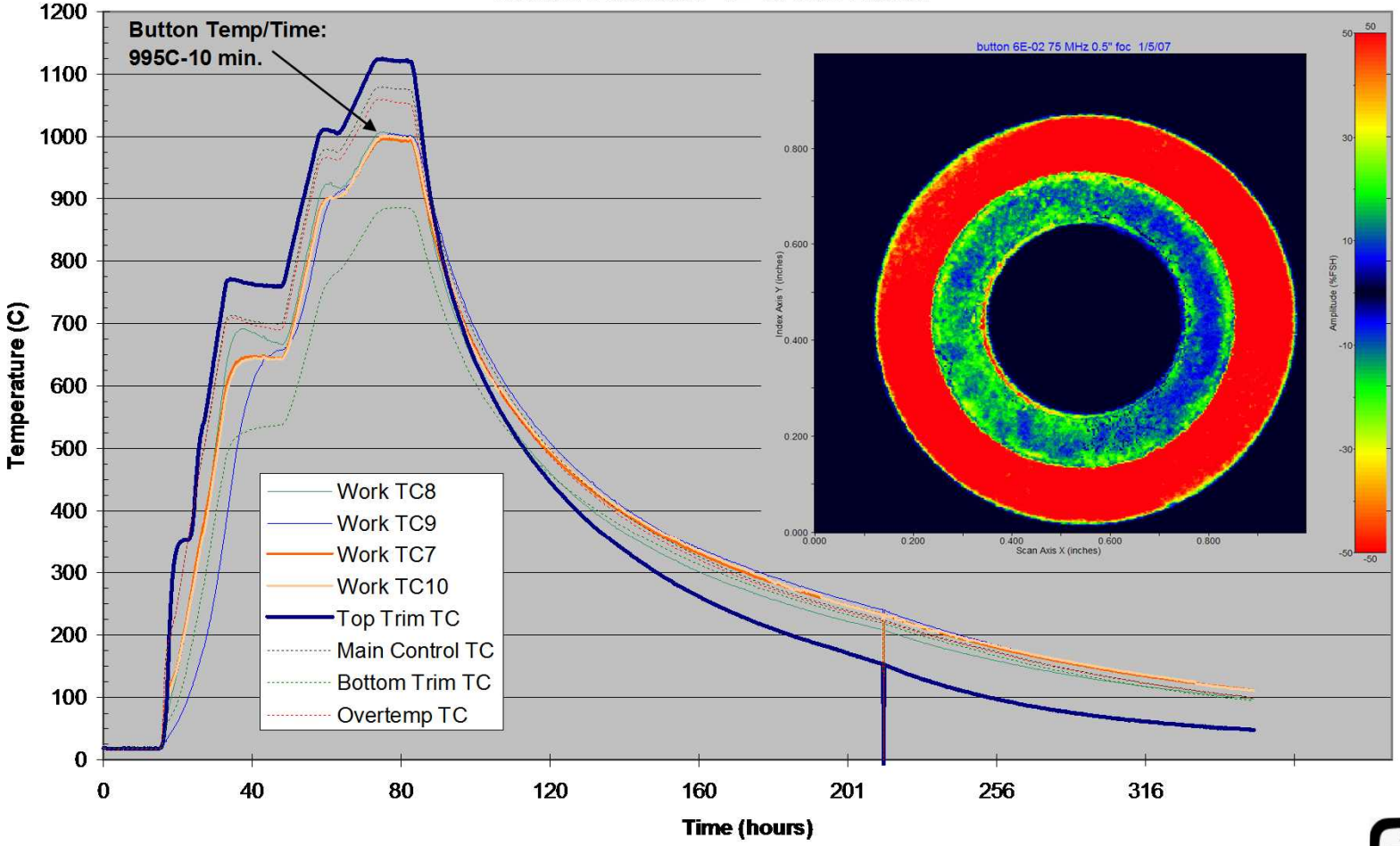
Trial 3

Temperature vs. Dew Point
Run 12192006F201
AgCuZr Paste ~0.005" thick, 1x weight
Helium leak rate: 4E-03 atm-cc/sec



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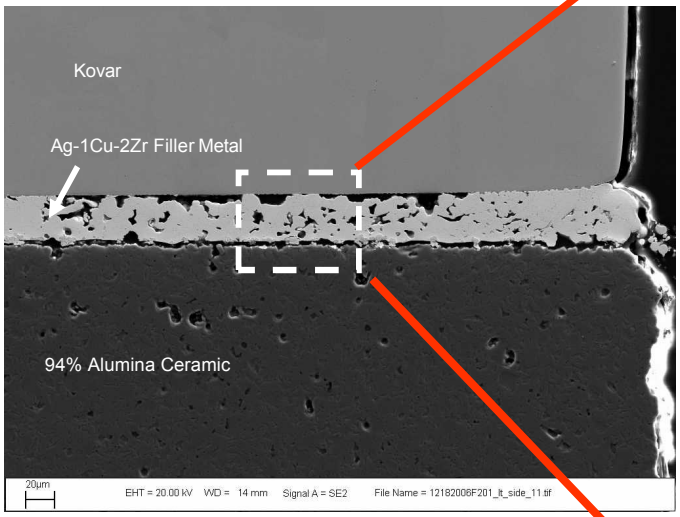
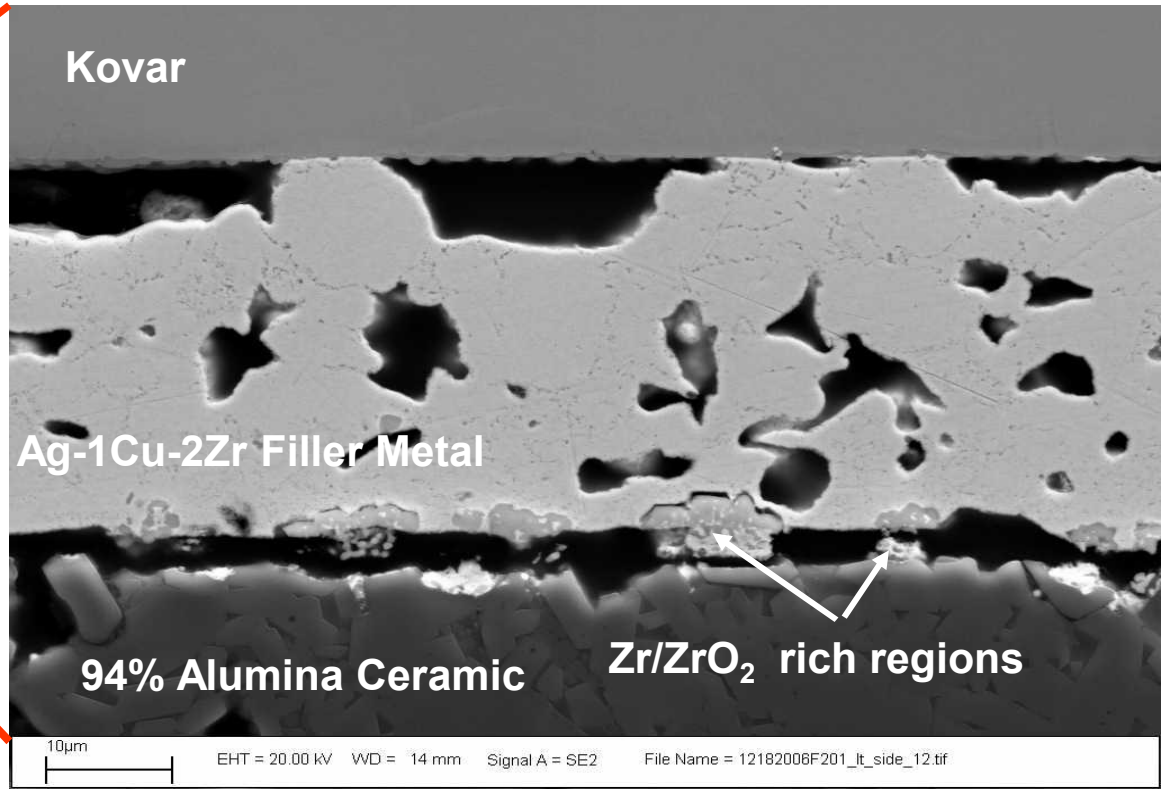
Joint Porosity





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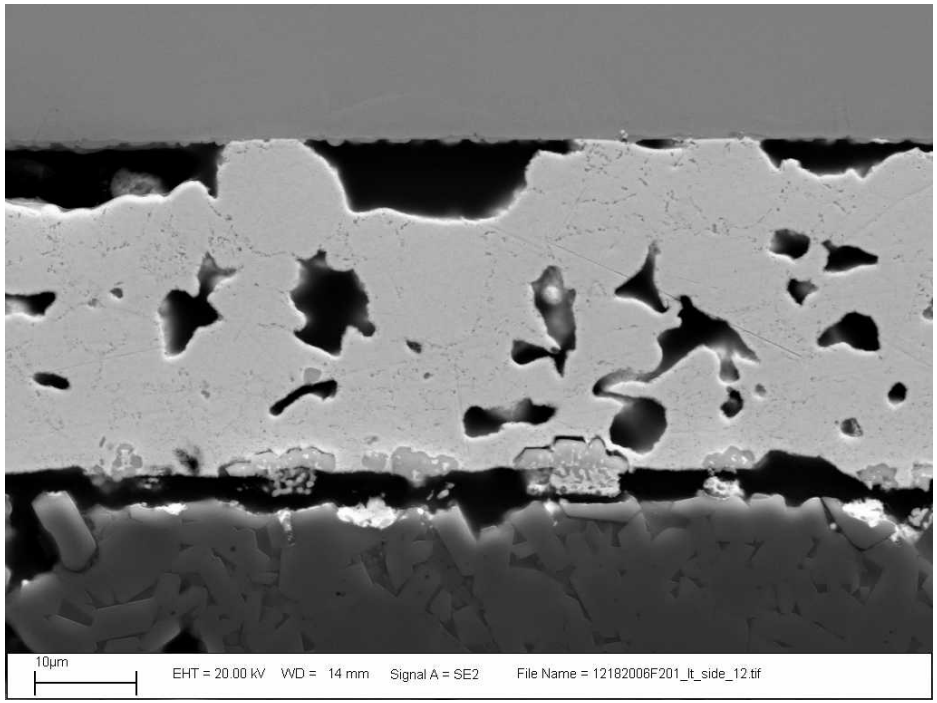
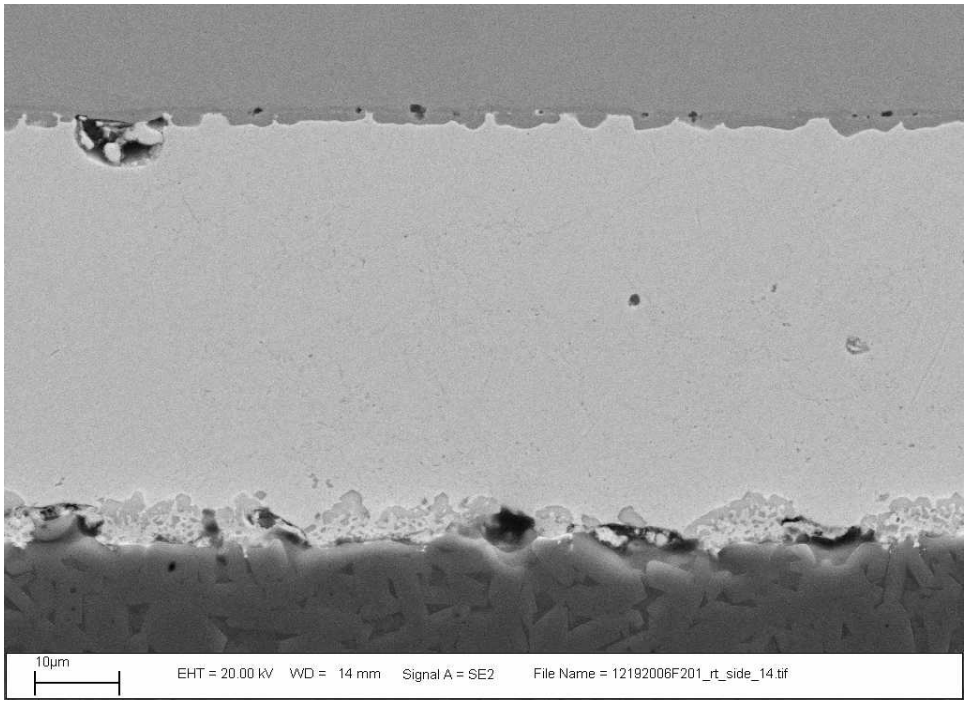
Joint Porosity

Identical Runs?

Dec 18 Run

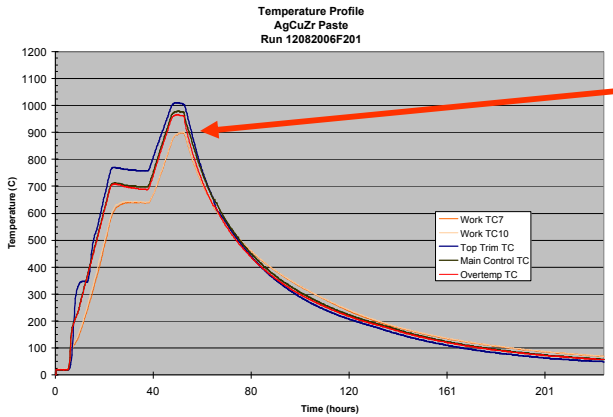


Dec 19 Run



Joint Porosity

Sample run on Dec 19 received 2 thermal cycles.



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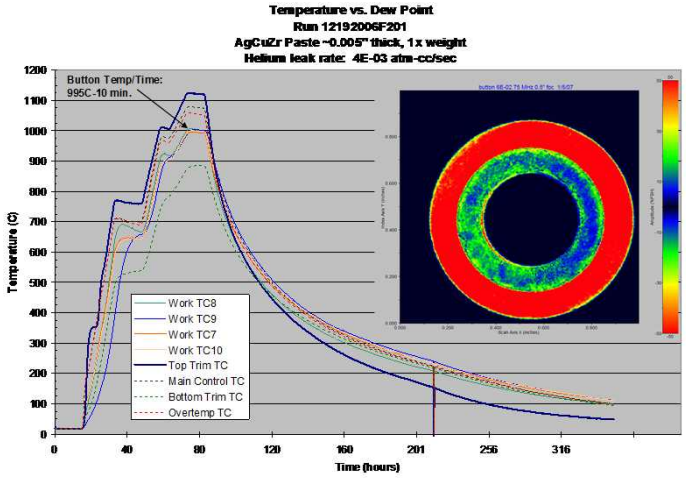
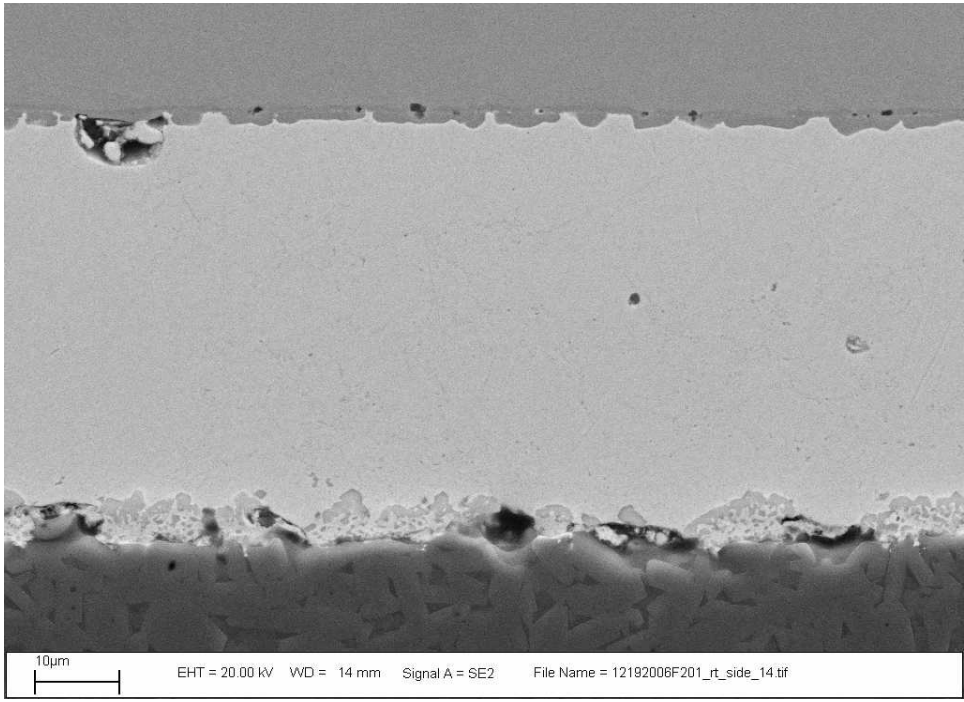


Failed to reach brazing temperature.

Sample was run Dec XX and again on Dec 19.



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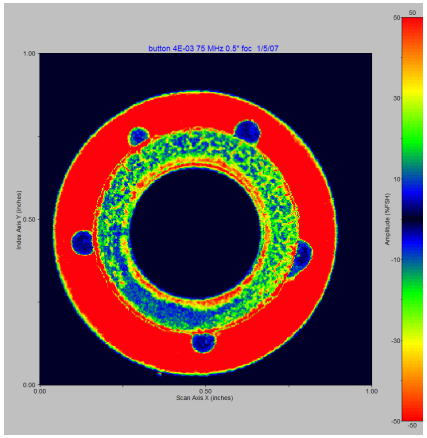
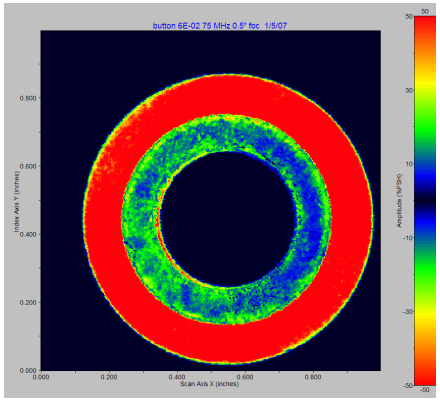
Joint Porosity Solved

He leak rate: 6E-02 atm-cc/sec

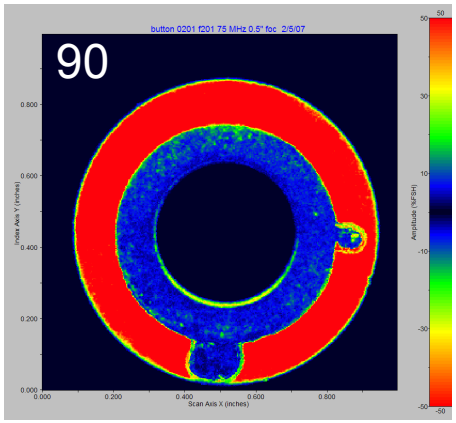


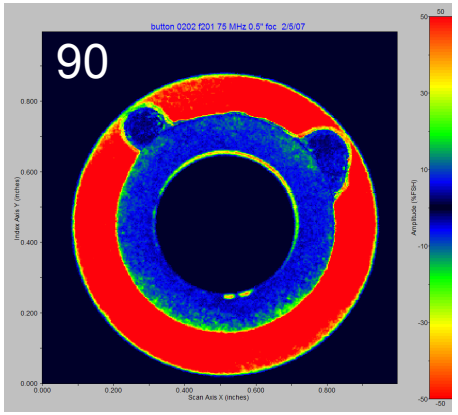
He leak rate: 4E-03 atm-cc/sec

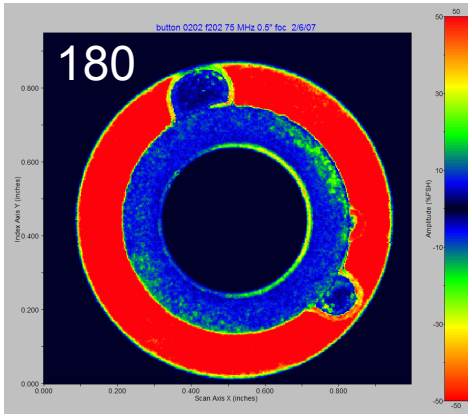


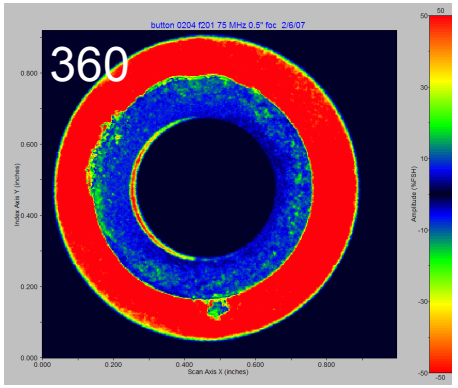
January 2007

Helium Leak Rates < 5E-09 atm-cc/sec









March 2007

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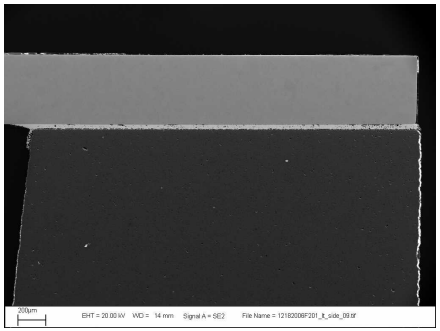
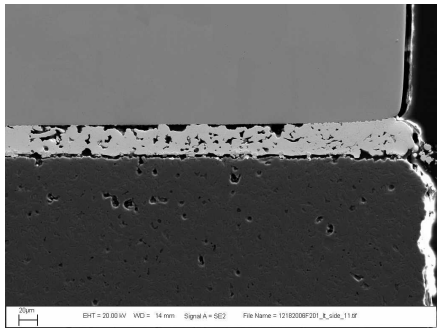
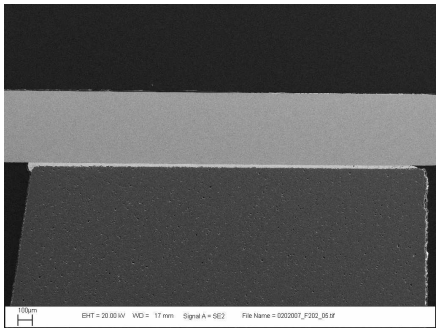
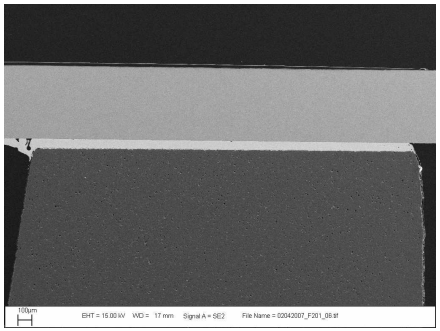
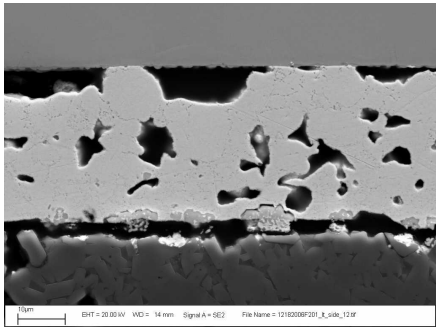
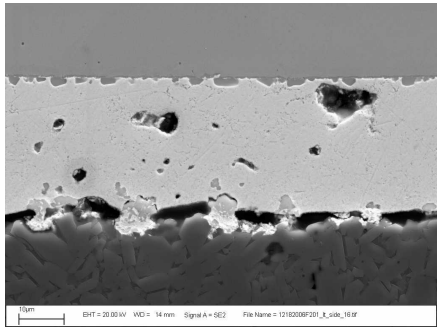
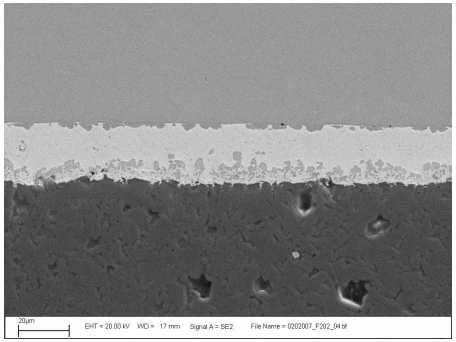
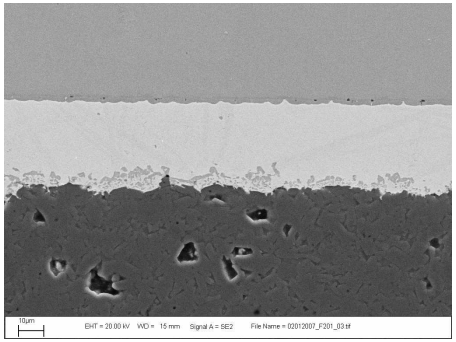
Joint Porosity Solved (continued)

January 2007

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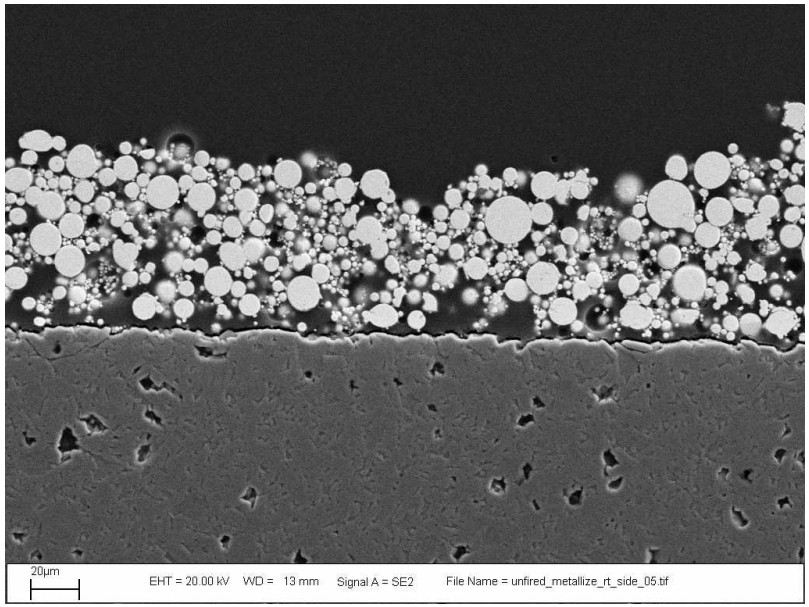
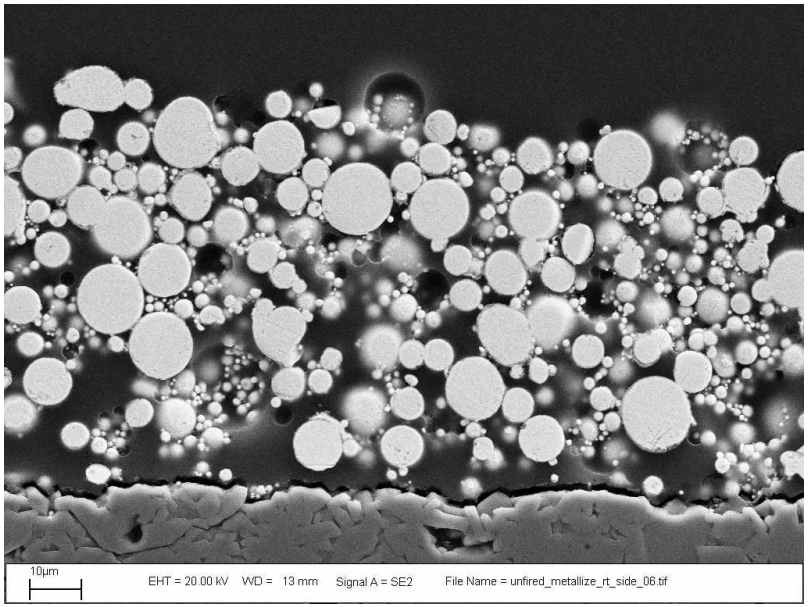
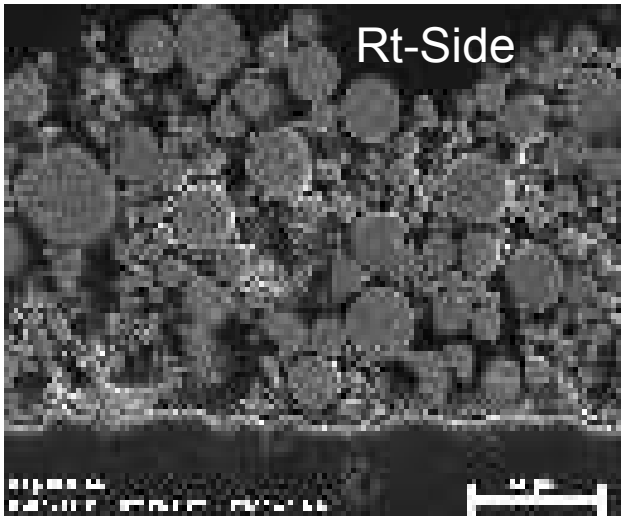
As-Printed and Air-dried Sections Analyzed

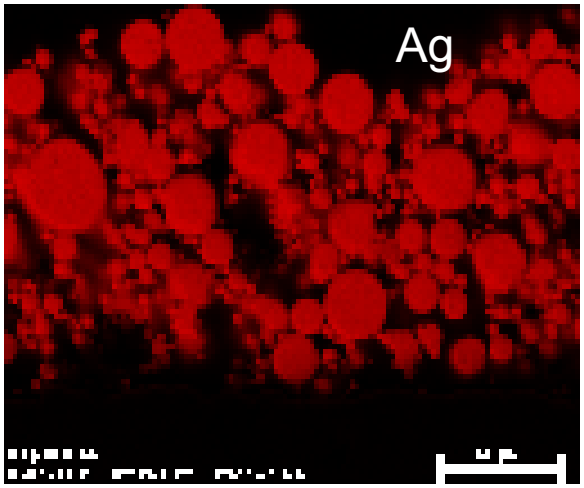


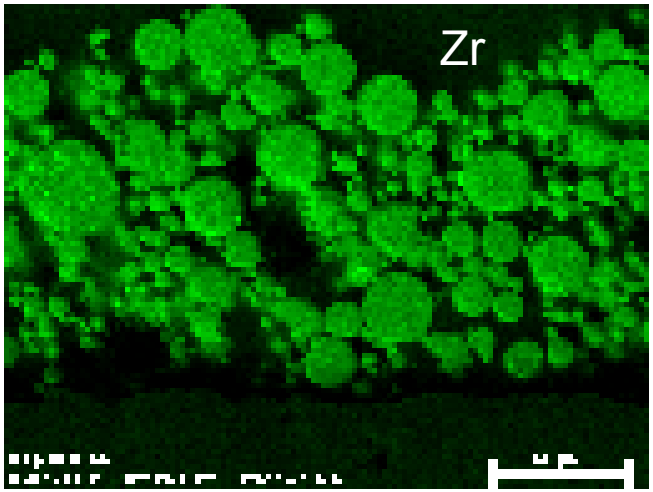


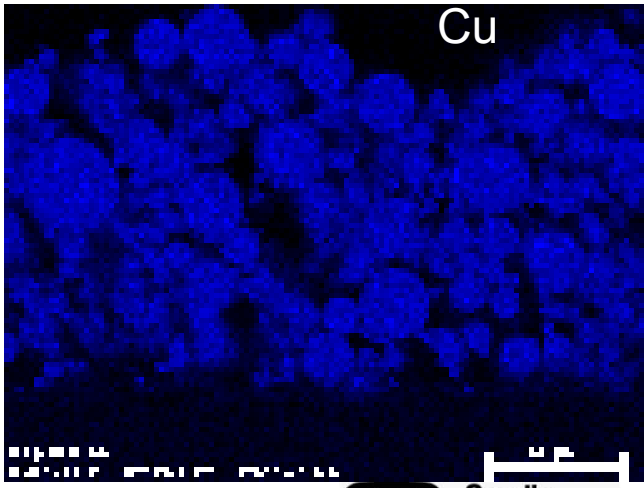
Metallography preformed by Alice Kilgo.
SEM & EDS work performed by Bonnie McKenzie

EDS Images of Air-dried paste









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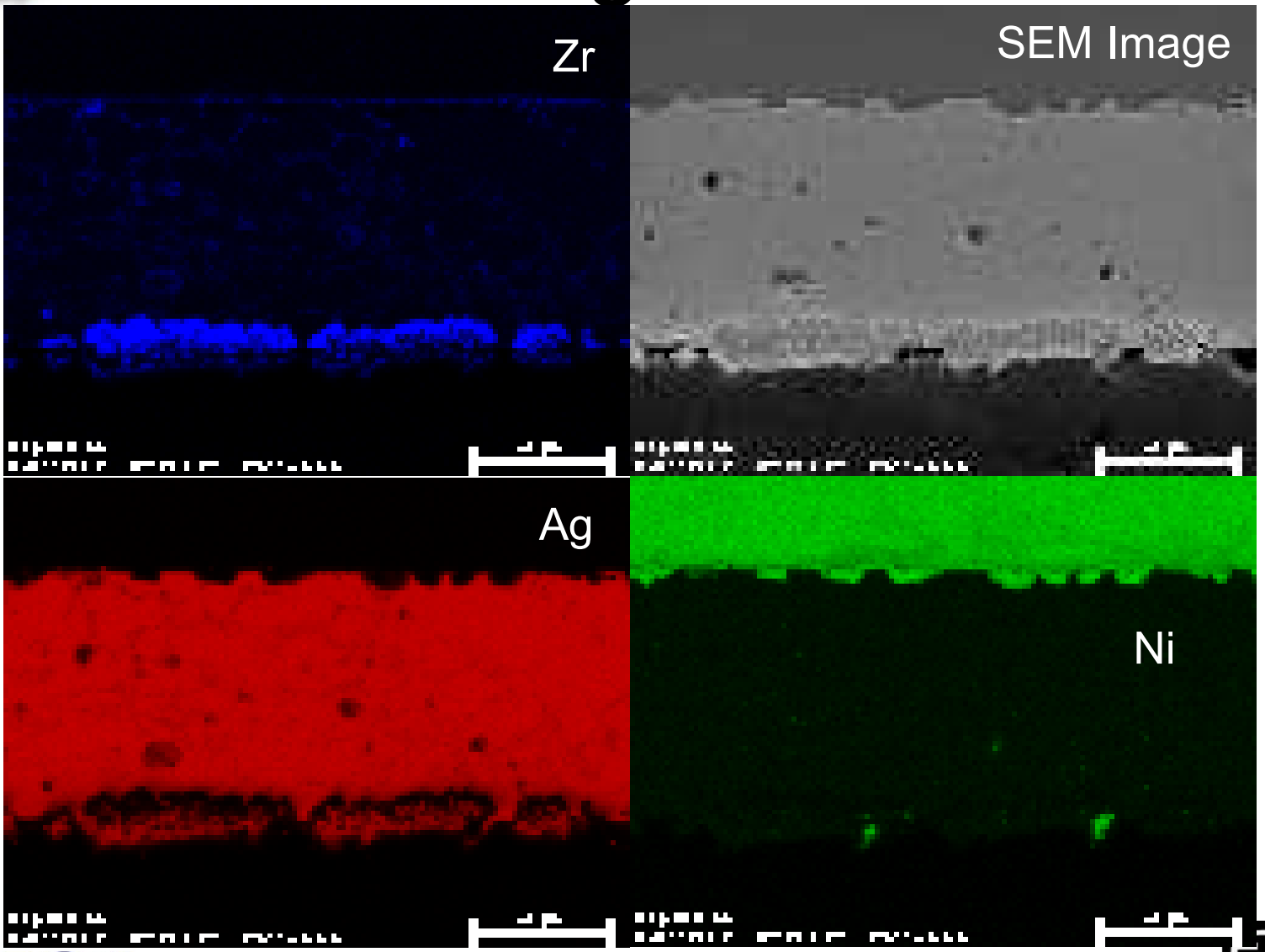
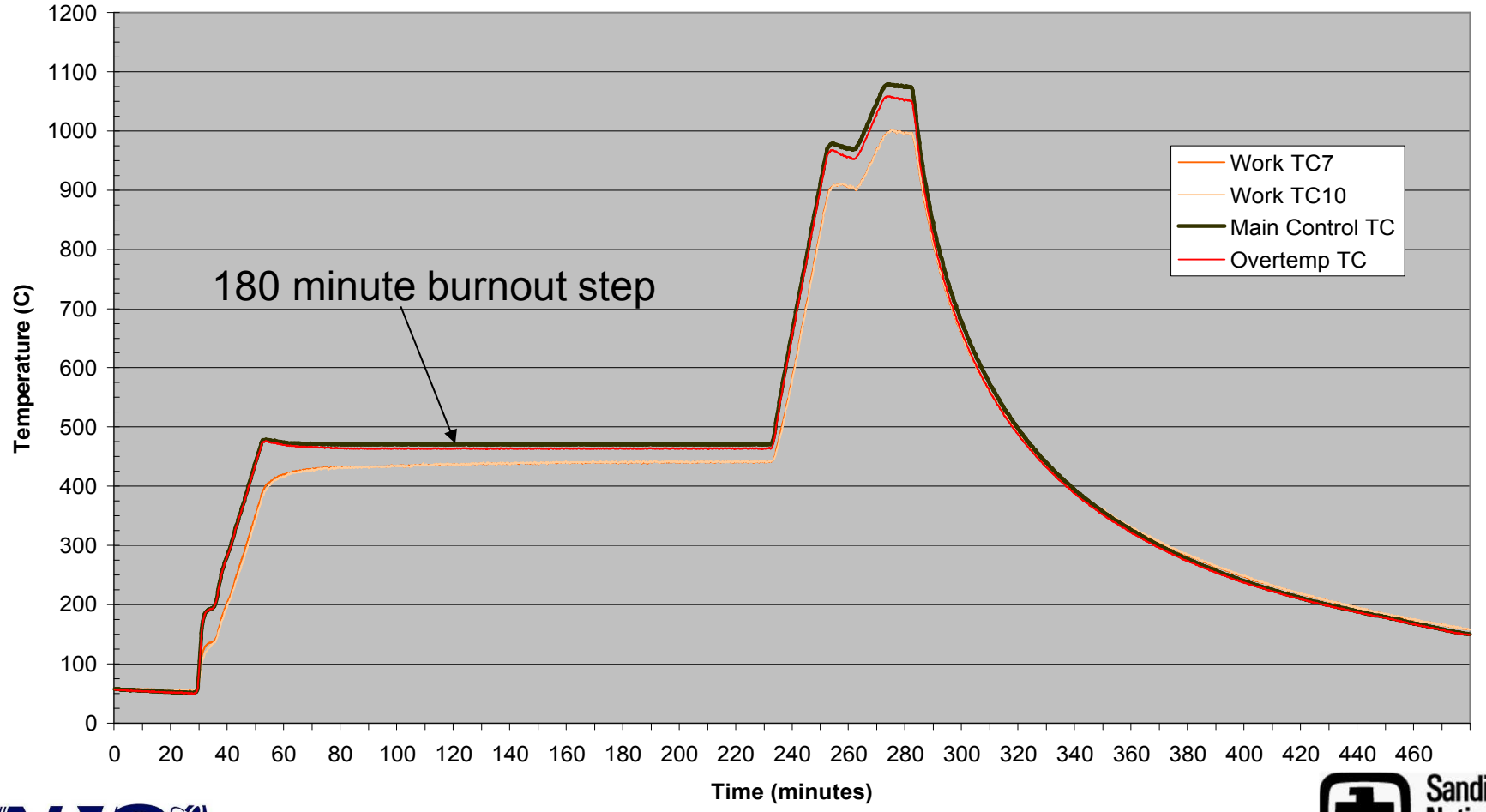
EDS Images of Brazed Joint



Trial 5

Temperature vs. Time
Run 02022007F202
Ag-1Cu-2Zr Paste



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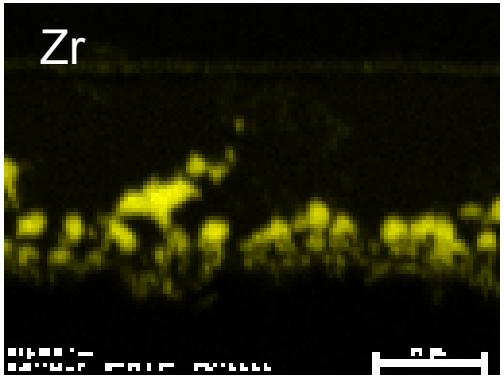
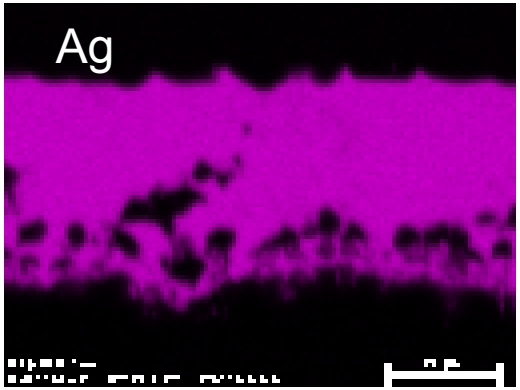
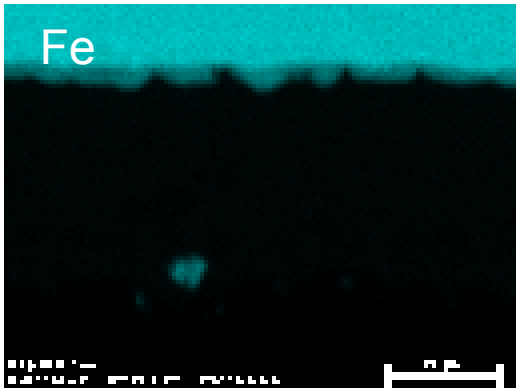
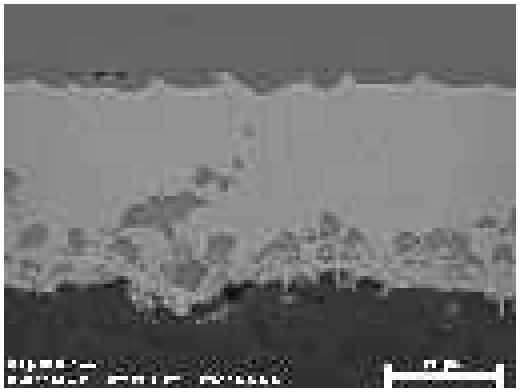
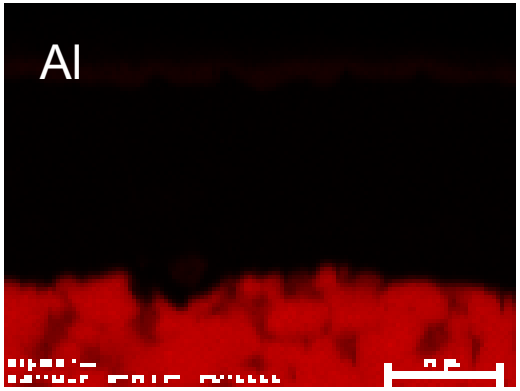
Trial 5 EDS Images

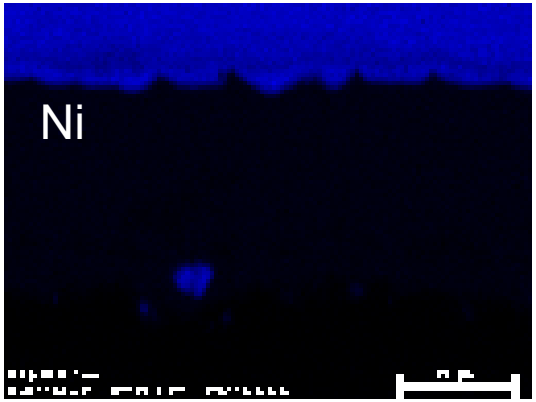


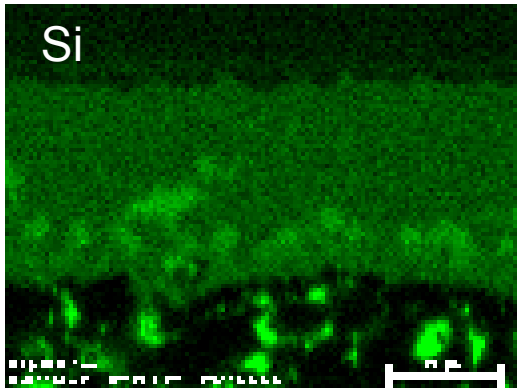












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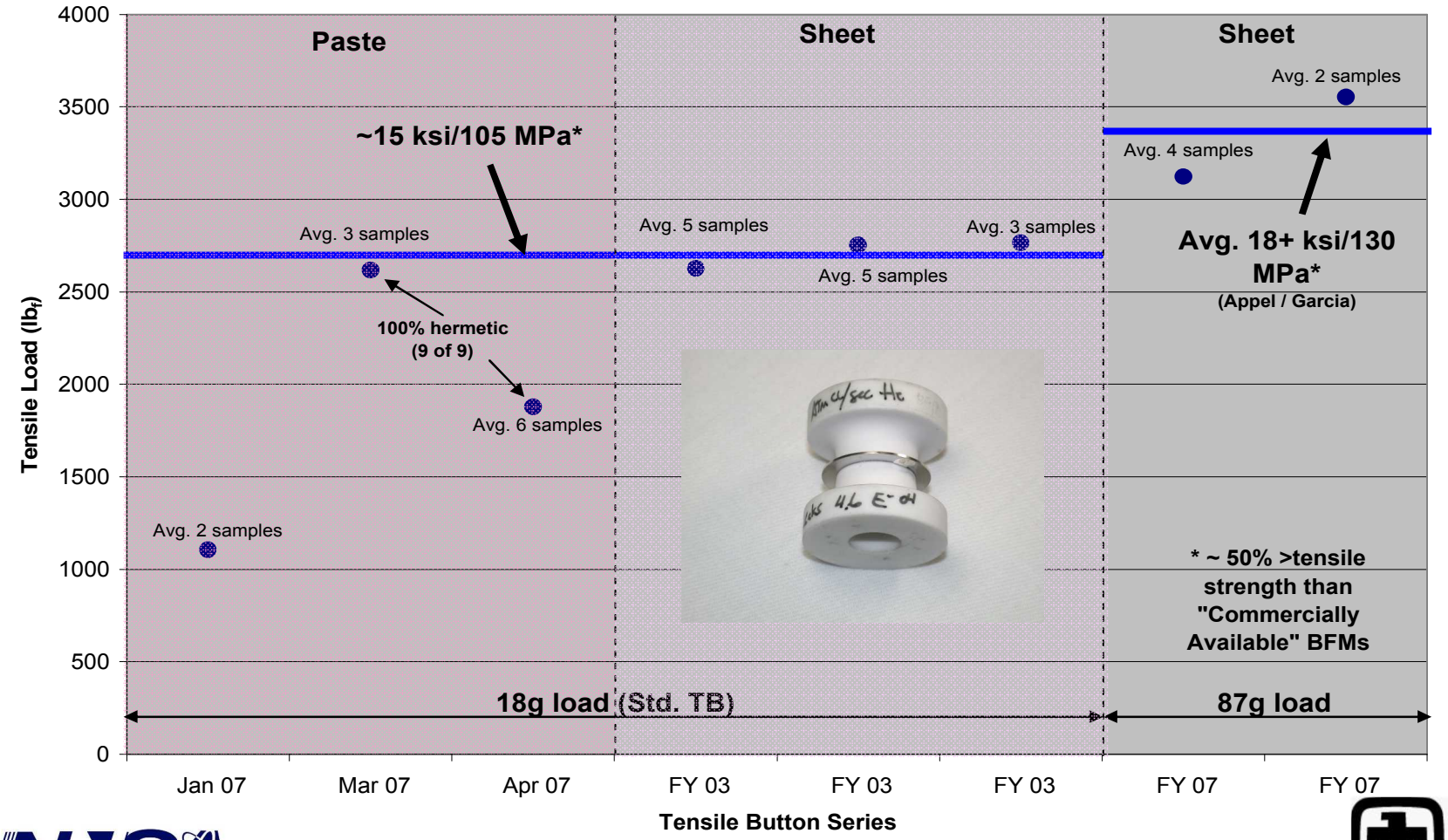
Tensile Strength Comparison Paste vs. Sheet

Ag-1Cu-2Zr
Tensile Button Strength



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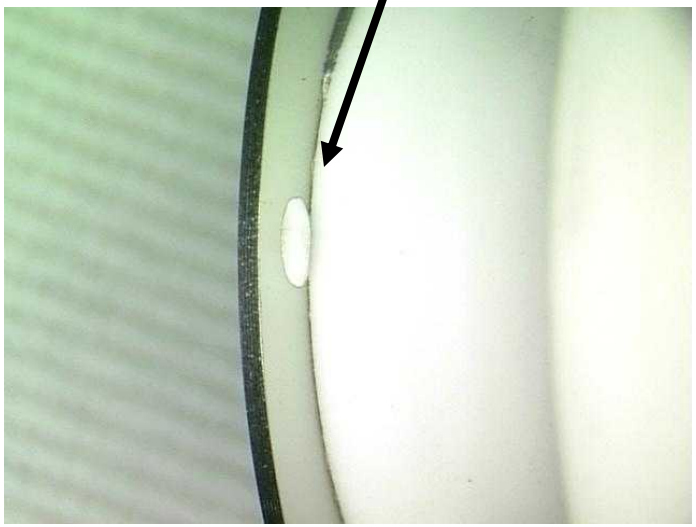
Braze Runout Unresolved

This condition, common with conventional braze washers could be mitigated by controlling volume (thickness) and applying surface treatment options



Current & Future Work

1) Eliminate the braze filler metal runout anomalies.
   - We will adjust parameters in an effort to remedy.
   - Exploration of printing the material on the Kovar™ surface to insure over-size filler metal zone.

2) Investigate direct application techniques on non-planar surfaces and/or more complex geometries in order to broaden the usefulness of active filler metal braze pastes.

Conclusions/Summary

- Successfully demonstrated an active braze filler metal paste screen-printing process.
- Verified that air-dried brazing paste adheres suitably to be used with standard handling procedures.
- Fabricated hermetic, porosity-free metal/ceramic brazed assemblies.
- Demonstrated similar brazed joint tensile strengths for metal foil and paste active filler metals.
- Discovered the necessity of including a low temperature extended time binder burnout step in the thermal cycle.
- The ability to rapidly change the footprint of the brazing material using inexpensive screens rather than new punches or tooling adds to the appeal of this process.
- To fully appreciate the usefulness of active filler metal braze pastes, further work in direct application techniques on non-planar surfaces and/or more complex geometries is needed.

Acknowledgements

The authors would like to thank Steven Younghouse, who performed the ultrasonic test analysis; Alice Kilgo, who performed the metallographic sample preparation; Bonnie McKenzie, for the SEM micrographs and EDS images; Tom Crenshaw, who performed the mechanical testing; and Jessica Weems for performing the supplier interfacing tasks.