

Laser Spot Weld Repair of MC4779 Shunt Wire Resistance Weld

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Gerald A. Knorovsky**

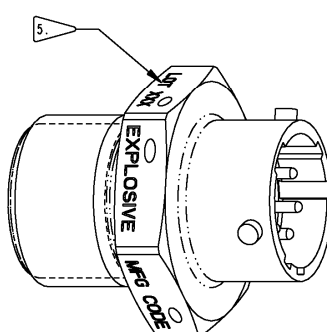
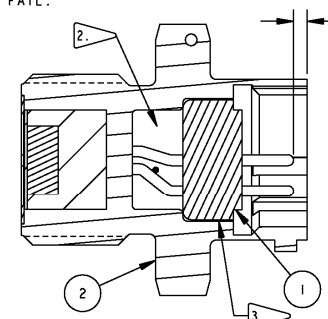
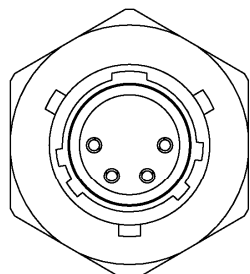
Dept 1813 Joining & Coating

**Sandia National Laboratories
Albuquerque, NM 87185**

***IMOG Joining Subgroup
March 12, 2008***

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Overall View of MC4779 Igniter

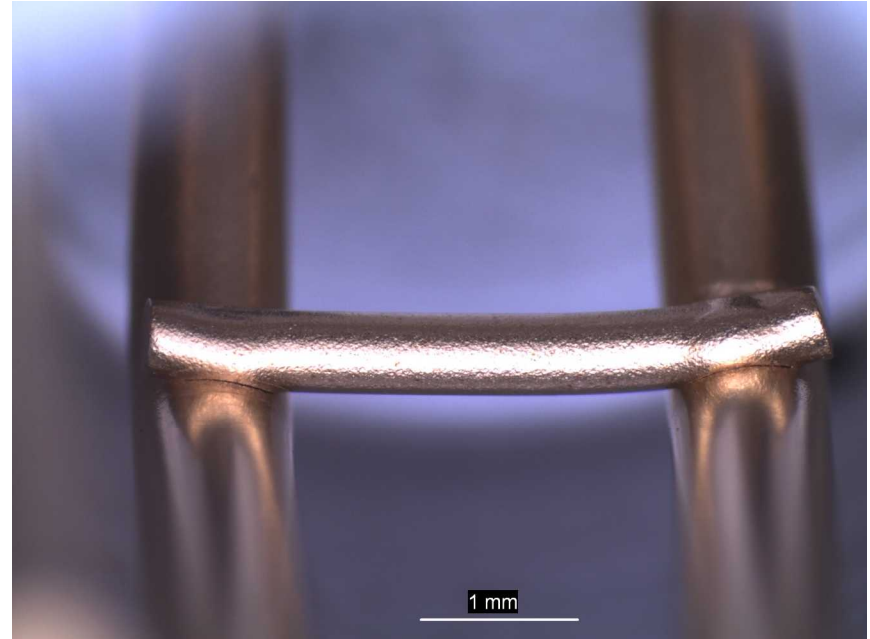
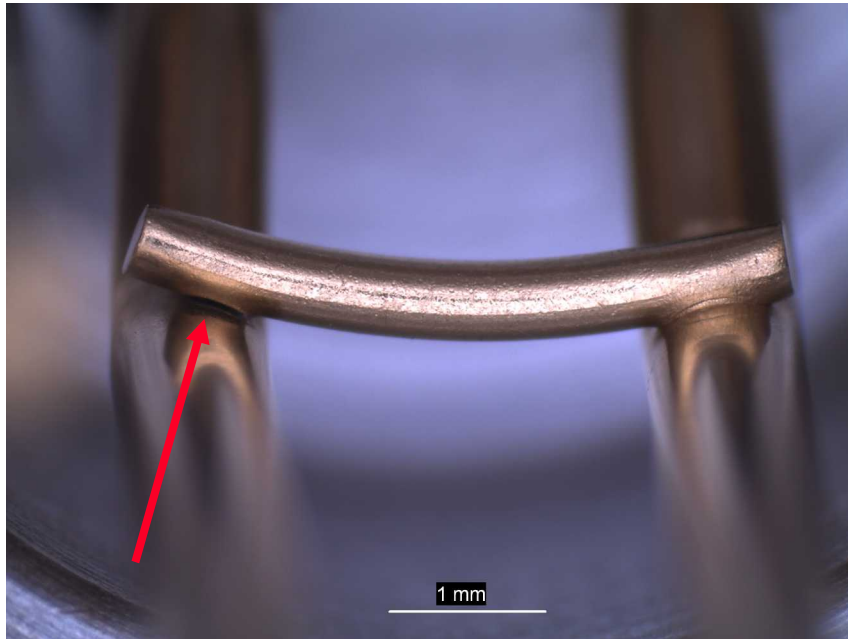
UNCLASSIFIED		UNCLASSIFIED																										
4		3	2	1																								
<p>NOTES:</p> <p>1. GENERAL REQUIREMENTS PER 9900000.</p> <p>2. THIS AREA SHALL BE FREE OF DEBRIS AND MOISTURE PRIOR TO PLUG INSTALLATION</p> <p>3. APPLY A BEAD OF EPOXY (3) APPROXIMATELY .10 DOWN INDICATED WALL OF HEADER (2) AND INSERT PLUG (1). CURE FOR 24 HOURS AT ROOM TEMPERATURE.</p> <p>4. CHECK PIN ALIGNMENT WITH GAGE GA9029. REJECT ALL UNITS THAT FAIL.</p> <p>5. MARK PER 9919100, CLASS K-1, APPROX. .05 HIGH ON HEX FLATS THE FOLLOWING: "MC4779" "1A4255-01" "SN [XXXX]" "LOT [XXXX]" "EXPLOSIVE" MFG CODE</p>		<p>PART NUMBER</p> <p>1A6589-00</p>	<table border="1" style="width: 100%; border-collapse: collapse;"><thead><tr><th colspan="2">ISS</th><th colspan="2">SHEET ZONE</th><th colspan="2">REVISIONS</th><th colspan="2">DATE</th></tr><tr><th colspan="2"></th><th colspan="2"></th><th colspan="2">DESCRIPTION</th><th colspan="2"></th></tr></thead><tbody><tr><td colspan="2">C</td><td colspan="2">ACO</td><td colspan="2">20061500SA</td><td colspan="2">04/20/06</td></tr></tbody></table>	ISS		SHEET ZONE		REVISIONS		DATE						DESCRIPTION				C		ACO		20061500SA		04/20/06		<p>UNCLASSIFIED</p>
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<p>5.</p> 		<p>2.</p> 		<p>(4x .050)</p> 		<p>UNCLASSIFIED</p>																						
		<p>SECTION A - A</p>		<p>UNCLASSIFIED</p>																								
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ARS	2651 / CATALYST 9	EPOXY, STYCAST	3
I	1A6588-00	HEADER, LOADED	2
I	1A6586-00	PLUG, GASKET SEAT	1
NA	9919100	MARKING, GENERAL METHODS	
NA	9900000	GENERAL REQUIREMENTS	
PART/CONTROL NO		DESCRIPTION/MATERIAL	NOTE SHEET ZONE ITEM
NO RFGD			
<p>QUANTITY: NA = NO QUANTITY FOR DOCUMENTS PM = PROCESS MATERIAL AR = AS REQUIRED ABBREVIATIONS: ALT = ALTERNATE EM = EXPENSE MATERIAL ARS = AS REQUIRED FOR ASSEMBLY</p>			
DRAWING: 1A6589-UNC		TITLE	
MODEL: 1A6589-00-UNC		IGNITOR SUBASSEMBLY	
TYPE: ASSEM			
<p>SANDIA NATIONAL LABORATORIES (NM)</p> <p>UNCLASSIFIED</p> <p>ENGLISH</p>		PART CLASSIFICATION	
		UNCLASSIFIED	
THIRD ANGLE PROJECTION		DRAWING CLASSIFICATION	
		UNCLASSIFIED	
ORIGIN		WILDFIRE 2.0	
STATUS		SA-REL - 04/20/06	

CURRENT ISSUE APPROVALS		DATE
DRAWN: MLBASILIERE 2997	04/20/06	
CHECKED: -		
DESIGNED: SLSZARKA 2552		
APPROVED: -		

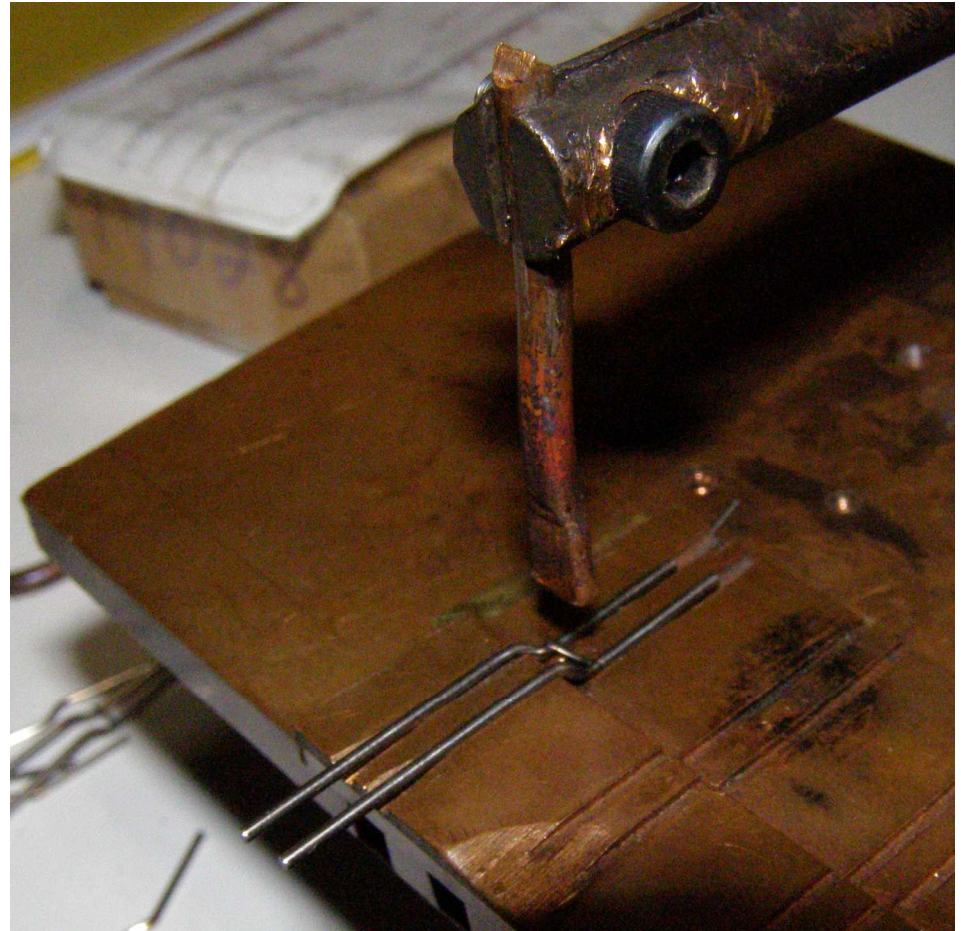


Alloy 52 Resistance Welded Shunt Wire



Normally cross-wire resistance welds are pretty bullet-proof. Not this time!

Vendor's RW Set-up

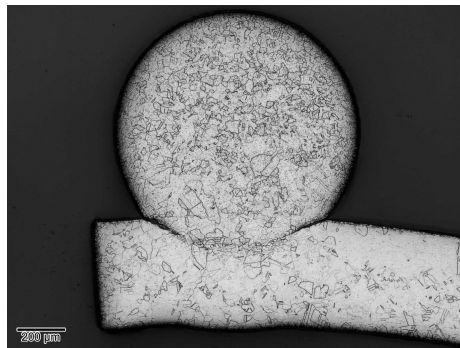
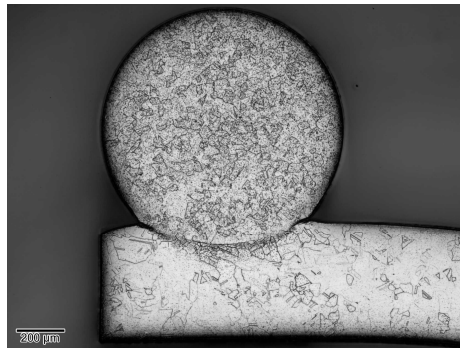
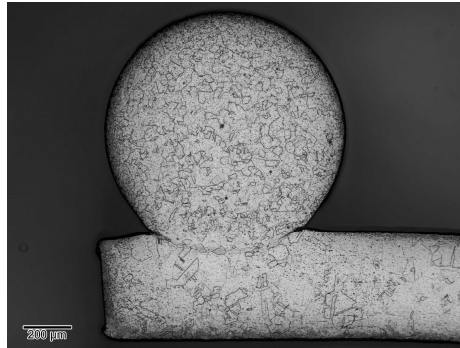


The vendor set up to make both welds simultaneously; apparently, the electrodes weren't precisely aligned and tended to underheat the right hand bond

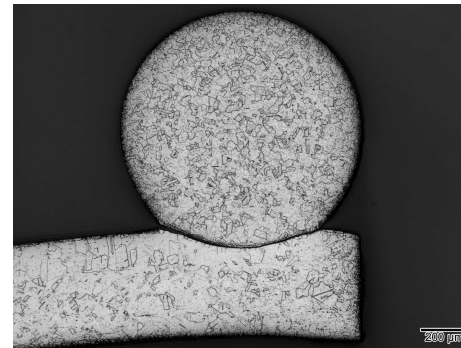
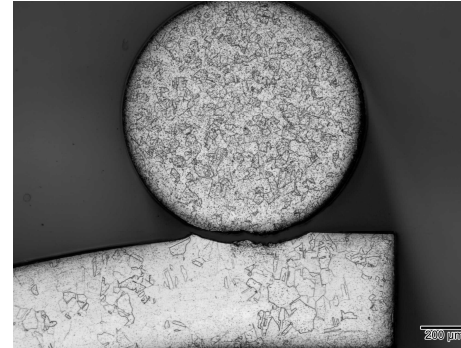
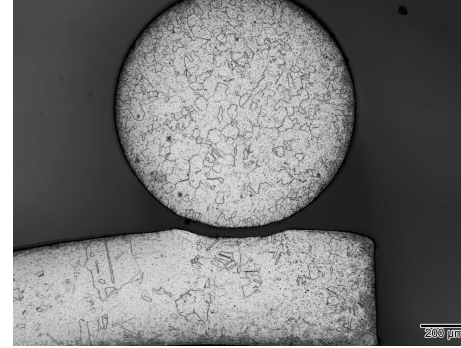


Metallography of RW

"good?"
side



bad side



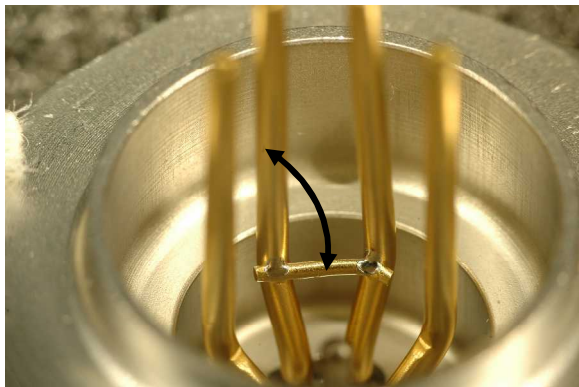
We proposed a Laser Spotweld repair



**Laser
Baasel AB Laser spot welder**



**Igniter Connector
Pin Housing
requires steep
angle for weld and
shooting through
another pair of pins
while avoiding the
pin connector body**



Igniter Connector Pin Housing: Alignment/Sighting



Details of LBW Schedule

Laser Parameters

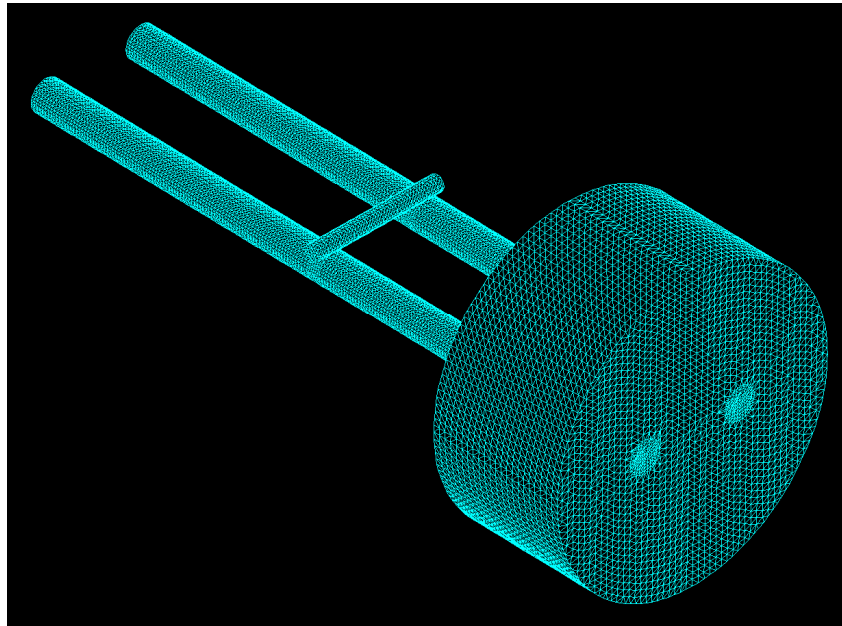
- 5 J/p (220 V at 1.5 Hz)
- 10 ms pulse length
- At focus with 5" f.l. lens
- Igniter Connector Pin Housing requires steep angle for weld
- No clamping of broken weld; i.e., there can exist a small initial gap for the laser spot weld to bridge
- UHP Ar shield gas



RHS: welded broken arm

LHS: welded intact arm

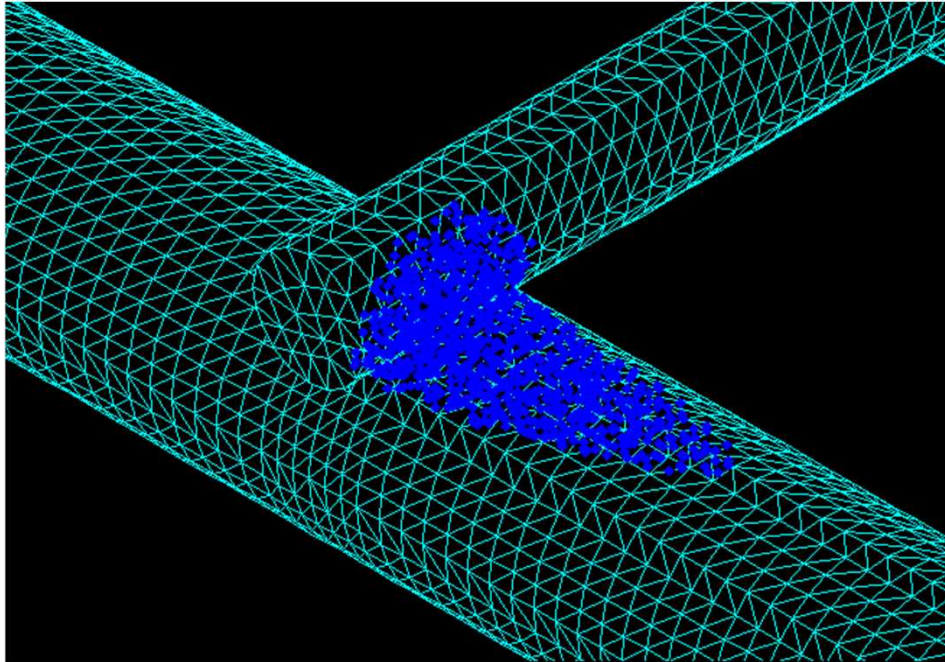
FEA Model to determine Heat rise at Powder surface



Heat transfer can take place along the vertical pins, through the glass seal to the explosive powder !

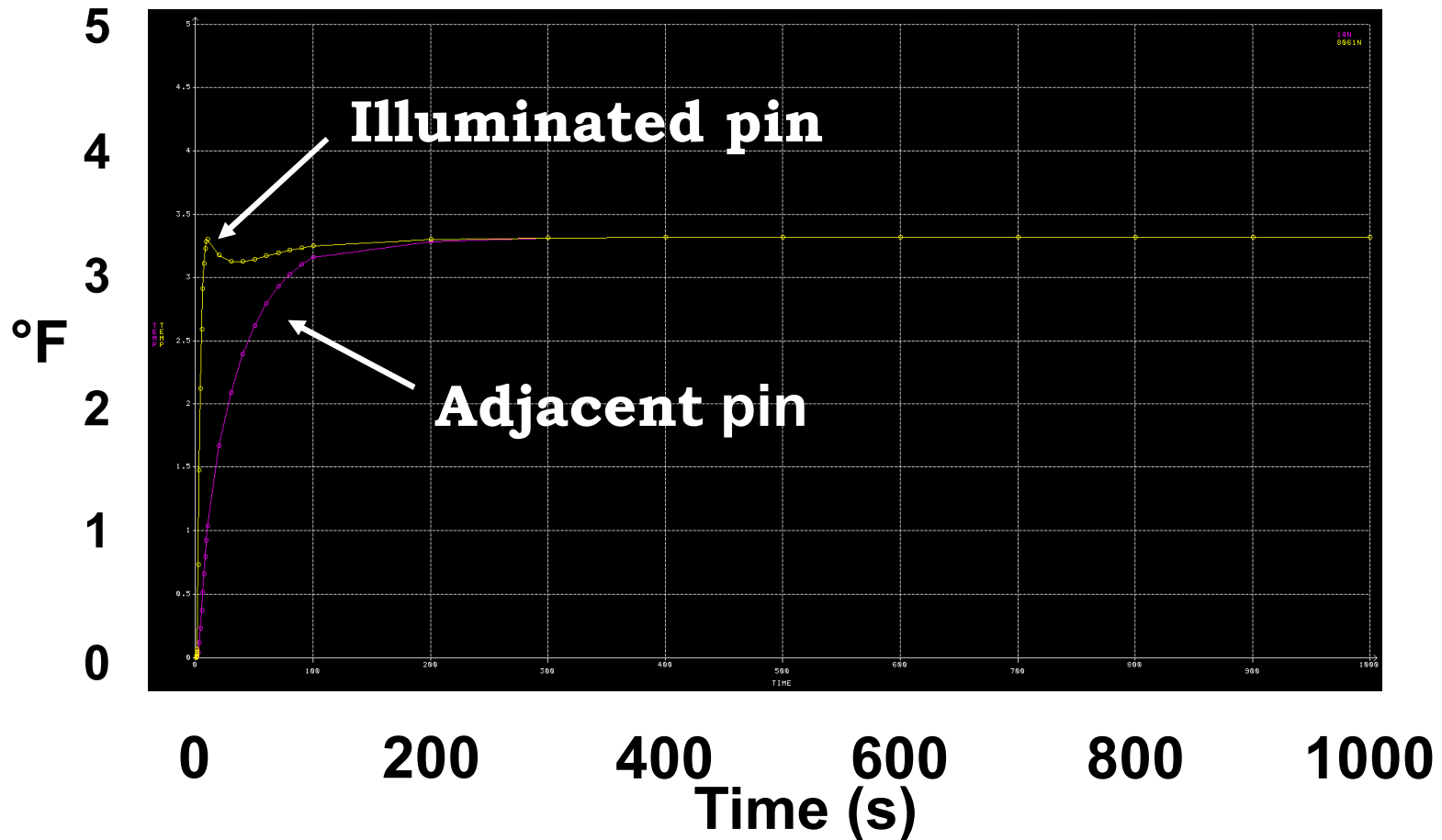


Heat Source



Volume-elements heat source impinging with a slightly more than 50% illumination of vertical post.

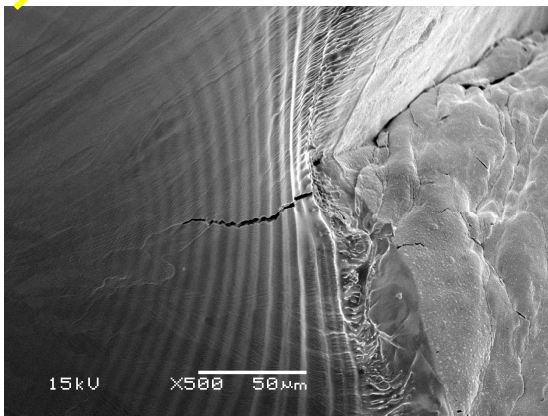
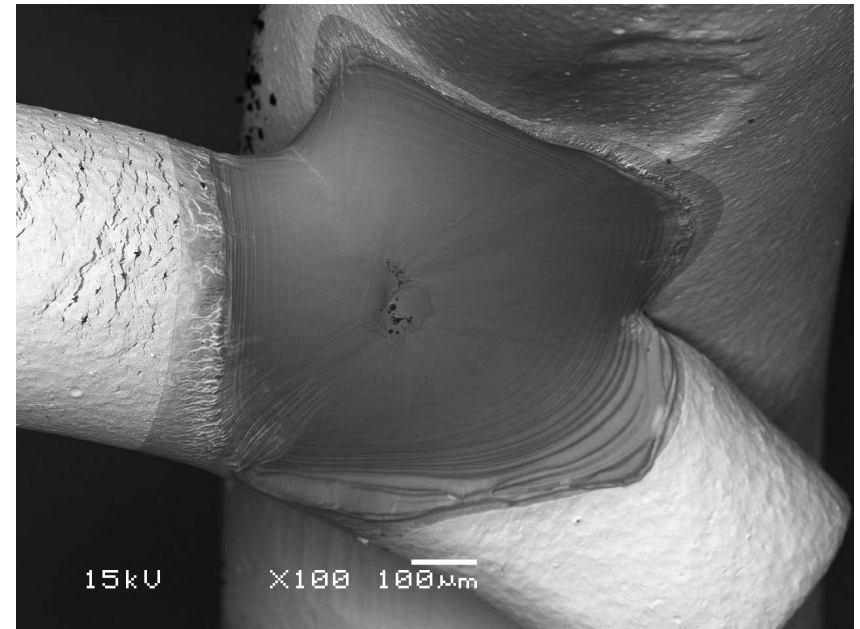
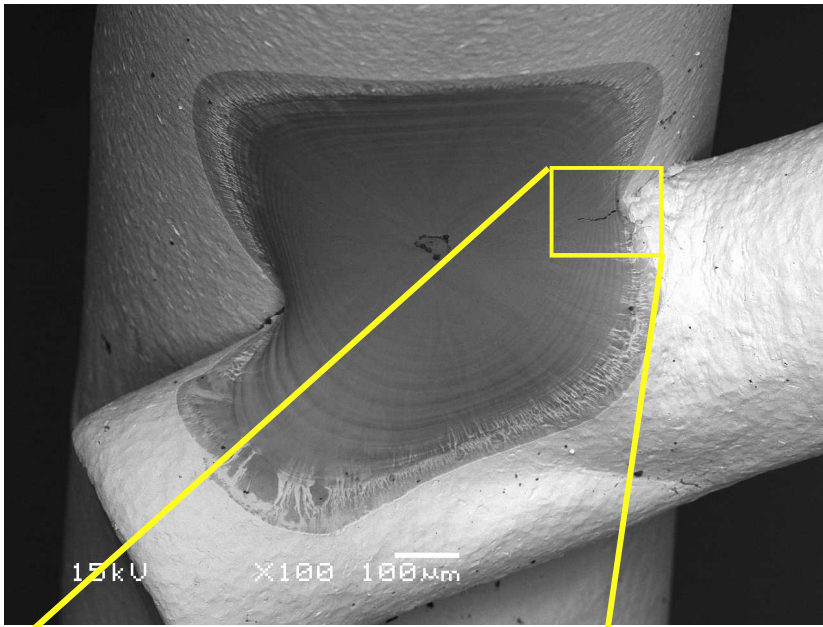
Temperature Rise Negligible



The predicted temperature RISE is 3.3 °F.

Note: *this is for a single pin.*

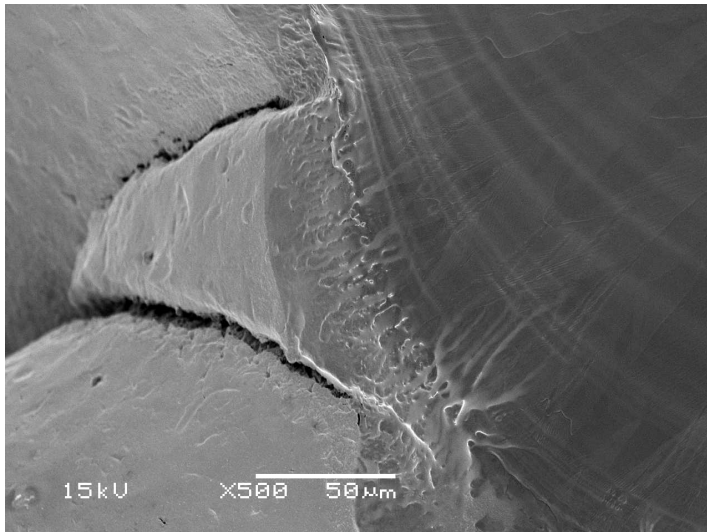
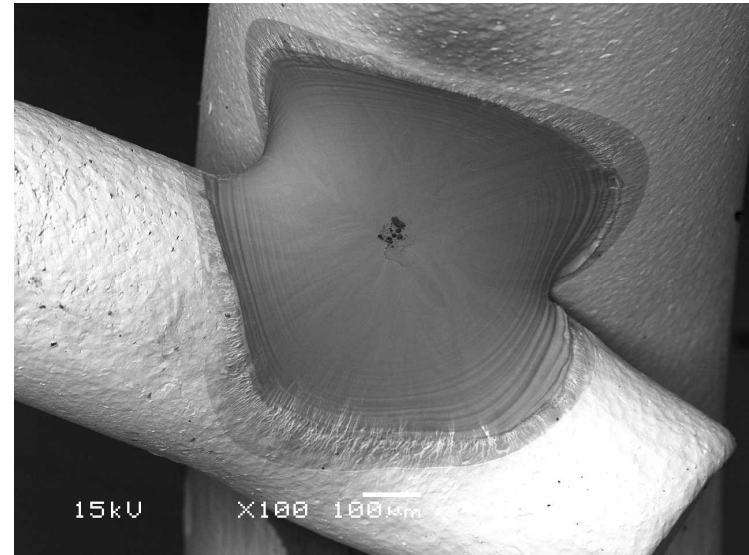
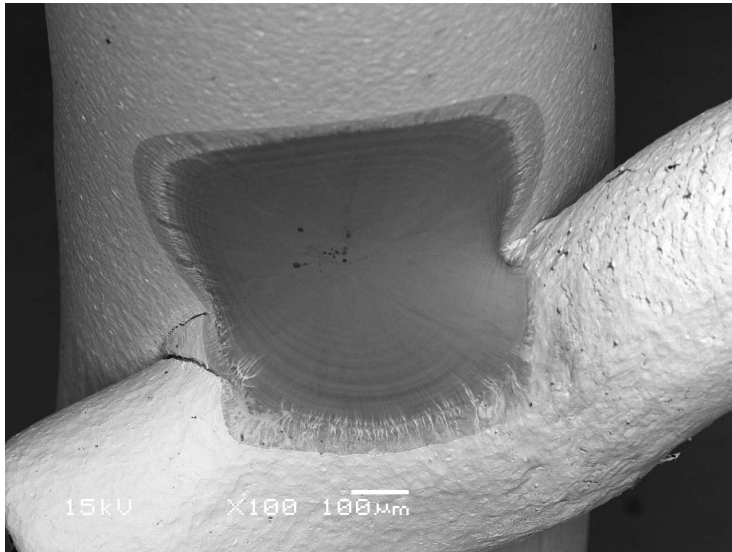
SEM of LBW



- **Au plating mixed into Alloy 52 leads to occasional hot cracks.**
- **The joint is not intended to bear a mechanical load; electrical only**



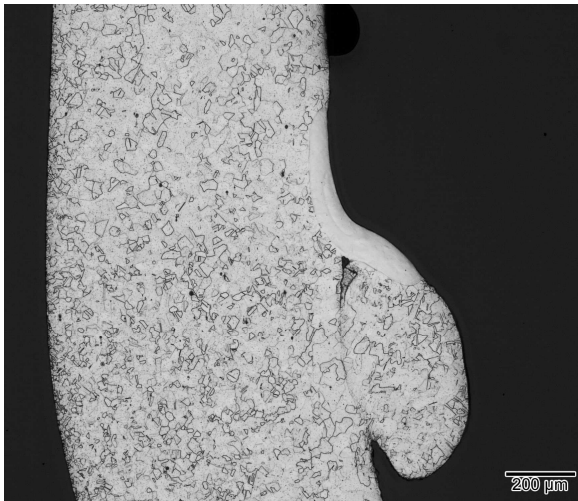
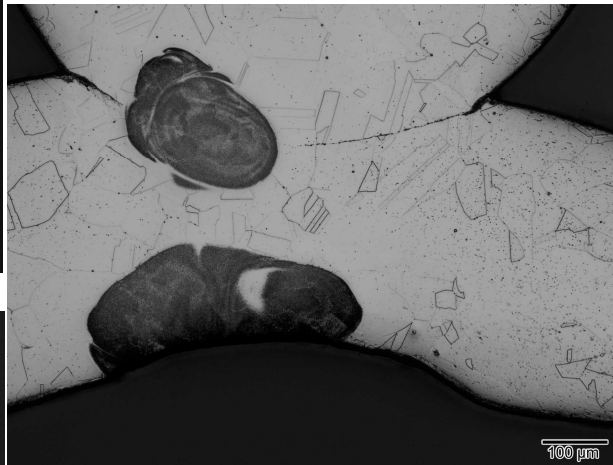
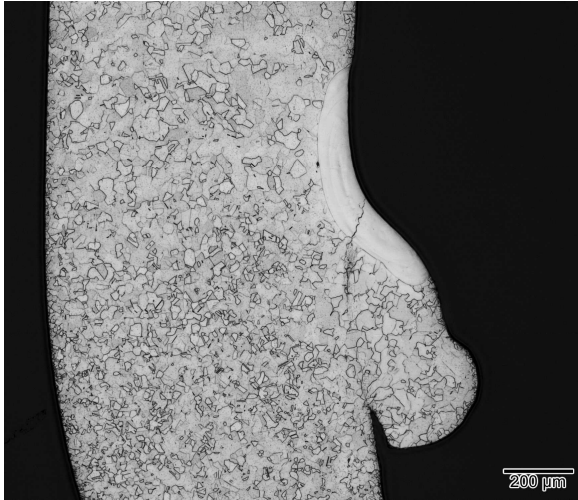
More SEM Pictures



**No pre-clamping
of shunt-wire
to pin was used.**

Metallography of LBW Repair Welds

section
parallel to
shunt wire



sections
parallel to
pins



Summary

- **Vendor's cross-wire resistance welds were at best "cold" and at worst, non-existent.**
- **We proposed a pulsed Nd:YAG laser spotweld repair.**
- **Modeling showed virtually no heat rise at the powder cavity.**
- **Occasional small hot cracks were seen at the edge of the LB fusion weld; since need is for conductivity only, not thought to be a problem.**



Acknowledgments

Kent Shelton, 02553 Energetic Component Production

Jo Bridge, 24312, Manufacturing Processing

Fred Hooper, 24312, Manufacturing Processing