

Laser Spot Weld Repair of MC4779 Shunt Wire Resistance Weld

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Albuquerque, NM 87185**

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

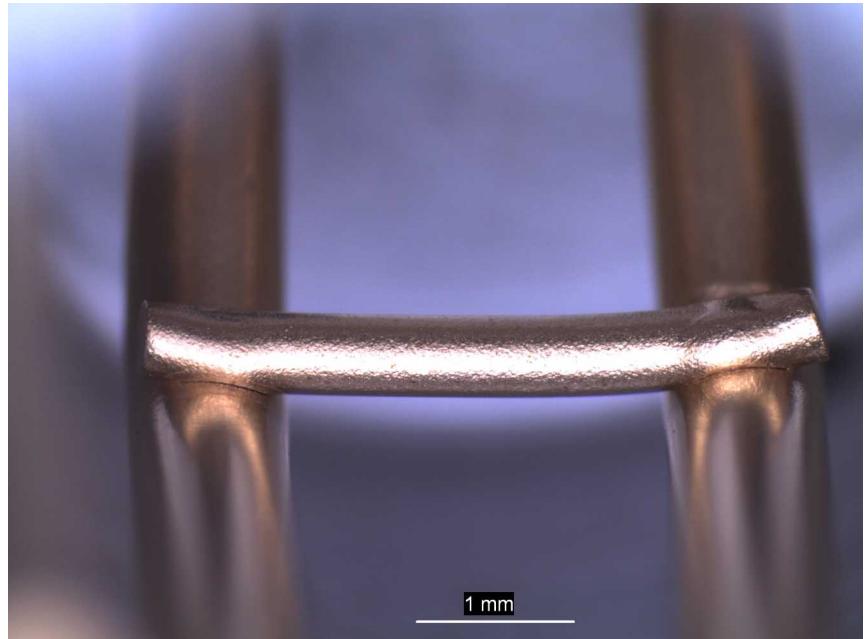
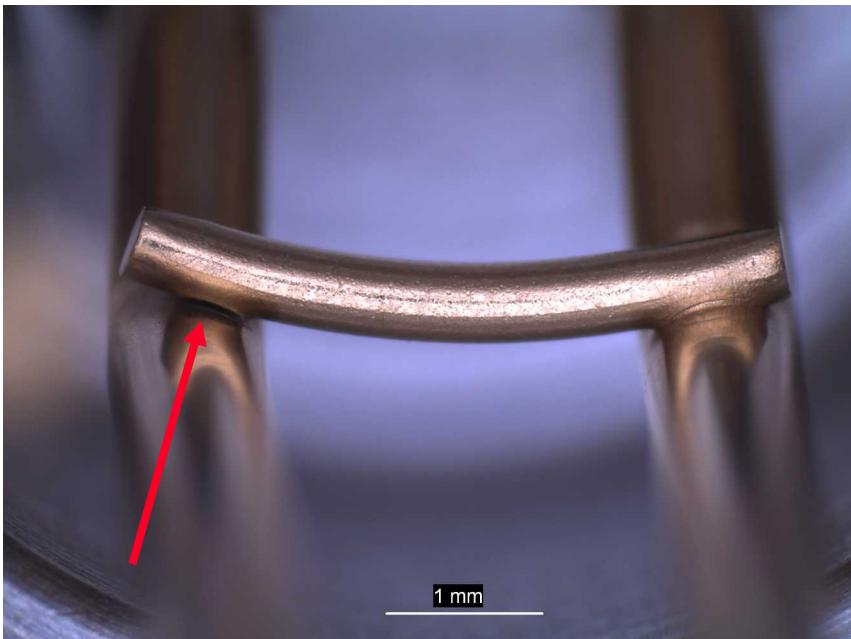
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Overall View of MC4779 Igniter

4	UNCLASSIFIED	3	2	UNCLASSIFIED	1																																																																																	
<p>NOTES:</p> <ol style="list-style-type: none"> GENERAL REQUIREMENTS PER 9900000. THIS AREA SHALL BE FREE OF DEBRIS AND MOISTURE PRIOR TO PLUG INSTALLATION APPLY A BEAD OF EPOXY (.05 APPROXIMATELY) DOWN INDICATED WALL OF HEADER (2) AND INSERT PLUG (1). CURE FOR 24 HOURS AT ROOM TEMPERATURE. CHECK PIN ALIGNMENT WITH GAGE GA9029. REJECT ALL UNITS THAT FAIL. MARK PER 9919100, CLASS K-1, APPROX. .05 HIGH ON HEX FLATS THE FOLLOWING: "MC4779" "IA4255-01" "SN [XXXX]" "LOT [XXXX]" "EXPLOSIVE" MFG CODE 			<table border="1"> <thead> <tr> <th rowspan="2">PART NUMBER</th> <th colspan="2">REVISIONS</th> </tr> <tr> <th>ISS</th> <th>SHET</th> <th>ZONE</th> <th>DESCRIPTION</th> <th>DATE</th> </tr> </thead> <tbody> <tr> <td>IA6589-00</td> <td>C</td> <td></td> <td>ACO 20061500SA</td> <td>04/20/06</td> </tr> </tbody> </table>			PART NUMBER	REVISIONS		ISS	SHET	ZONE	DESCRIPTION	DATE	IA6589-00	C		ACO 20061500SA	04/20/06																																																																				
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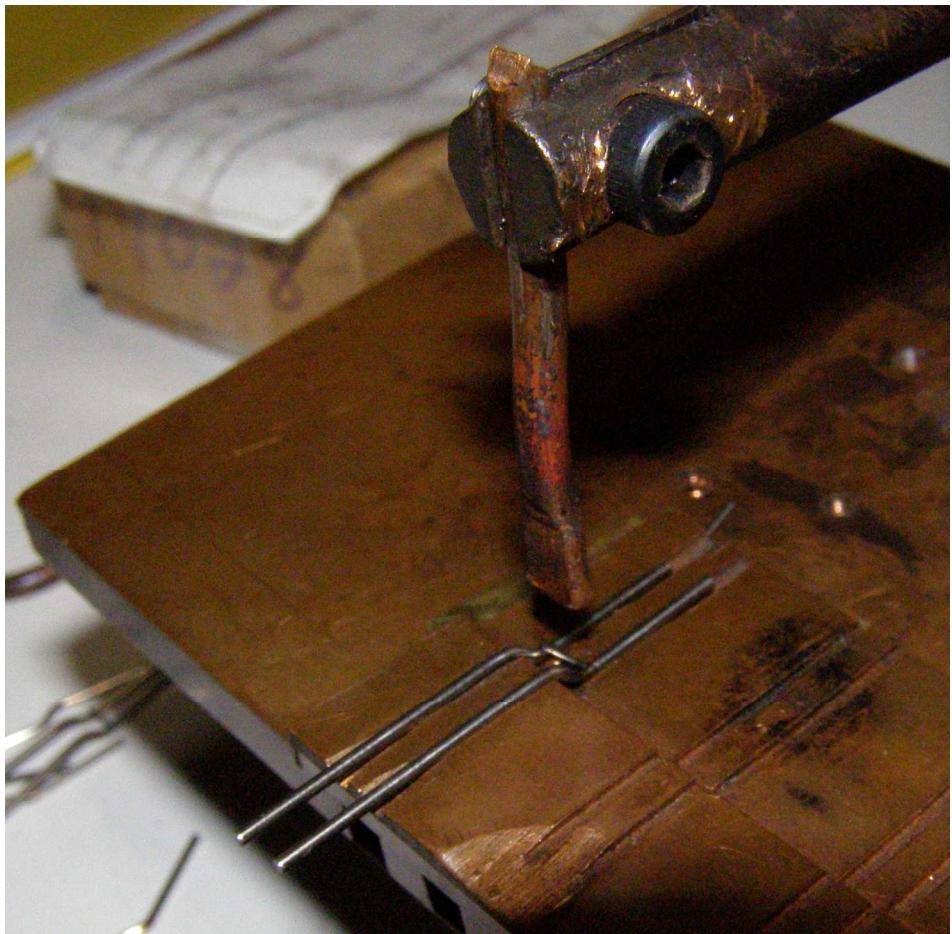
Alloy 52 Resistance Welded Shunt Wire



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



Vendor's RW Set-up

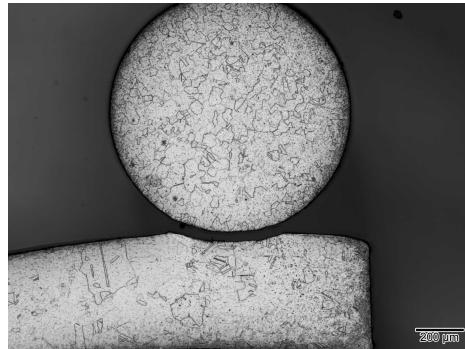
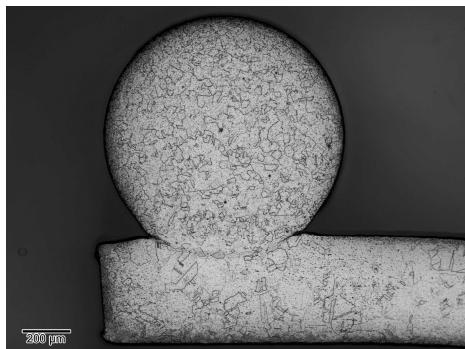


The vendor set up to make both welds simultaneously; apparently, the electrodes weren't precisely aligned and tended to underheat the right hand bond

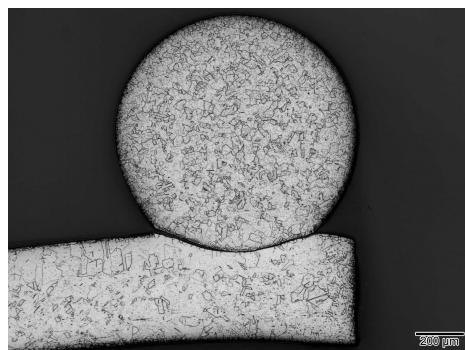
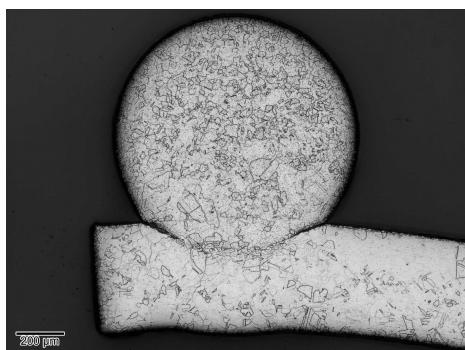
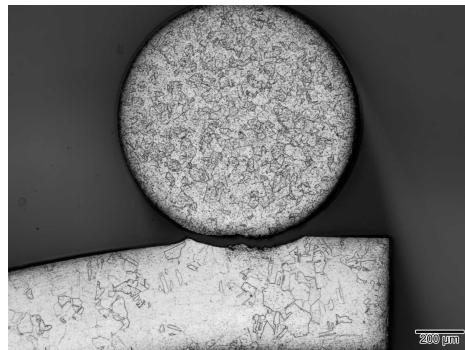
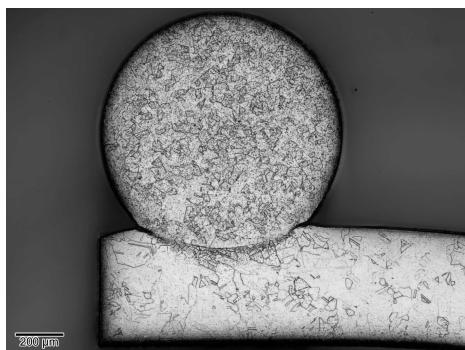


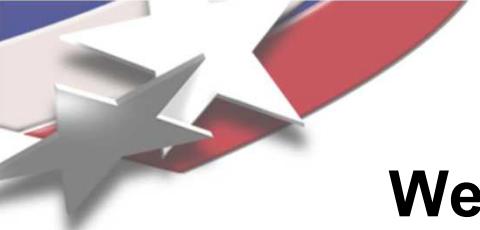
Metallography of RW

**"good?"
side**

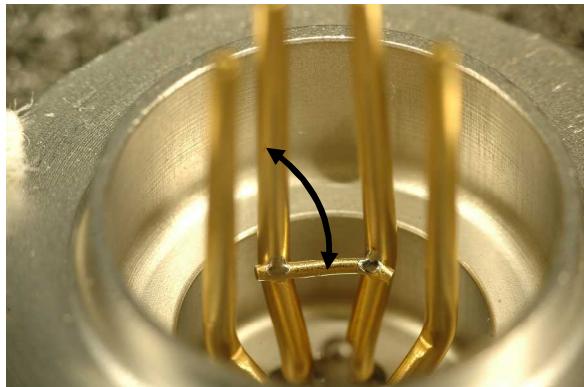


bad side





We proposed a Laser Spotweld repair



Igniter Connector Pin Housing: Alignment/Sighting

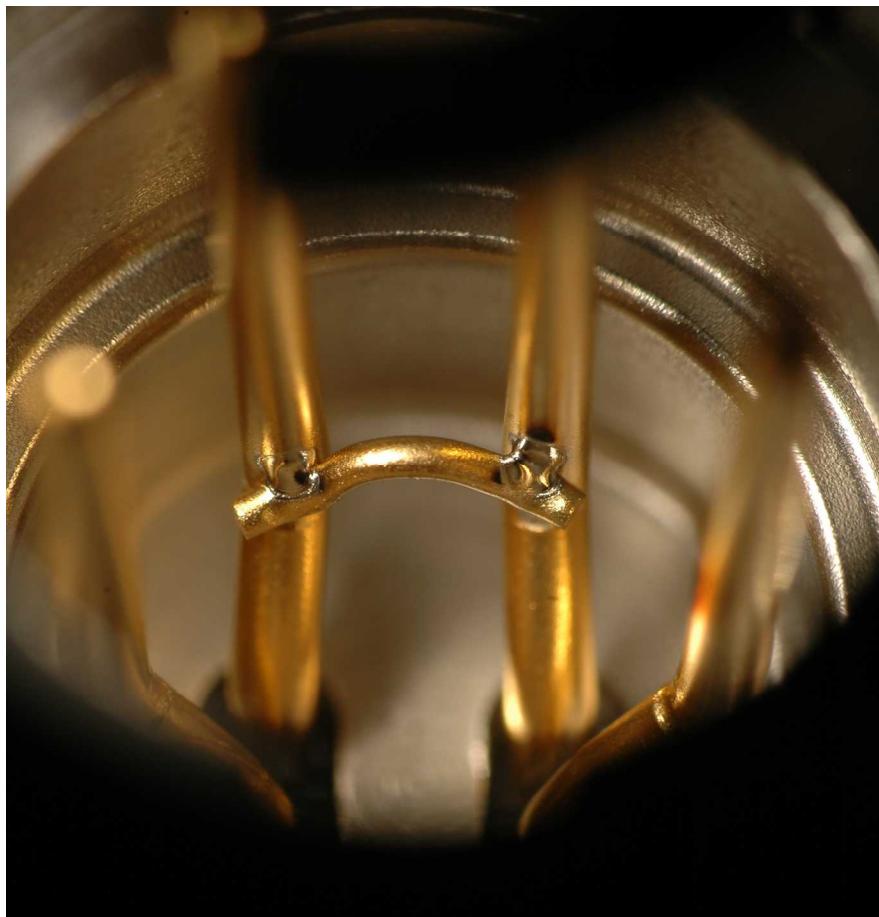
Laser

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



Details of LBW Schedule



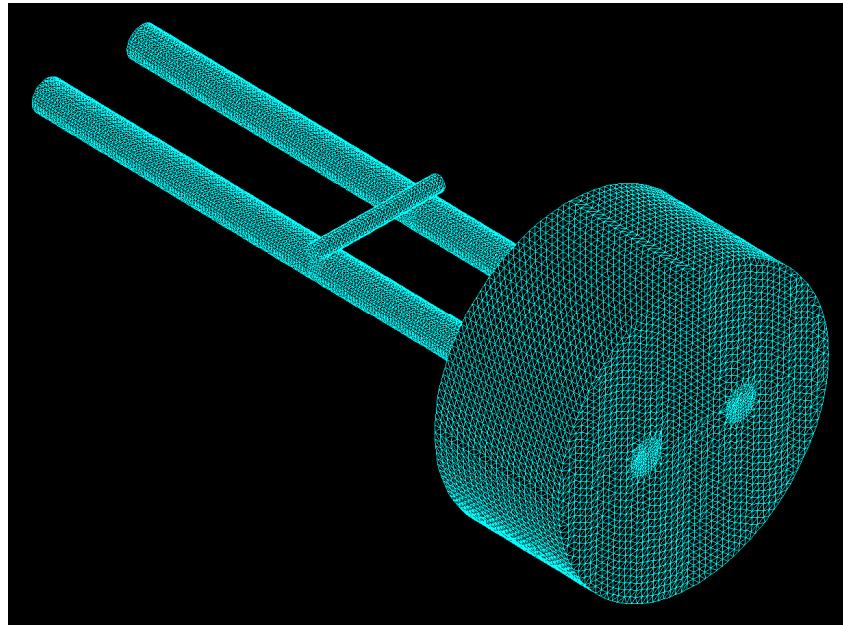
RHS: welded broken arm
LHS: welded intact arm

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**



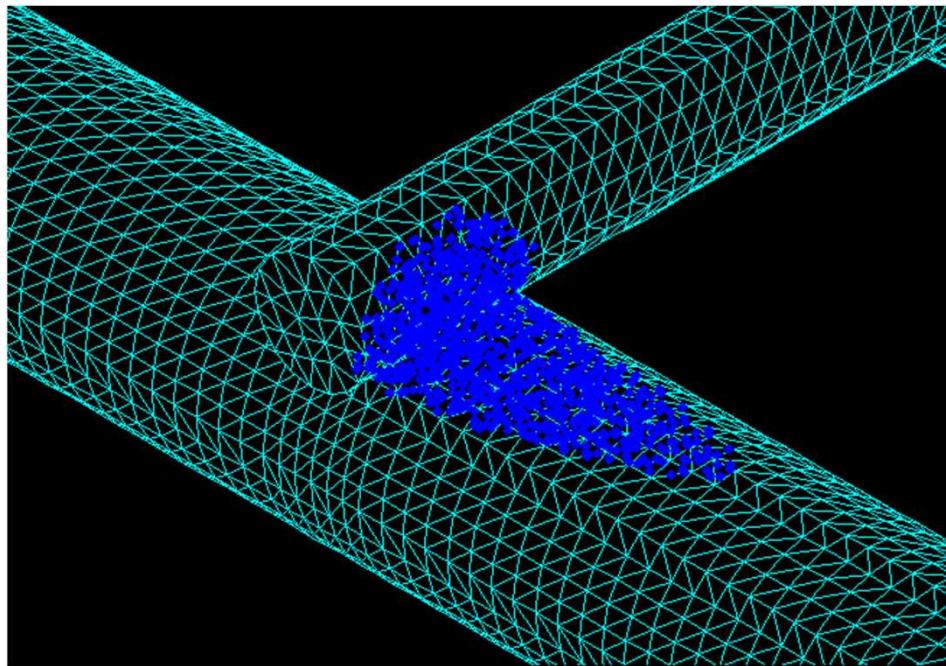
FEA Model to determine Heat rise at Powder surface



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

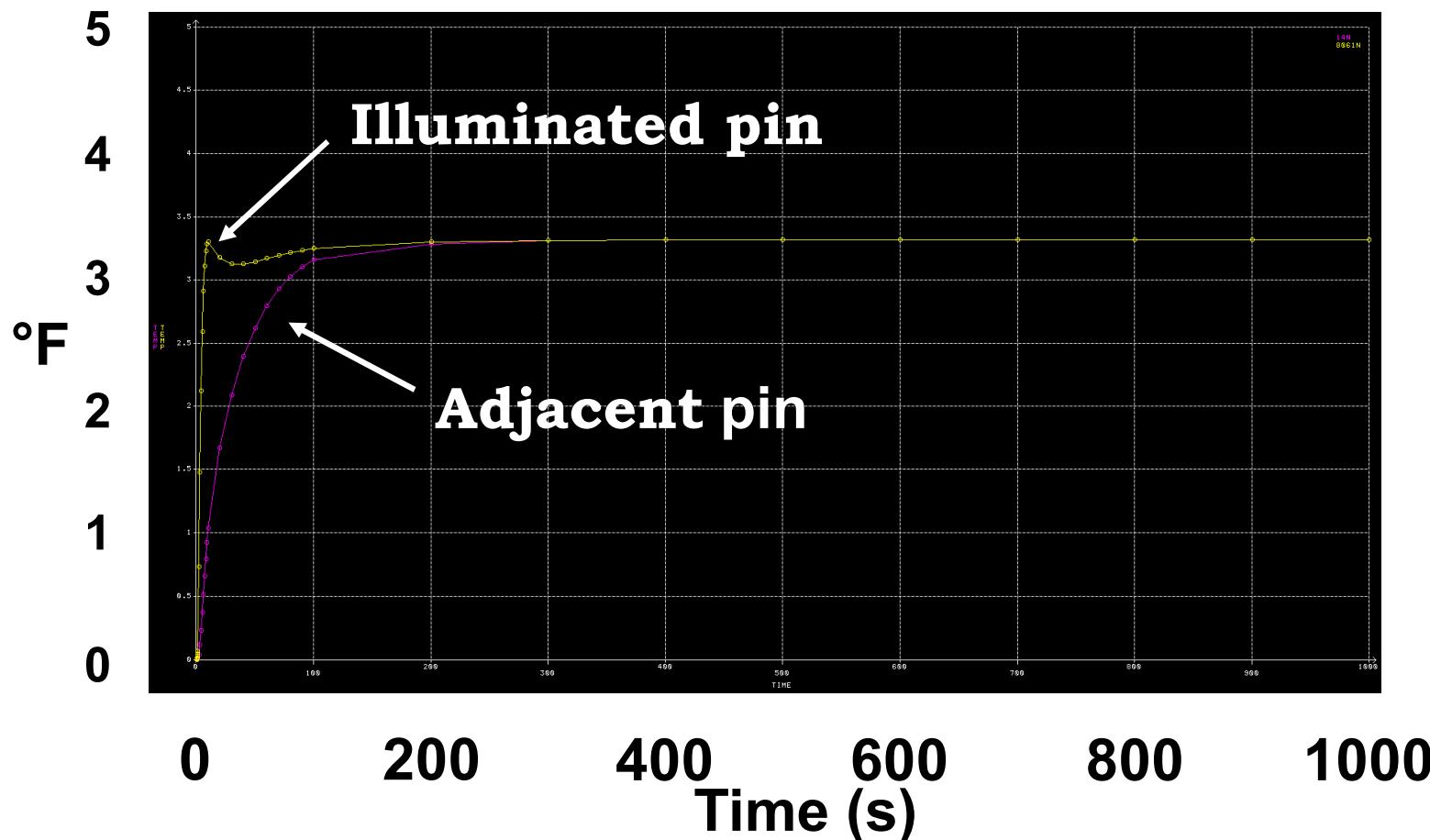


Heat Source



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

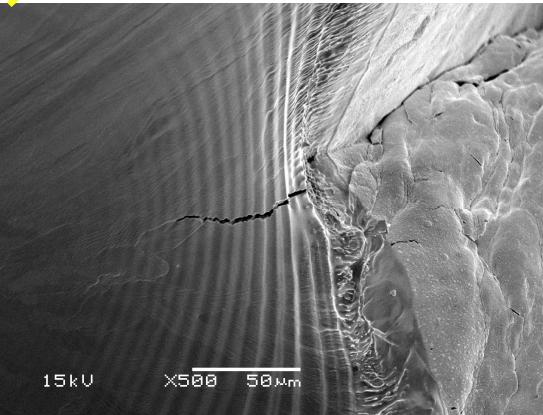
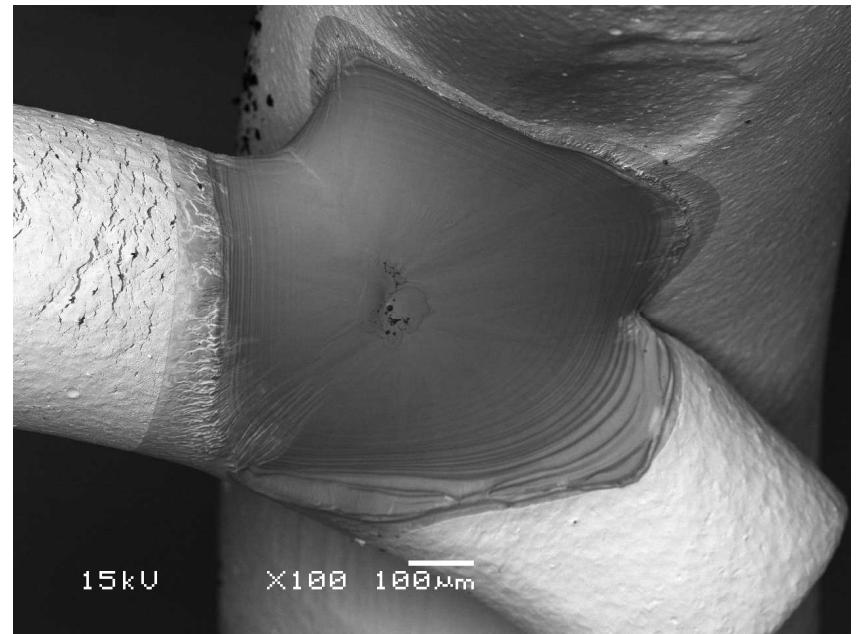
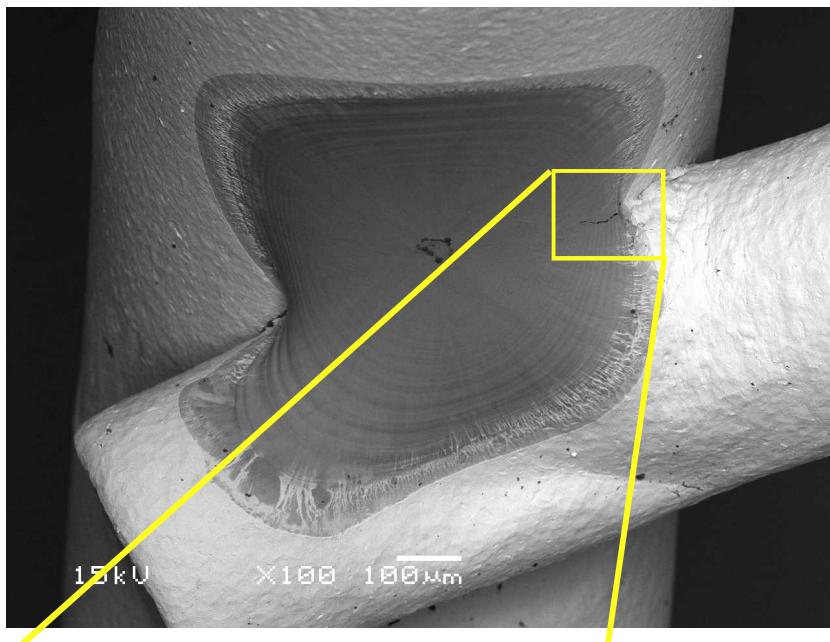
Temperature Rise Negligible



The predicted temperature RISE is 3.3 °F.
Note: *this is for a single pin.*



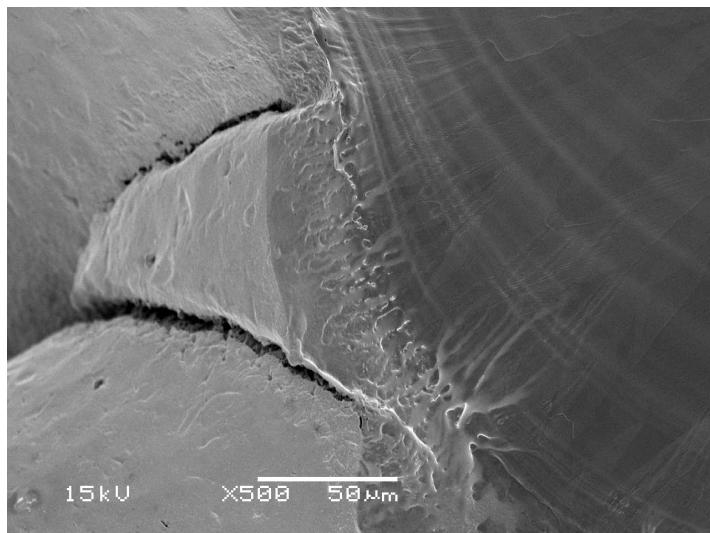
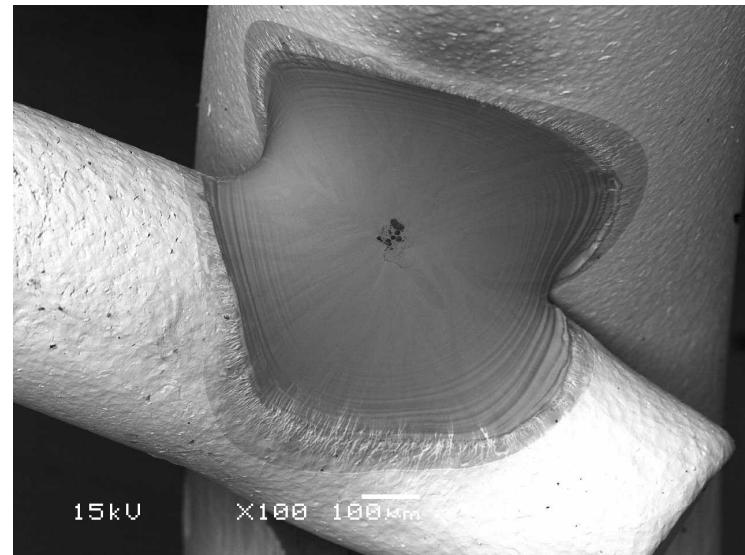
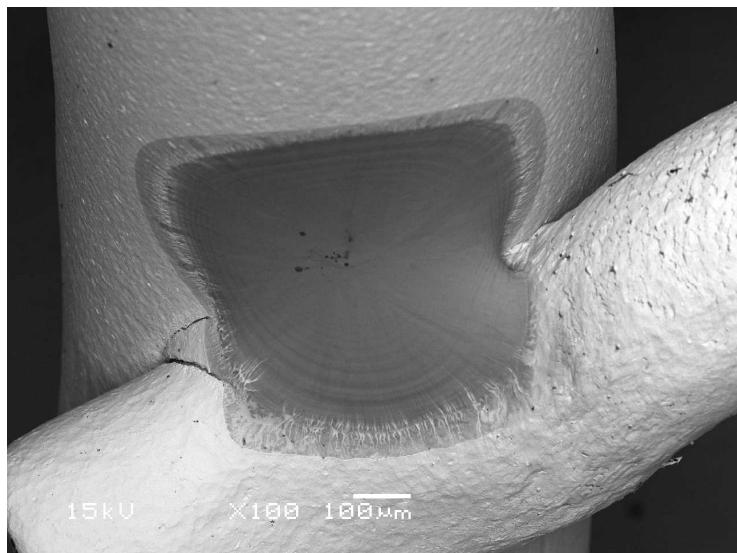
SEM of LBW



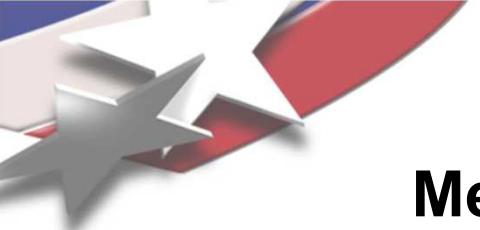
- Au plating mixed into Alloy 52 leads to occasional hot cracks.
- The joint is not intended to bear a mechanical load; electrical only



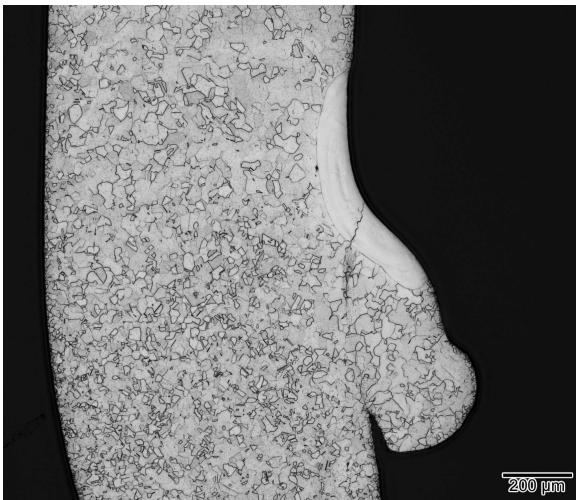
More SEM Pictures



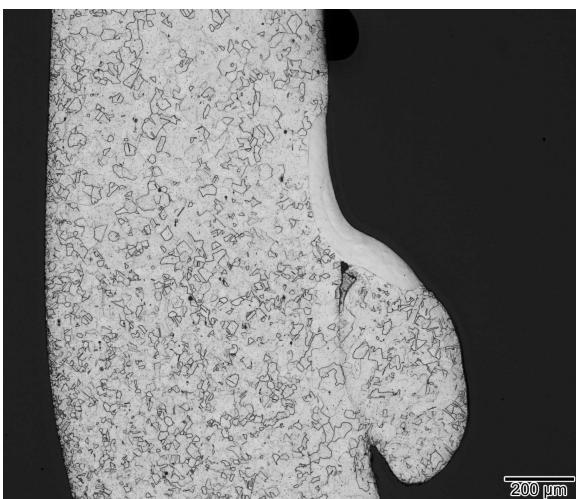
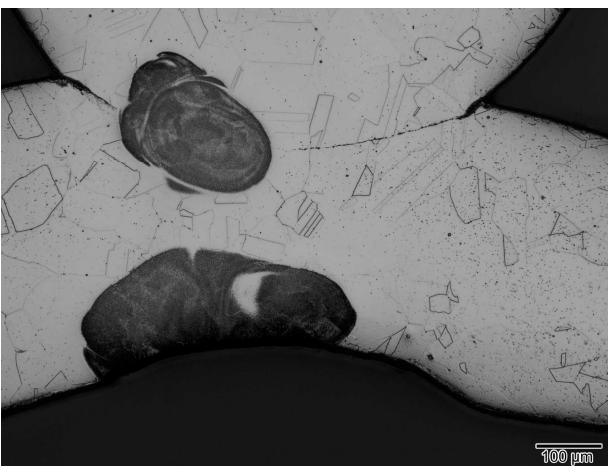
**No pre-clamping
of shunt-wire
to pin was used.**



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