SAND2012-7286P

Microscopy imaging of aluminum welds and electronic archiving of handbook for commercial aluminum alloys

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Sandia is a multiprogram laboratory operated by Sandia's Corporation, a Lockheed Martin Company for the United States Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000.

Outline

- Background and Motivation
- Objective
- Experimental Procedure
- Results
- Summary

Background and Motivation

- Aluminum is the most abundant lightweight metallic element on earth.
- Aluminum alloys are generally extracted by the Bayer process from bauxite ore.
- Aluminum is an important strategic metallic material for consumer products, architectural structures, energy, transportation and defense applications.
- Commercial aluminum alloys (1xxx to 7xxx), in general, conta Fe, Si, Mn.
  - Impurities inherited from the bauxite ore.
  - Leads to the formation of 2nd phase particles (Mg-Si, or Al-Mn-Fe-Si etc.) that may be harmful or beneficial to the material properties, depending on the application.

A compilation of microstructures of commercial aluminum alloys will be a useful reference for scientists at SNL.

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Objective

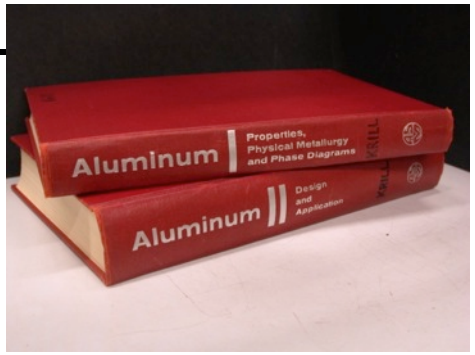
- Conduct literature search and electronic compilation of microstructure and second phase formation for commercial aluminum alloys.

- Demonstrate material characterization of aluminum welds using optical metallography, scanning electron microscopy, and X-ray spectroscopy techniques.

Experimental Procedure

- Scanning device was used at a resolution of 600 ppi.
- For illustration, the optical microscope and scanning electron microscope (SEM) were used to generate images of the microstructure and elemental distribution of polished Al 2219.
- Complementary SEM imaging techniques used in this presentation are secondary electron imaging (SEI) and backscattered electron imaging (BEI).
- Quantification of chemical composition for the second phase is illustrated using energy dispersive X-ray (EDX) spectrum and mapping.


Scanner



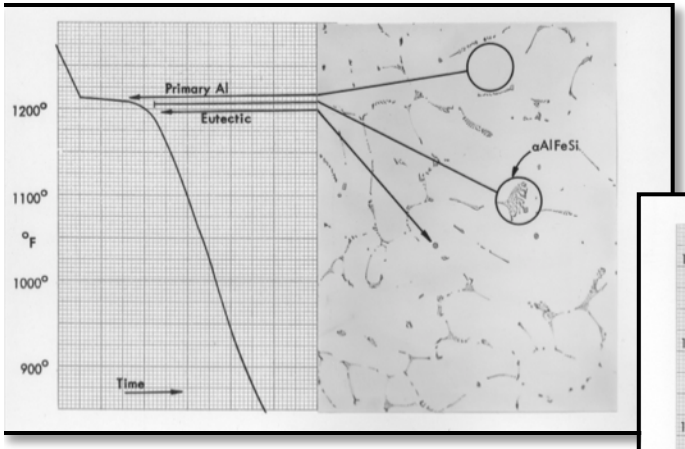

SEM


Optical Microscope

Example of optical image of 2nd phase formation during solidification found from literature

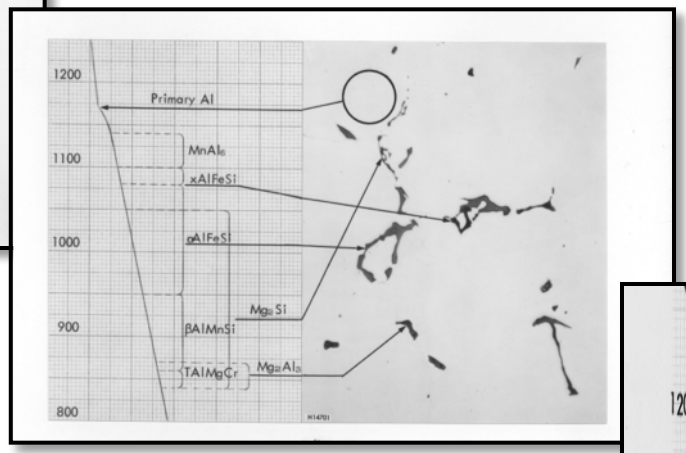
1100 alloy

αAlFeSi



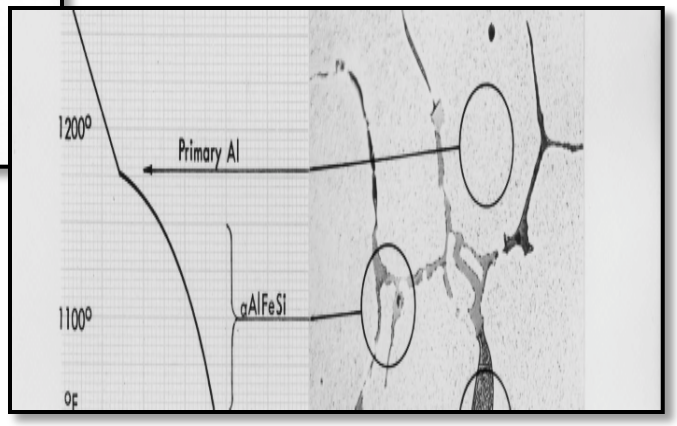
5083 alloy

$MnAl_6$
xAlFeSi
αAlFeSi
Mg_2Si
Mg_2Al_3



7075 alloy

αAlFeSi
Al_2CuMg
Mg_2Si



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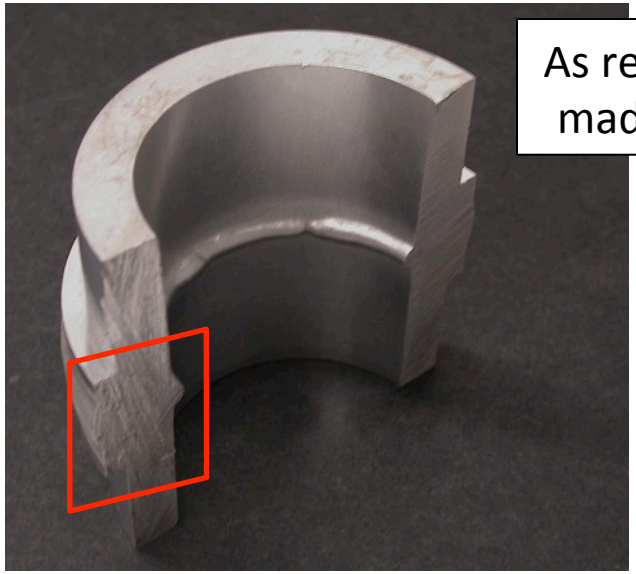
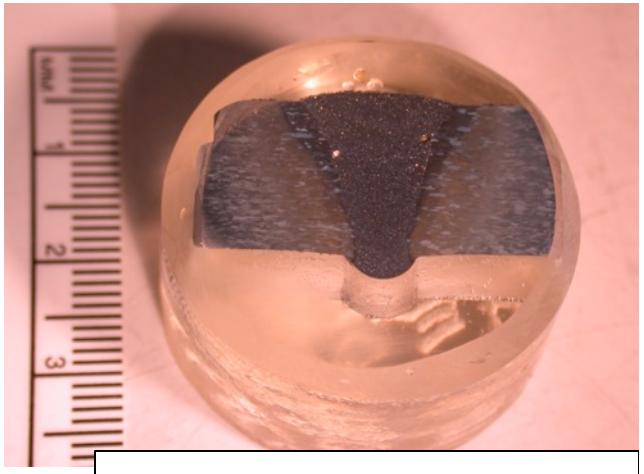
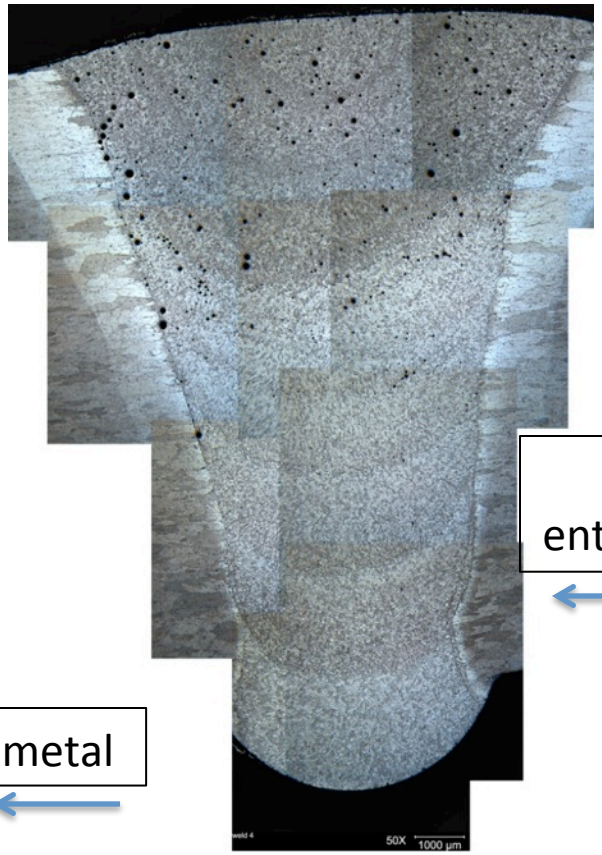
Optical images examine weld interface and grain structure near heat-affected-zone (HAZ) in Al 2219 GTA weld



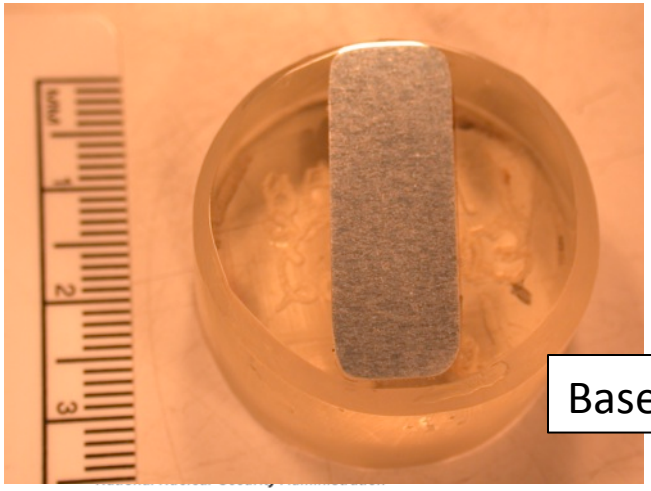
As received welds made at SNL, CA



Metallographic polished and etched cross section

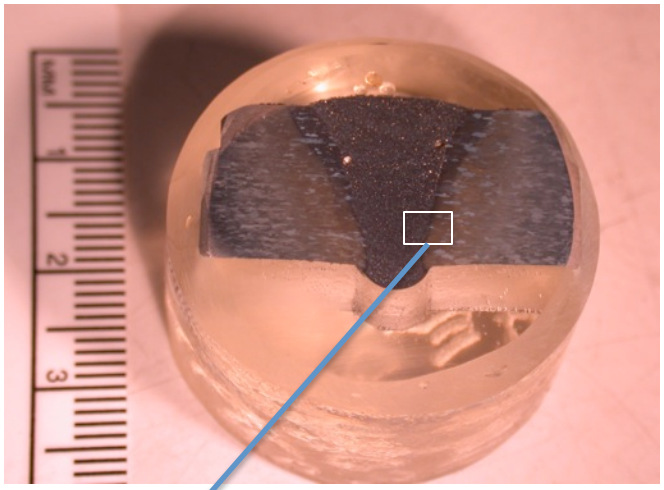


Montage of entire weld at 50X

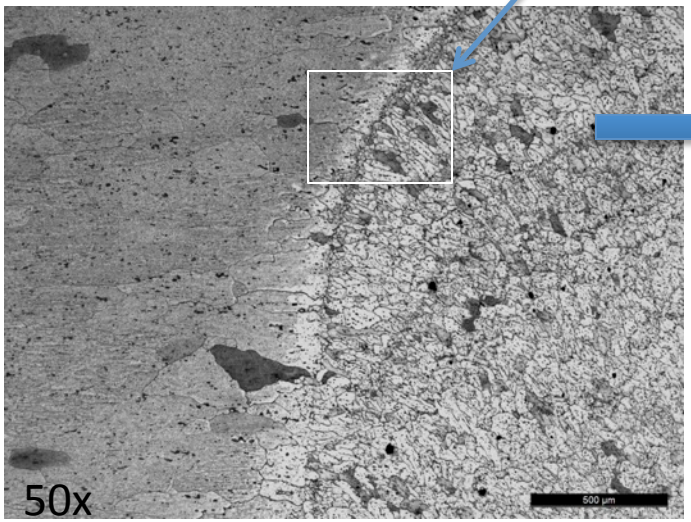


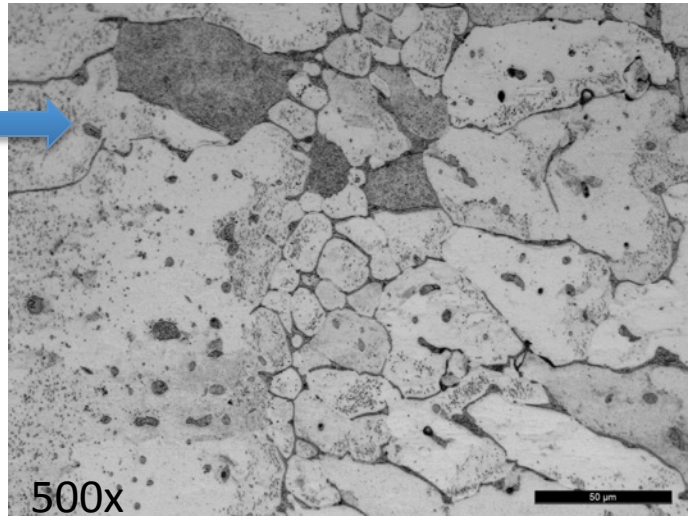
Base metal

Optical images examine weld interface and grain structure near heat-affected-zone (HAZ) in Al 2219



Metallographic cross section: polished, and etched with Keller's reagent

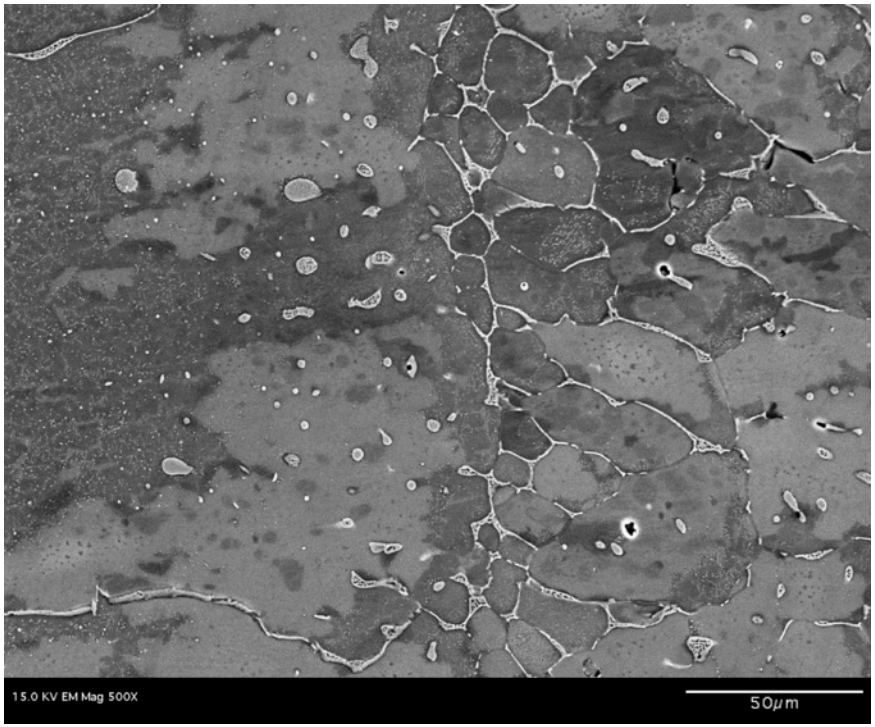




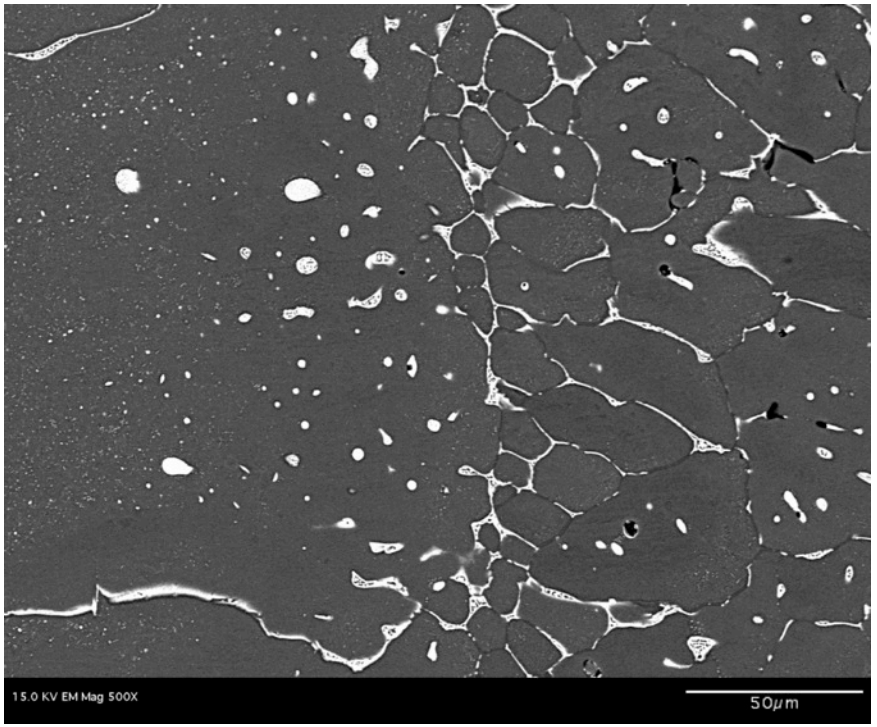
Optical image took from the metallographic mount

SEM images at 500x examine second phase particles along weld interface using complementary SEI and BEI

SEI – shows topographic contrast



BEI – shows compositional contrast



Aluminum 2219 GTA weld

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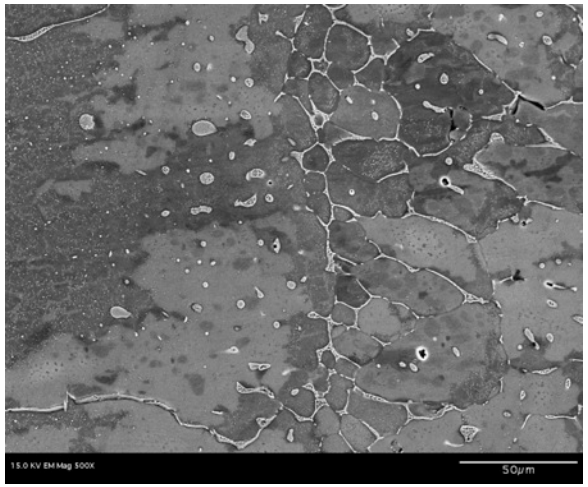
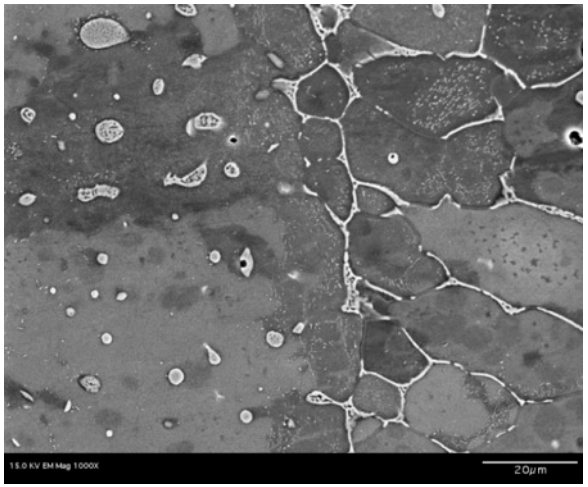
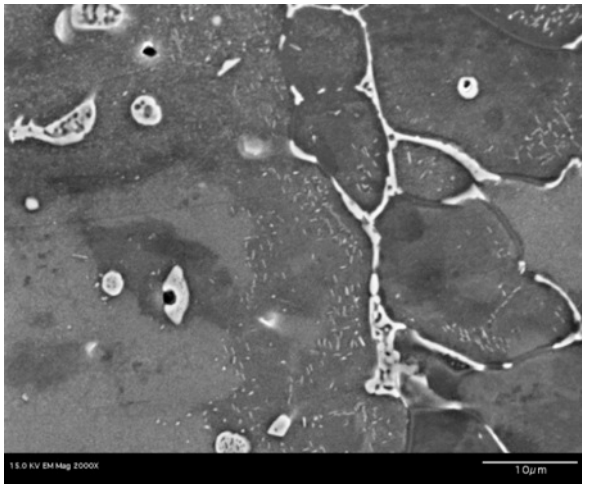
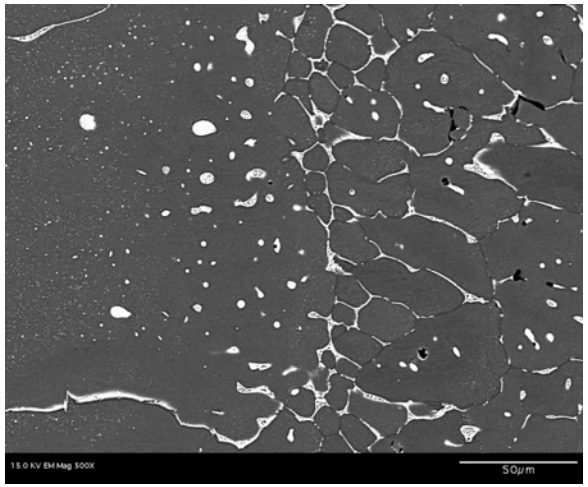
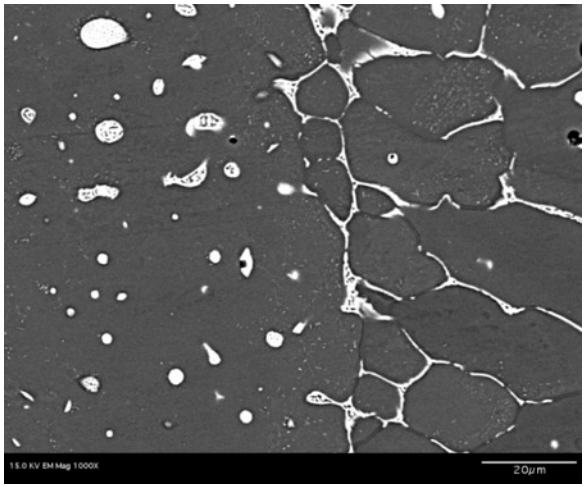
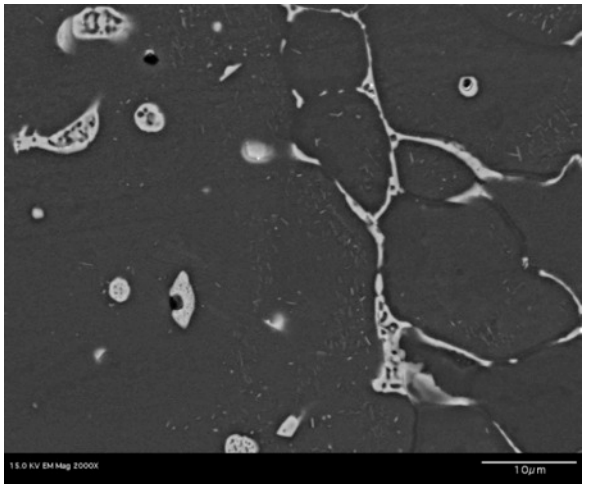
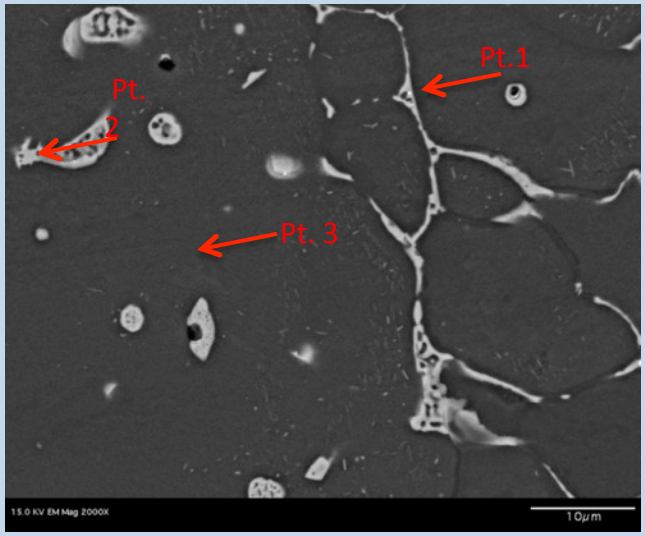
Higher mag. SEM images examine second phase particles along weld interface in Al 2219 GTA weld

	500x	1000x	2000x
SEI			
BEI			

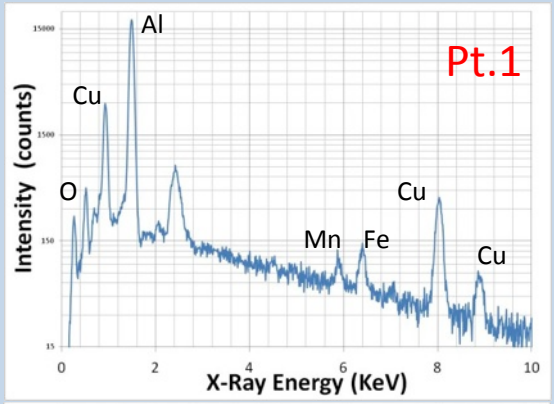
SEM/EDS identify chemical composition of the second phases and matrix in Al 2219 GTA weld

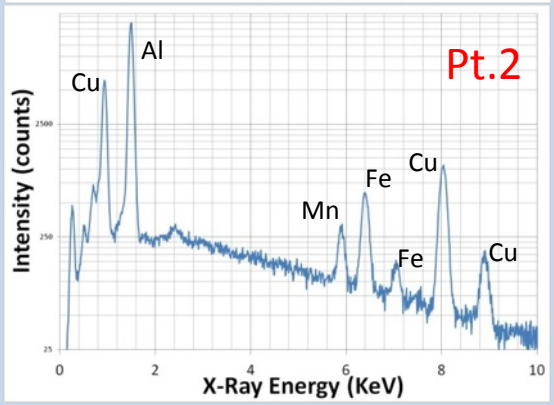
BEI 2000x

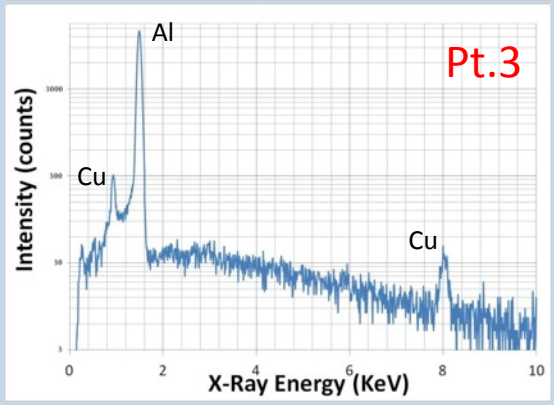


Weight Percentage

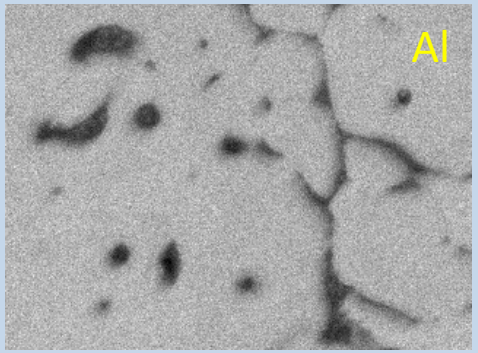
	Al	Cu	Fe	Mn
Pt. 1	70.33	24.09	4.07	1.51
Pt. 2	58.22	32.65	6.96	2.17
Pt. 3	76.21	21.17	1.78	0.81
Nominal Composition		6.00	0.12	0.26

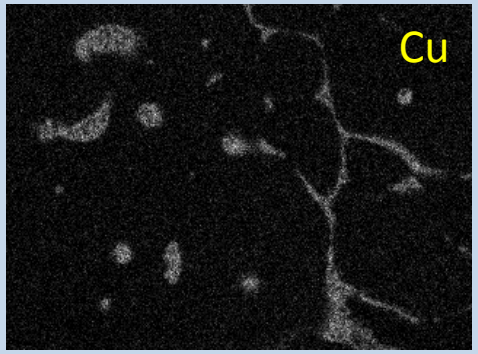


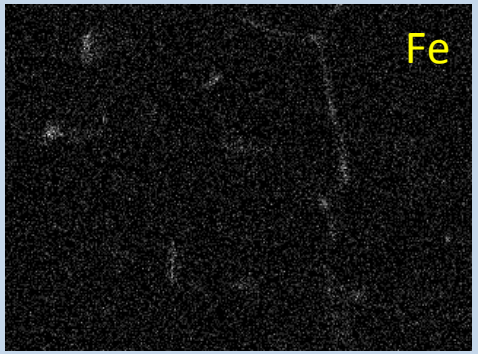




X-ray mapping







Summary

- Data archiving is completed for future reference.
- The procedure for imaging the microstructure of A2219 GTA aluminum weld is illustrated.
- We also demonstrated the complementary SEM imaging and advanced EDX chemical analysis for the second phase particles and matrix in A2219 weld.

Acknowledgements

- Thank you to Nancy Yang and Chris San Marchi for giving me this opportunity to learn about scientific research and its importance.
- Special thanks again to Nancy Yang and Albert Wu for their daily guidance.
- Technical assistance from Jeff Chames, Ryan Nishimoto, Andy Gardea, and Lauren Hughes is greatly appreciated.