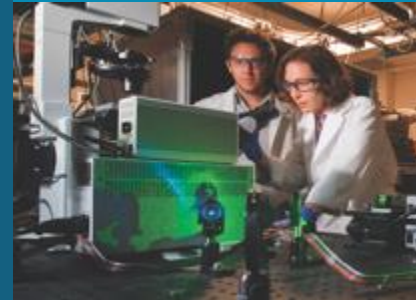


Digital Image Analysis of Dendritic Microstructures in Vacuum Arc Remelted Nickel Alloy 718



PRESENTED BY

¹Thomas Ivanoff, ²Trevor Watt, and ³Eric Taleff

¹Sandia National Laboratories, Albuquerque, NM

²Vulcan Laboratories, Belton, TX

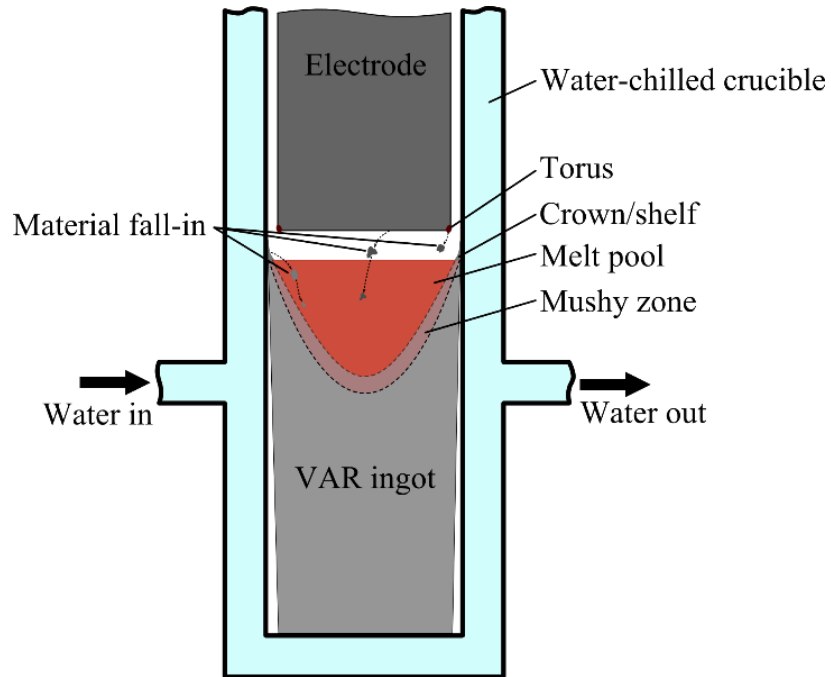
³The University of Texas at Austin, Austin, TX



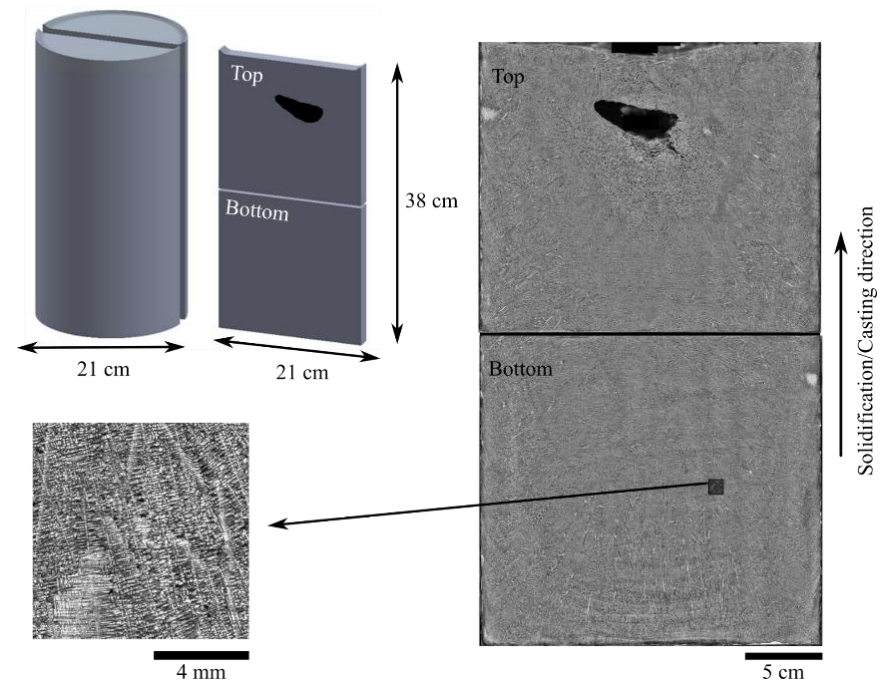
- Motivation
- Experimental methods
 - Image acquisition
 - Digital image processing
- Analysis techniques
 - Particle identification
 - Two-point correlation
- Results
 - Primary dendrite arm orientation (PDAO)
 - Secondary dendrite arm spacing (SDAS)
- Conclusions



Vacuum arc remelting (VAR)

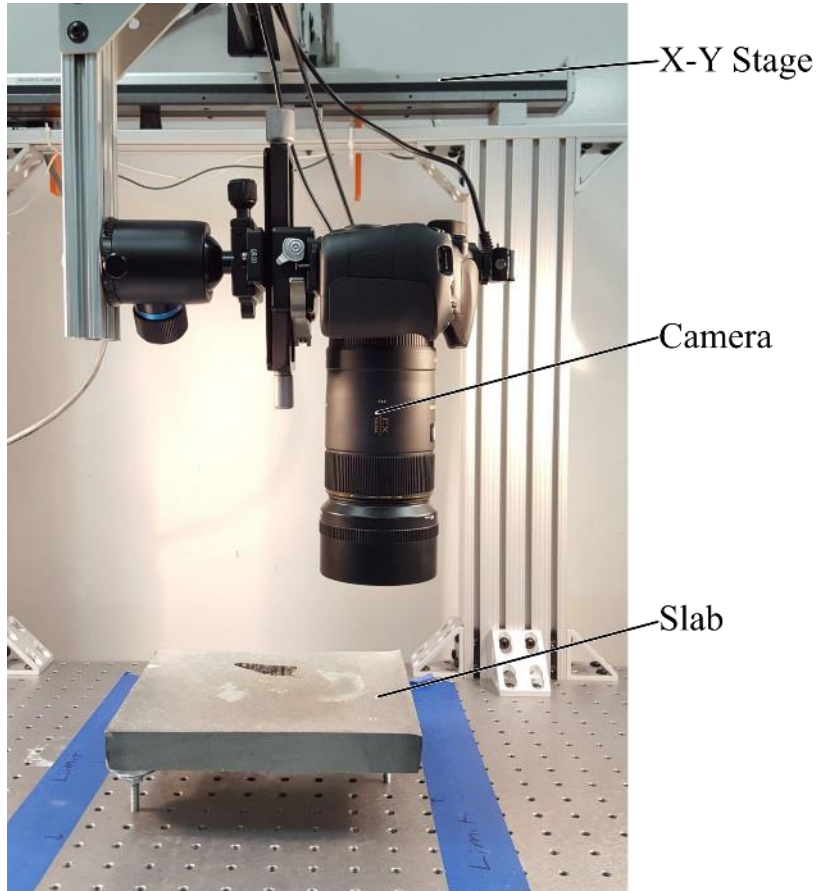


Laboratory-scale alloy 718 VAR ingot

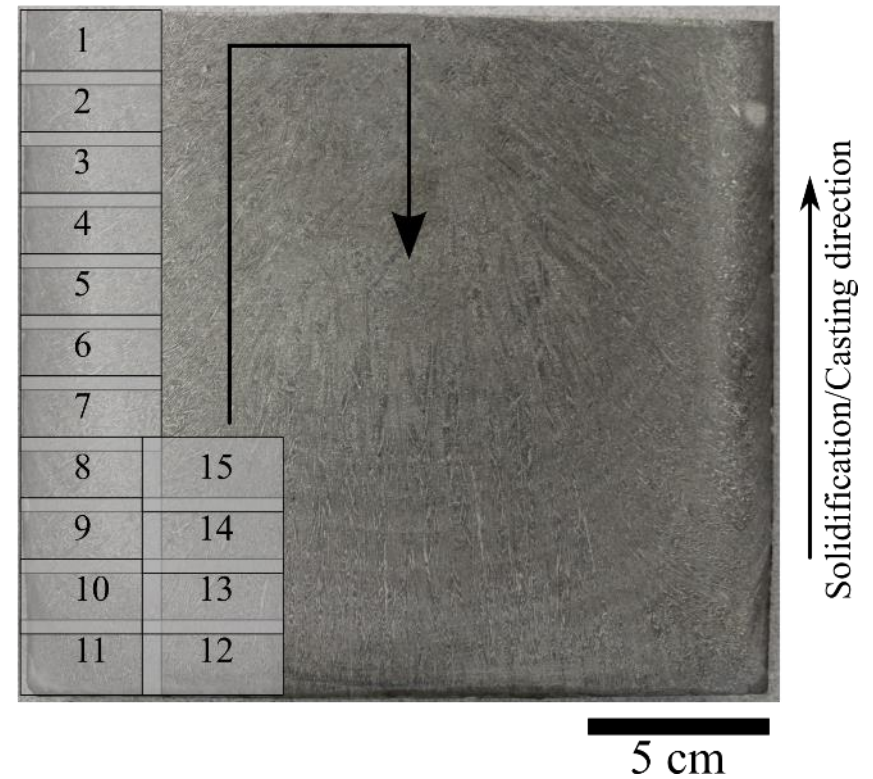




Imaging stage

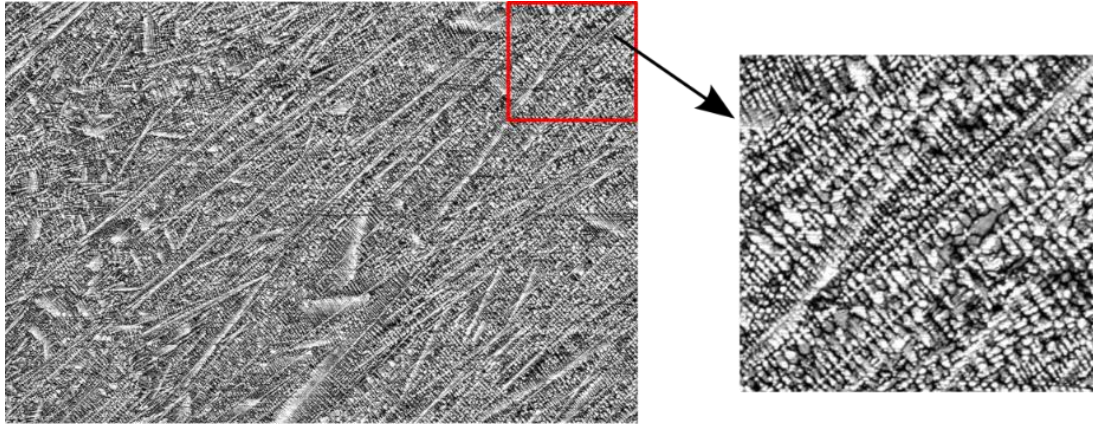


Imaging pattern

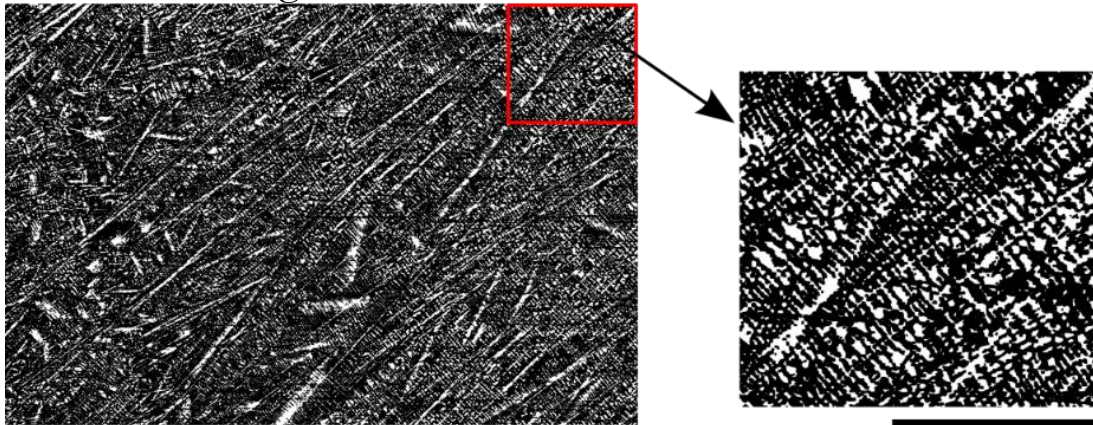




Original image



Processed image



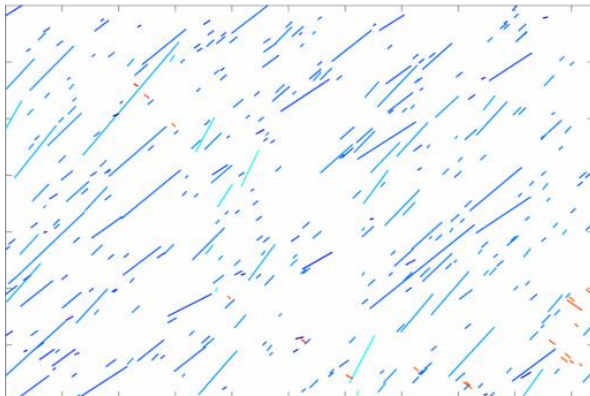
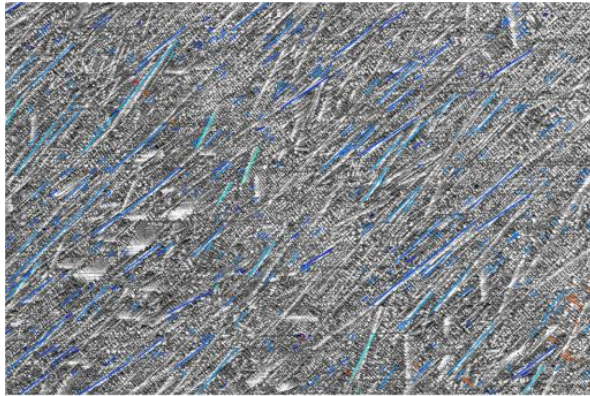
5 mm

2 mm

- Process image to improve dendrite detection
- Reduce complexity to permit computerized analysis
- Analysis techniques:
 - Particle identification
 - Two-point correlation

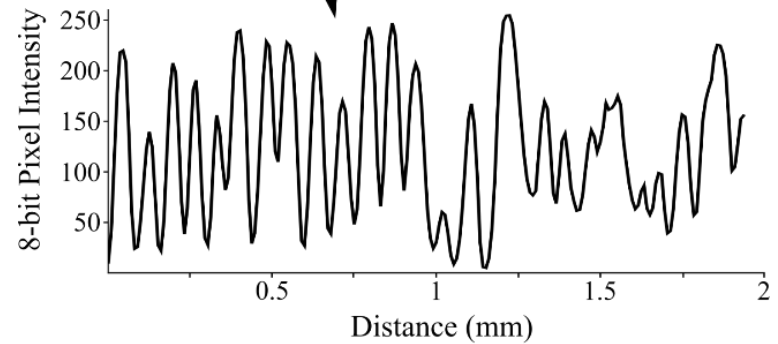
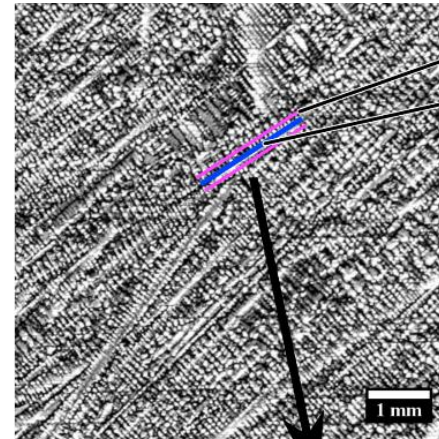


Primary dendrite arms



4 mm

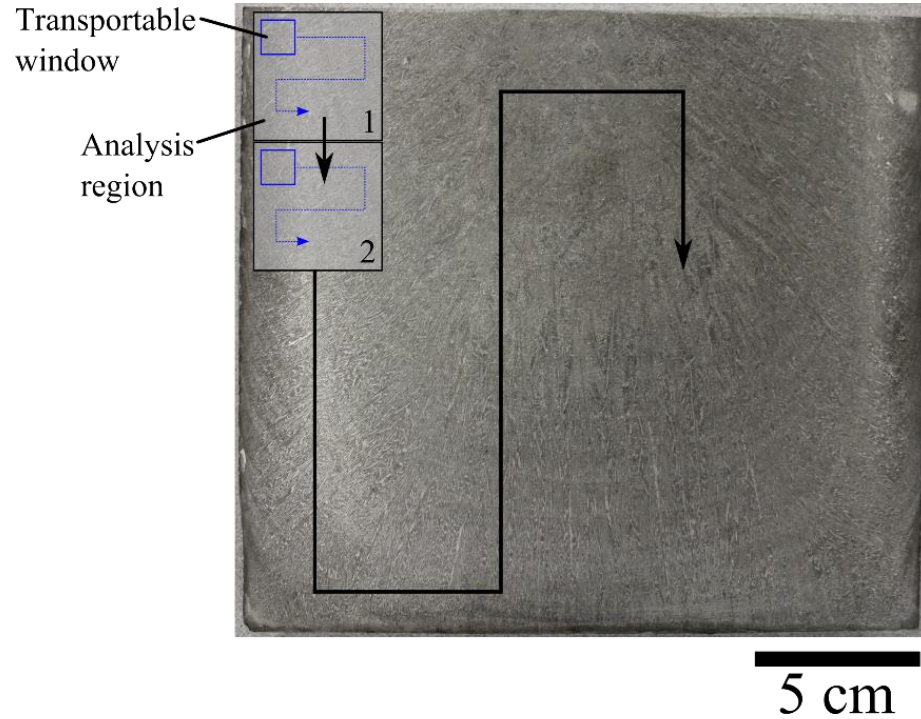
Secondary dendrite arms



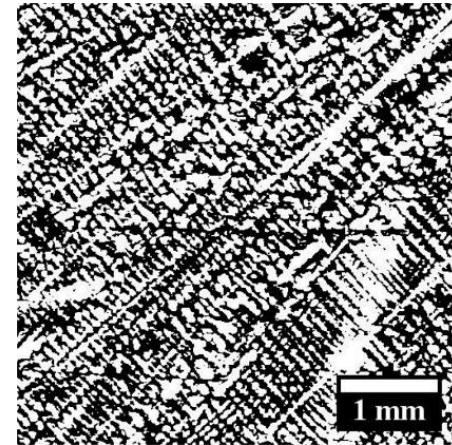
7 Two-point Correlation



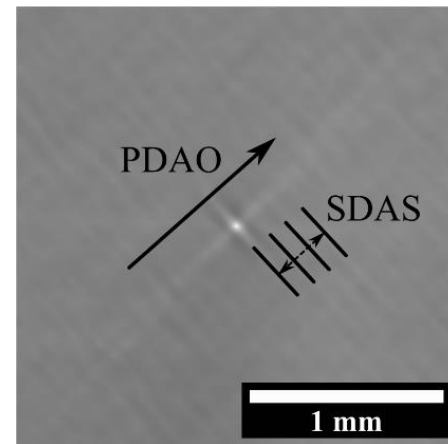
Analysis pattern



Analysis region

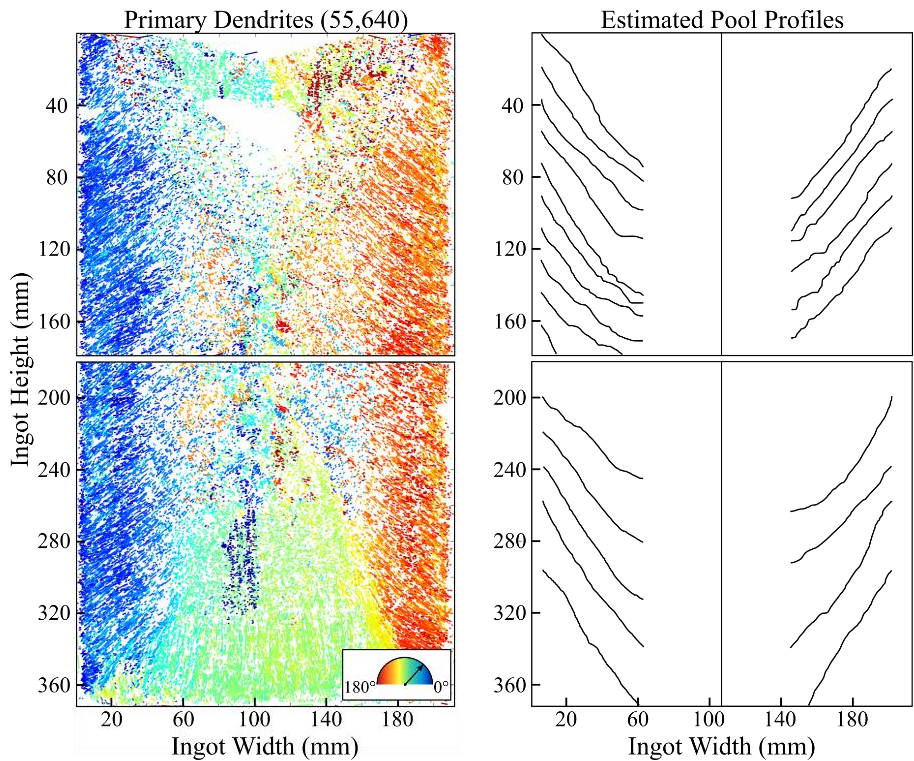


Two-point correlation

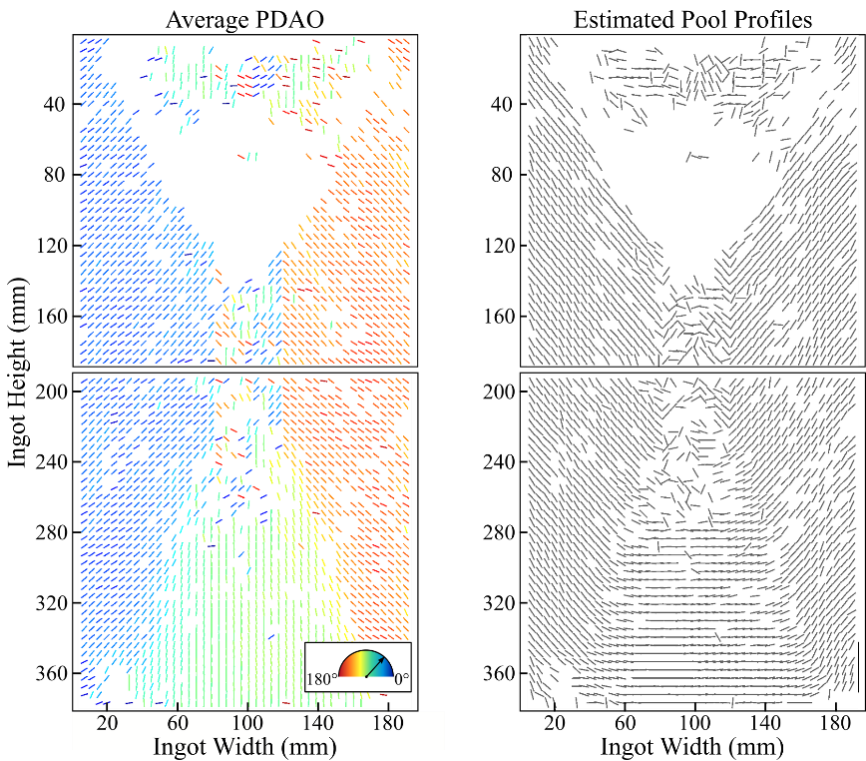


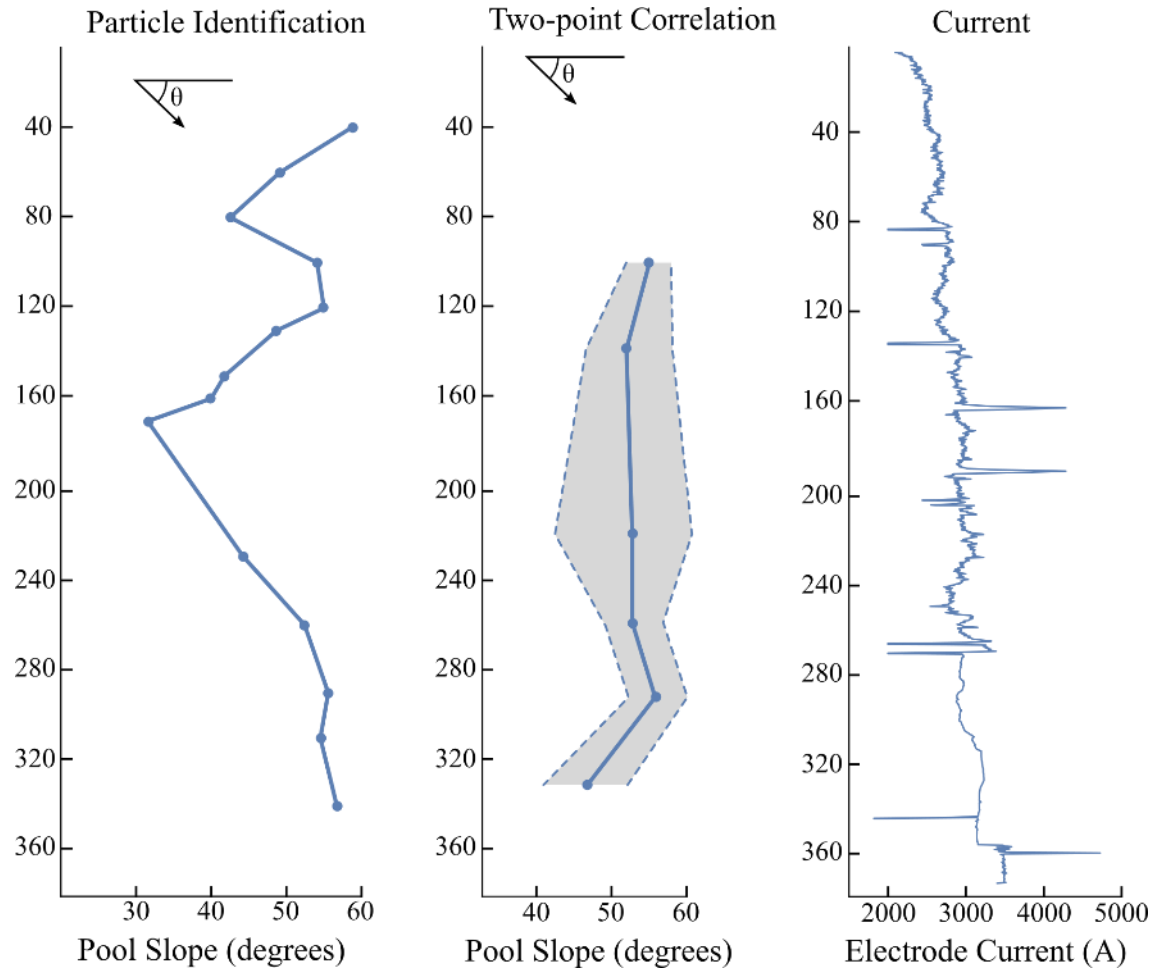


Particle Identification



Two-point Correlation

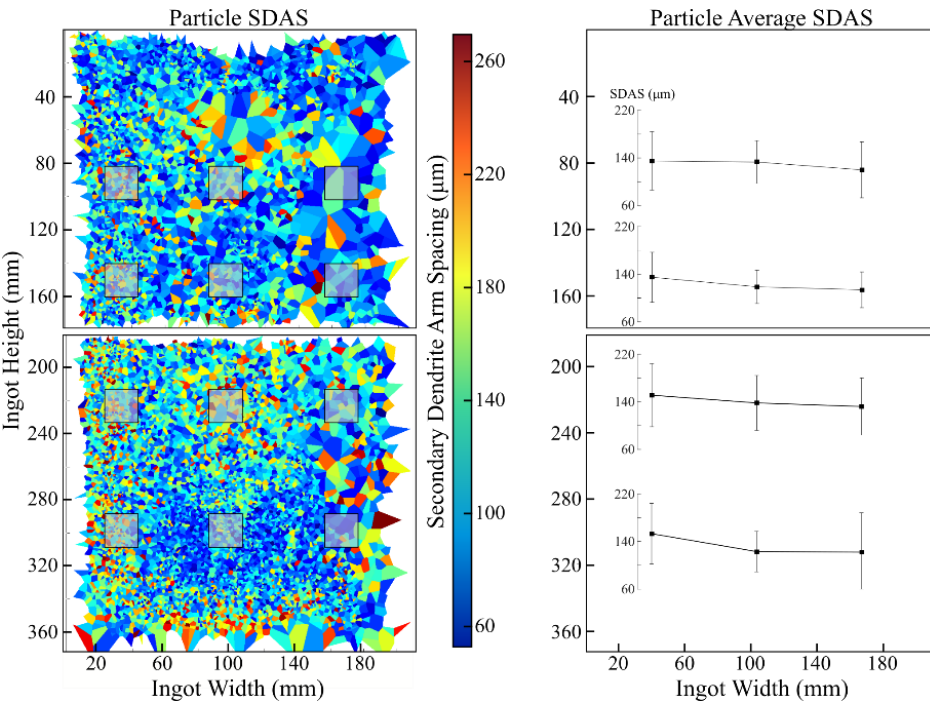




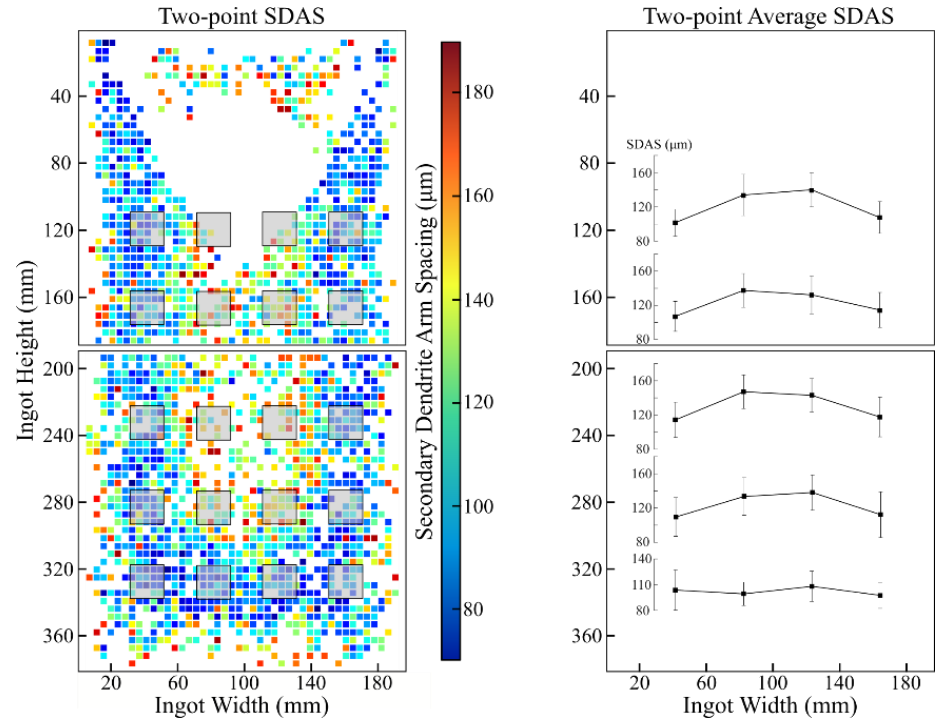
- Particle identification
 - Slope varies along ingot height
- Two-point correlation
 - Slope remains approximately constant along ingot height

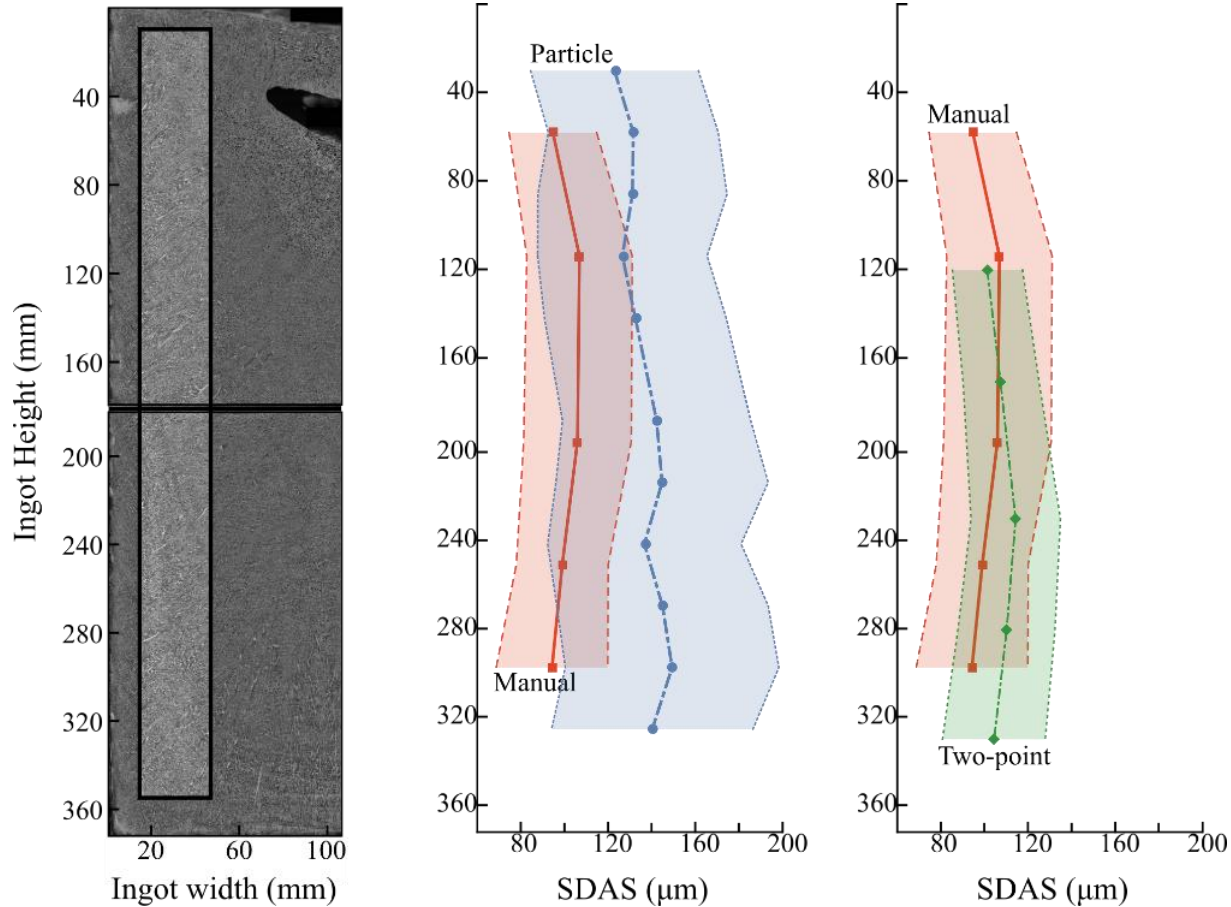


Particle Identification



Two-point Correlation





- Particle identification
 - Poor precision
- Two-point correlation
 - Accurate and precise

$$\lambda = 5.5(Mt_f)^{1/3}$$

$$M = 2.74 \mu\text{m}^3/\text{s for alloy 718}$$

W. Kurz and D. J. Fisher, Fundamentals of Solidification, Enfield, NH: Trans Tech Publications Inc, 1998.



- Digital image analysis techniques provide a practical means to characterize large microstructural data sets
- Dendritic microstructures can be used to reconstruct solidification history in remelted alloy 718 material.
 - Microstructure is compared to process parameters
- Particle identification is less precise than two-point correlation
 - Data averaging improves results
- Computational models can be validated against the results produced

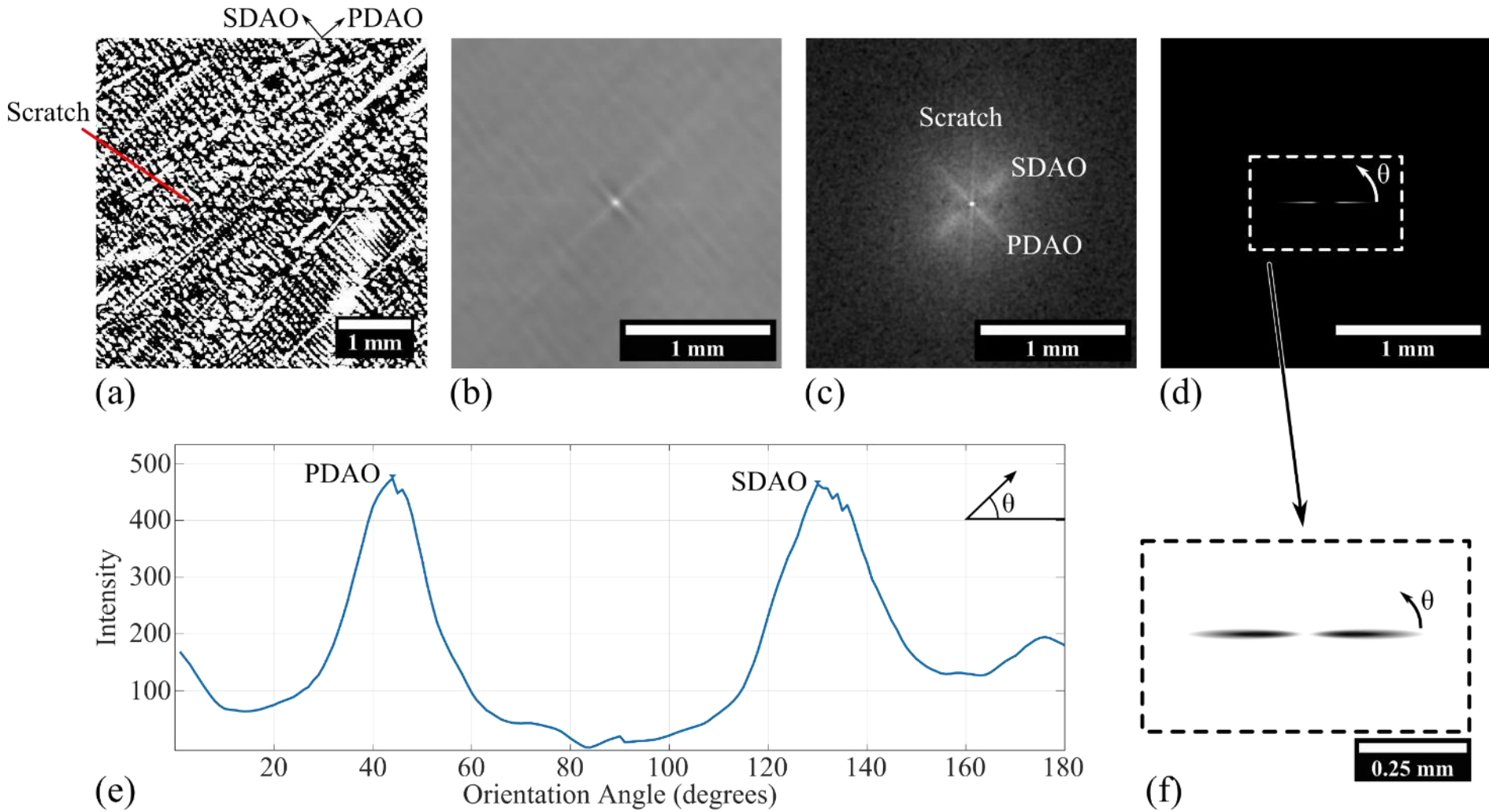


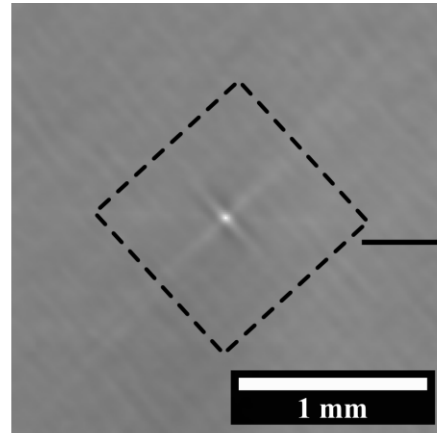
- Mykal Madrid and Katie Adams
- Air Force Research Lab (AFRL)
 - FA8650-11-2-5224-B
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 - N00014-11-1-0366
 - N00014-12-1-0811
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 - Special Metals Corp.
 - Carpenter Technology Corp.
 - Allegheny Technologies Inc.



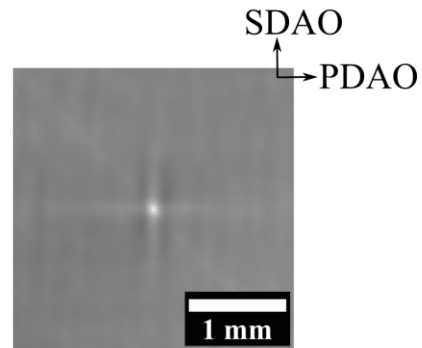
Questions



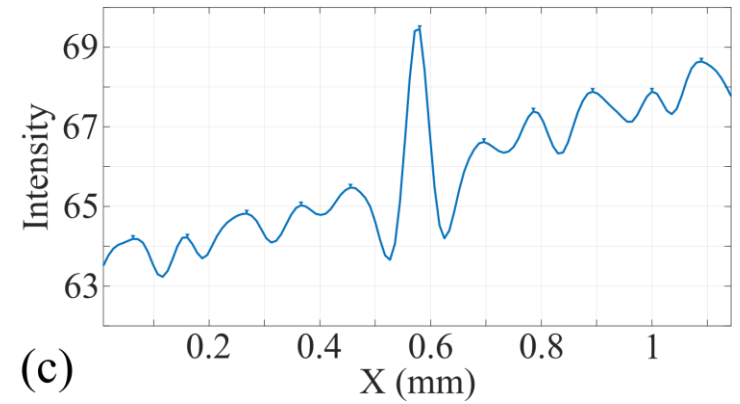




(a)



(b)



(c)