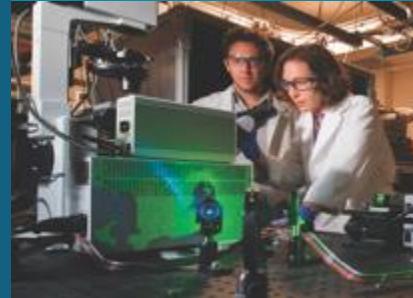




Sandia
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Digital Image Analysis of Dendritic Microstructures in Vacuum Arc Remelted Nickel Alloy 718



PRESENTED BY

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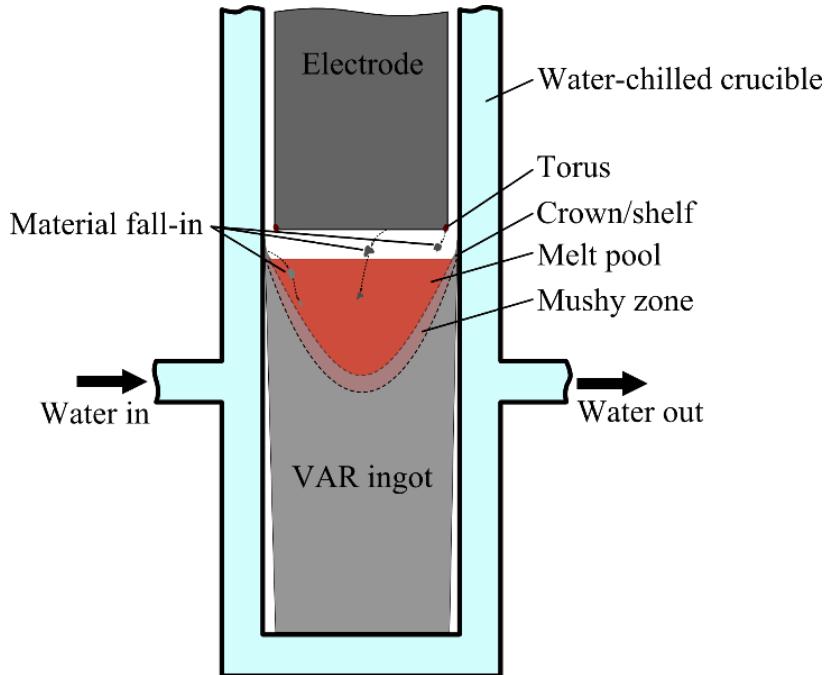


- Motivation
- Experimental methods
 - Image acquisition
 - Digital image processing
- Analysis techniques
 - Particle identification
 - Two-point correlation
- Results
 - Primary dendrite arm orientation (PDAO)
 - Secondary dendrite arm spacing (SDAS)
- Conclusions

Motivation



Vacuum arc remelting (VAR)



Laboratory-scale alloy 718 VAR ingot

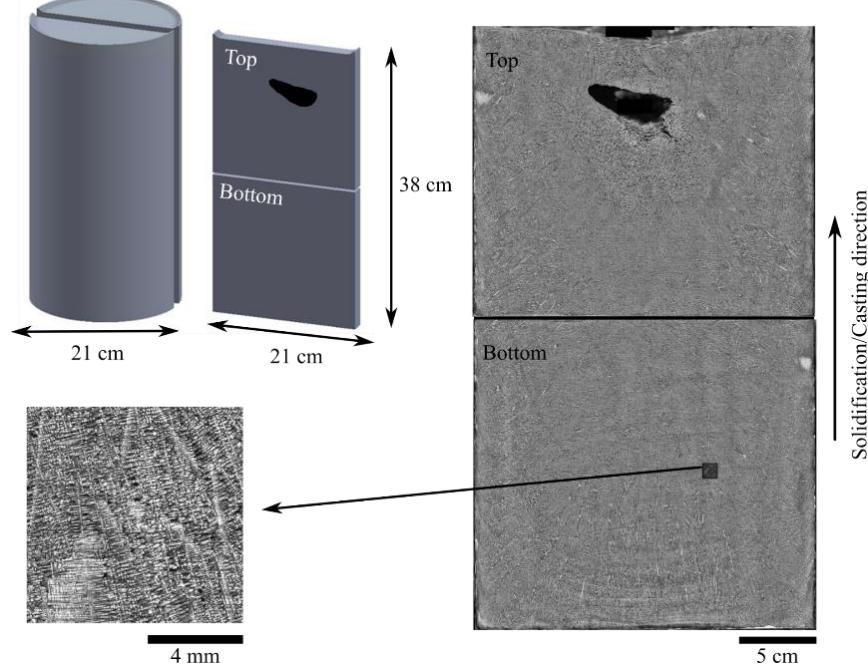
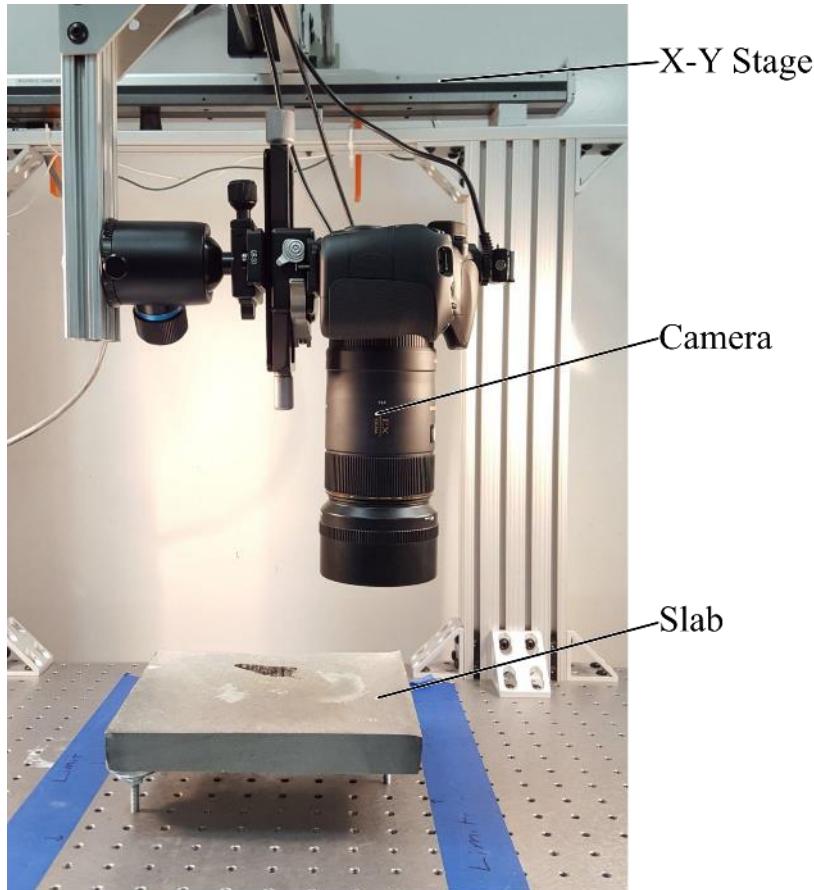


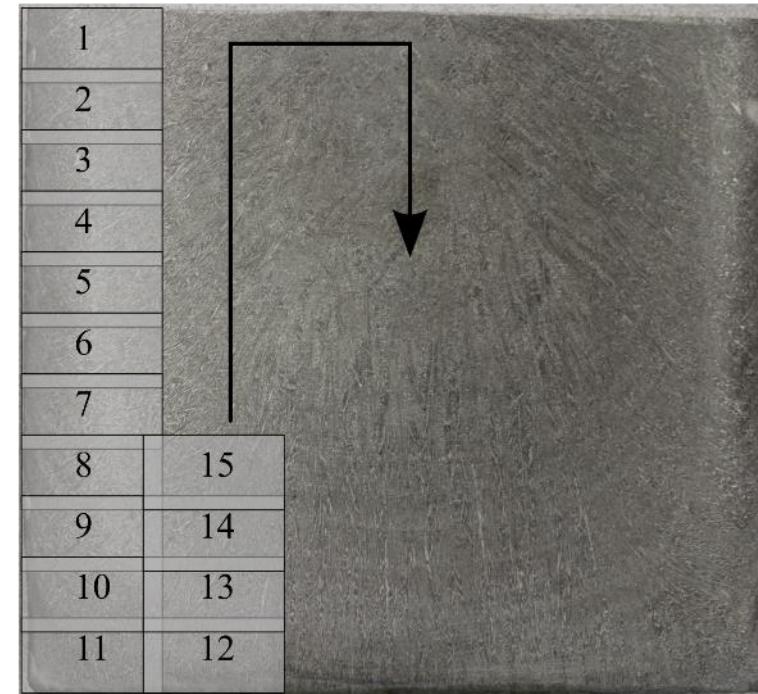
Image Acquisition



Imaging stage



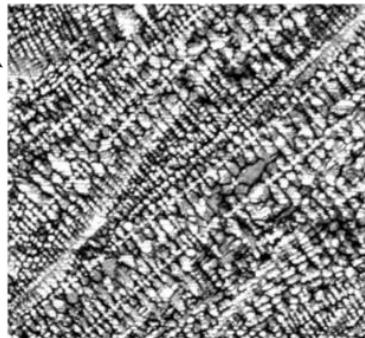
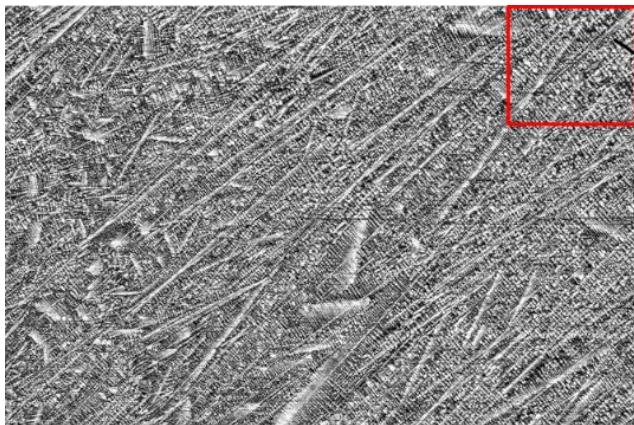
Imaging pattern



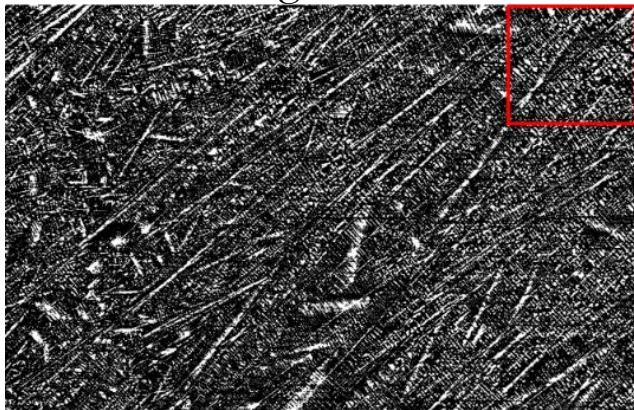
↑ Solidification/Casting direction



Original image



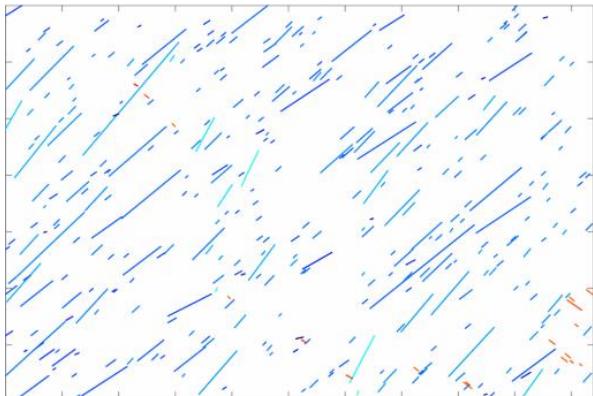
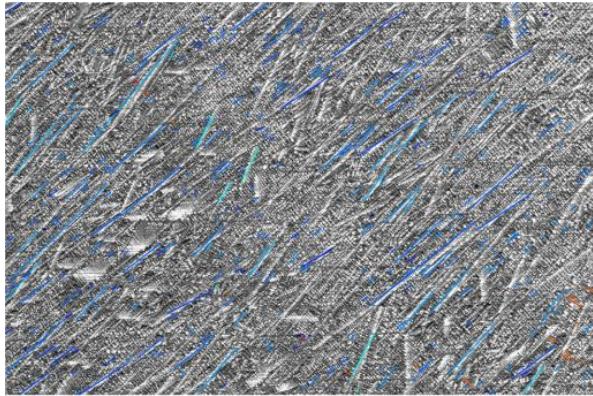
Processed image



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

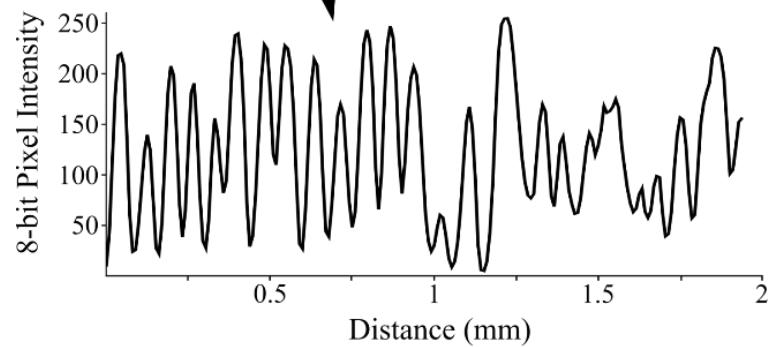
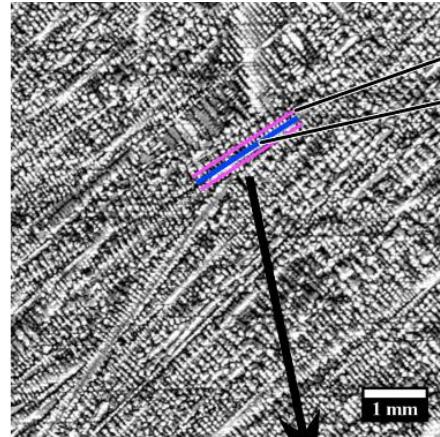


Primary dendrite arms



4 mm

Secondary dendrite arms

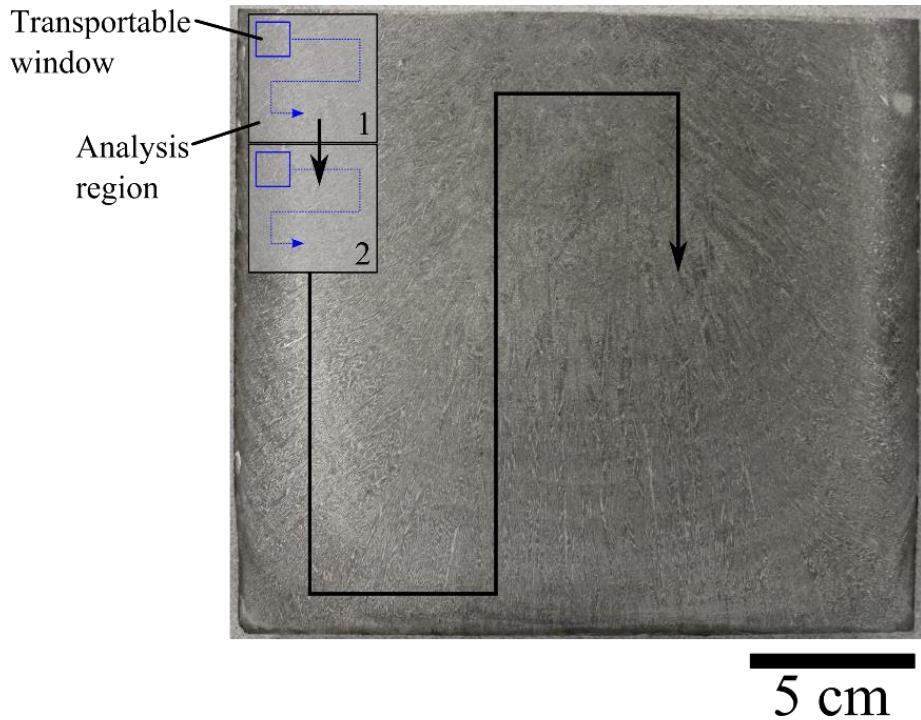


SDAS analysis line 1
Primary dendrite arm analyzed

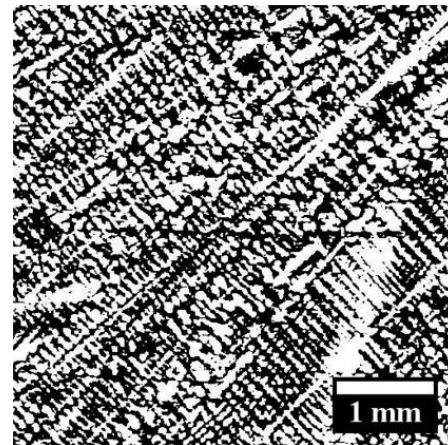
Two-point Correlation



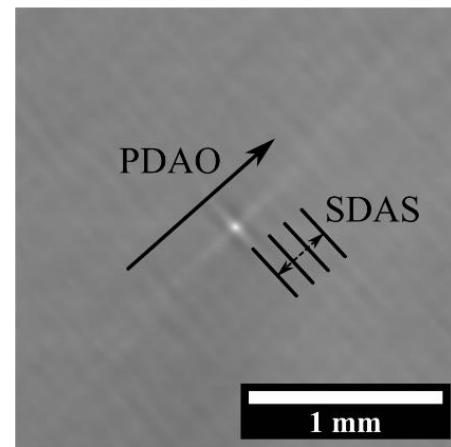
Analysis pattern



Analysis region

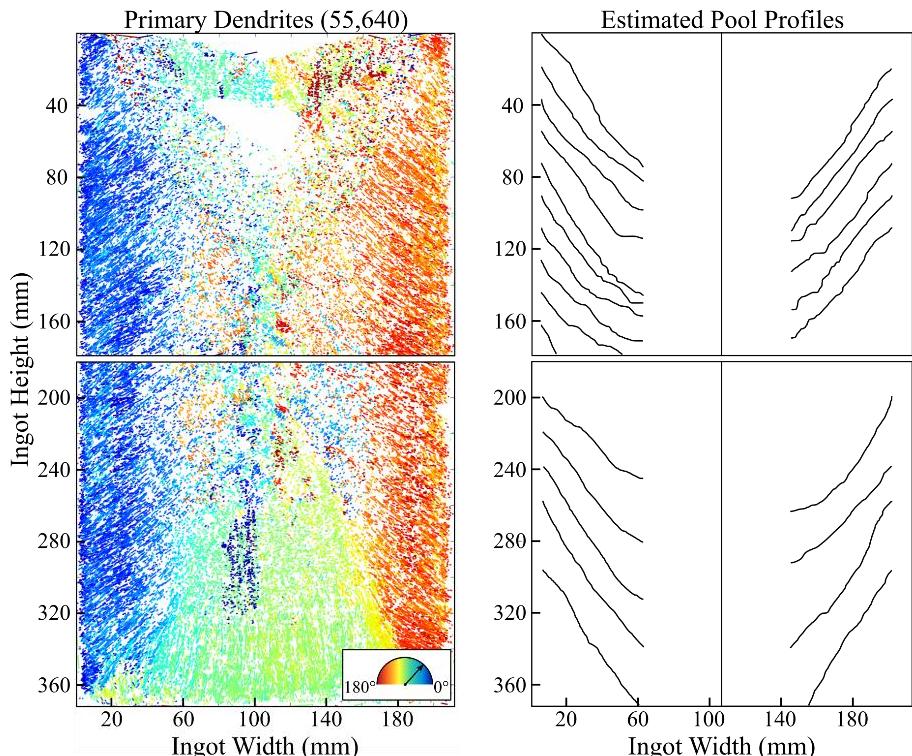


Two-point correlation

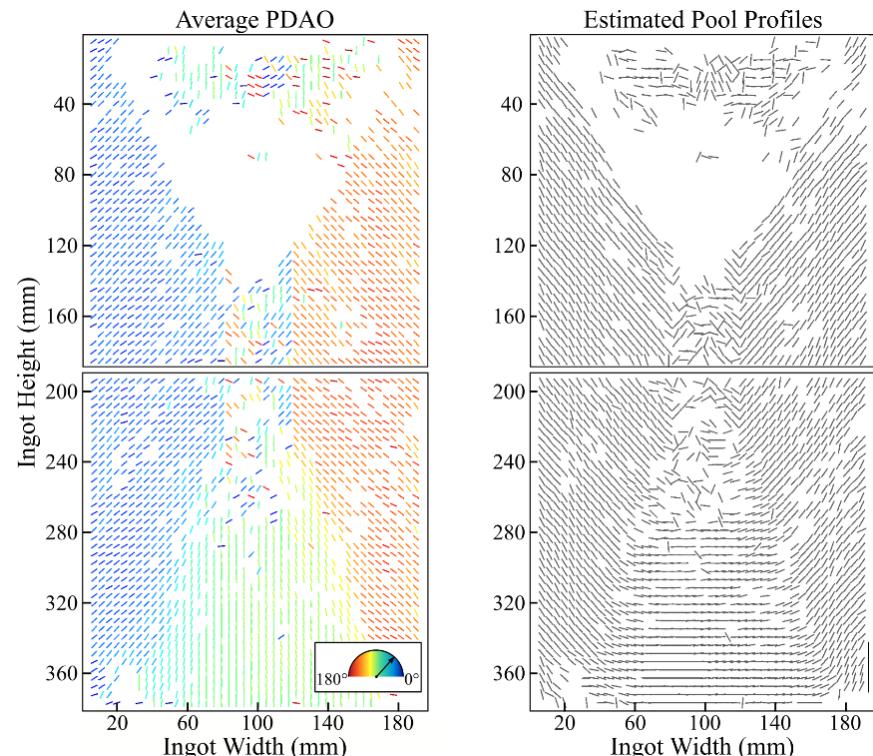




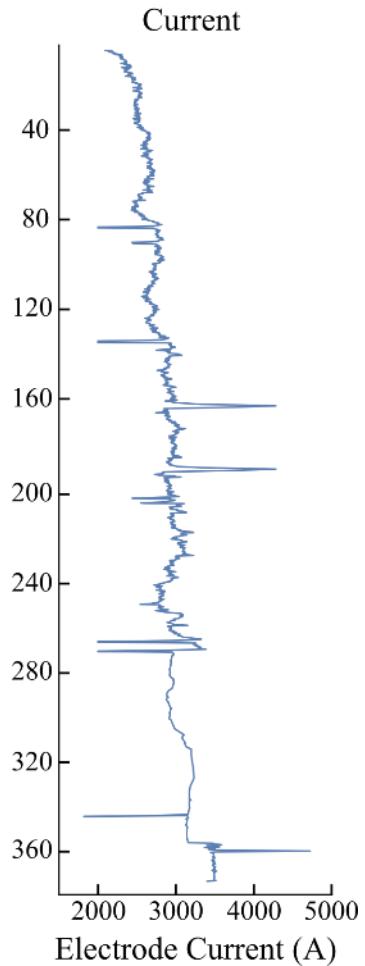
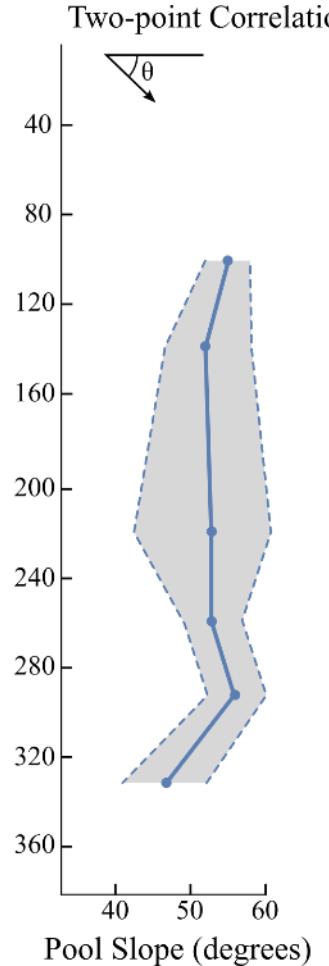
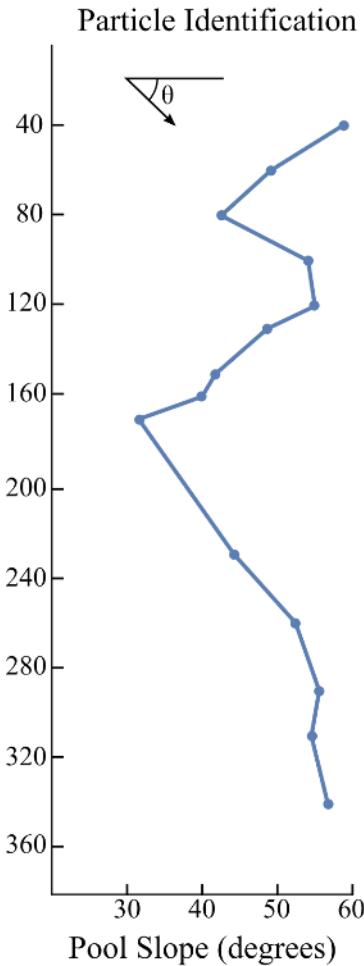
Particle Identification



Two-point Correlation



Melt Pool Profile Slopes

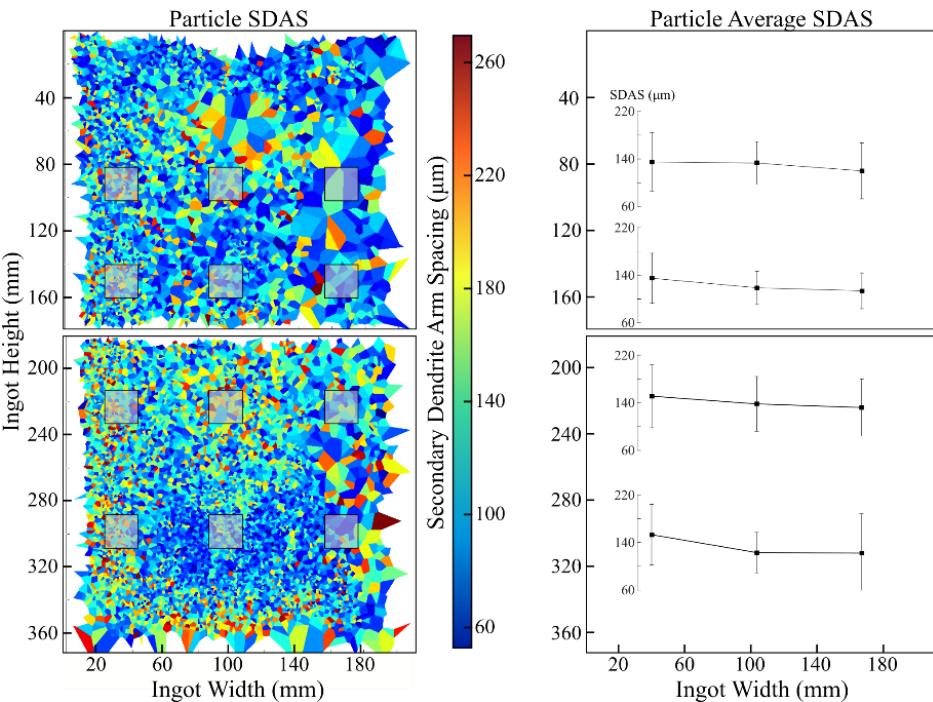


- Particle identification
 - Slope varies along ingot height
- Two-point correlation
 - Slope remains approximately constant along ingot height

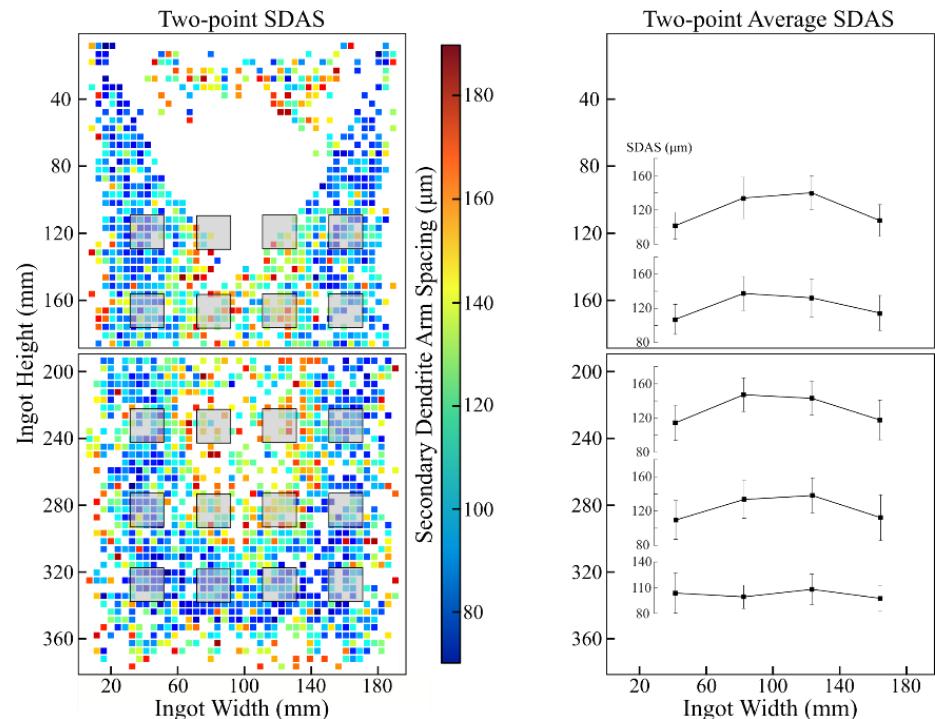
Secondary Dendrite Arm Spacing

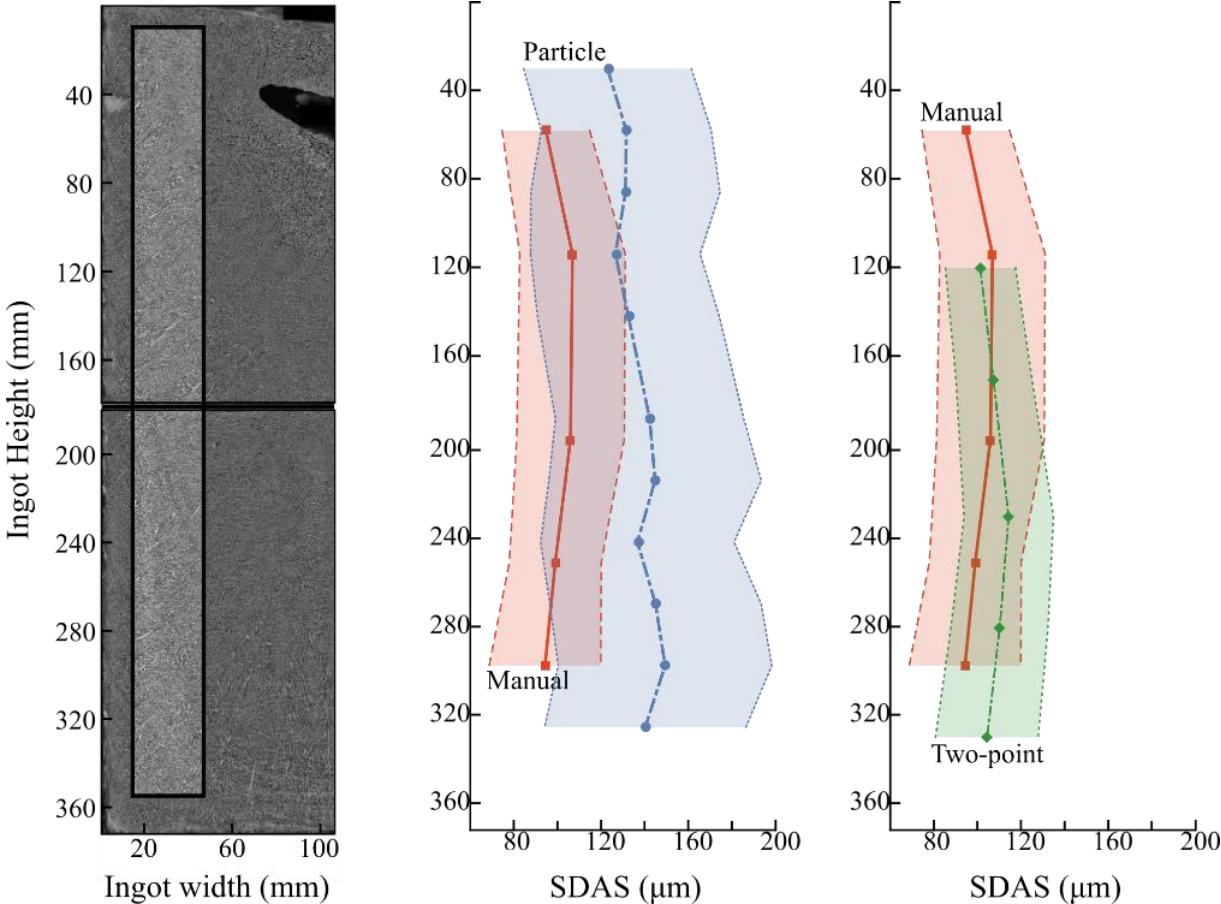


Particle Identification



Two-point Correlation





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

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

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

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

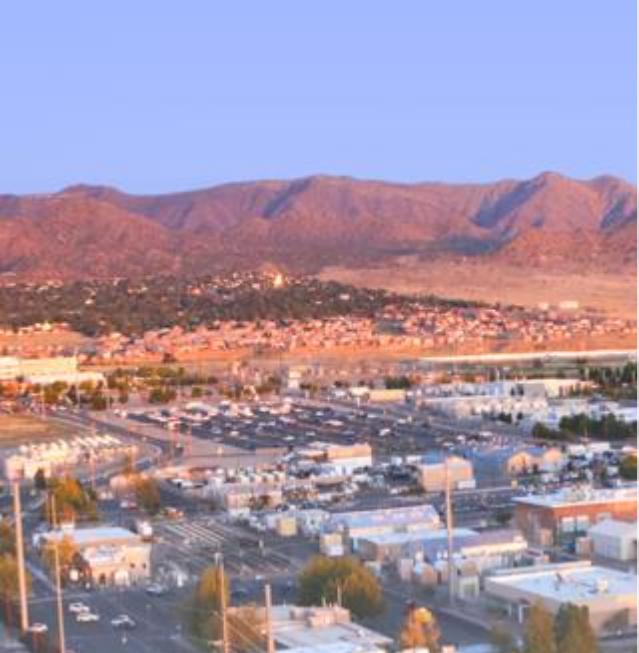


- Digital image analysis techniques provide a practical means to characterize large microstructural data sets
- Dendritic microstructures can be used to reconstruct solidification history in remelted alloy 718 material.
 - Microstructure is compared to process parameters
- Particle identification is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

Acknowledgements

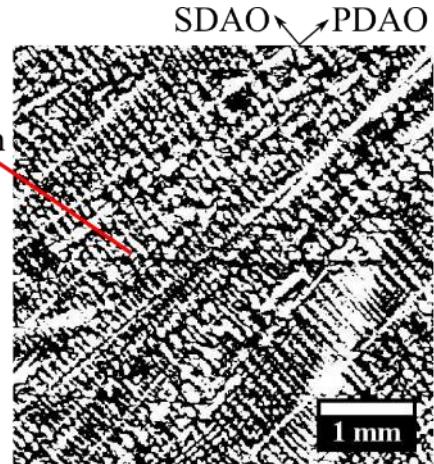


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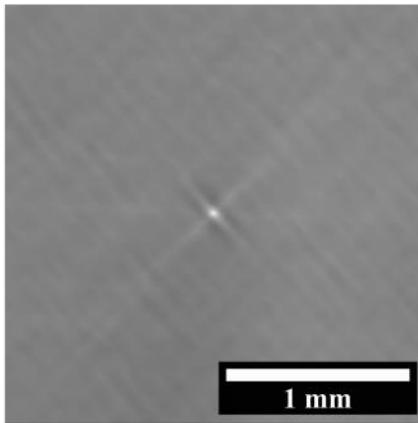


Questions

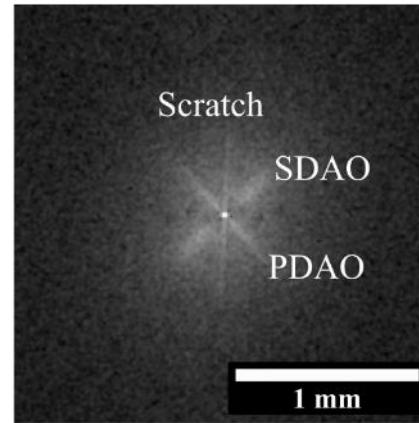
PDAO Calculation from Two-point Correlation



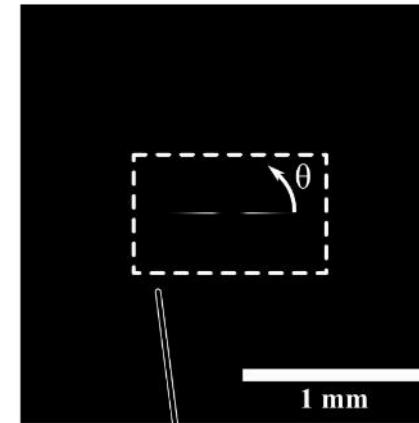
(a)



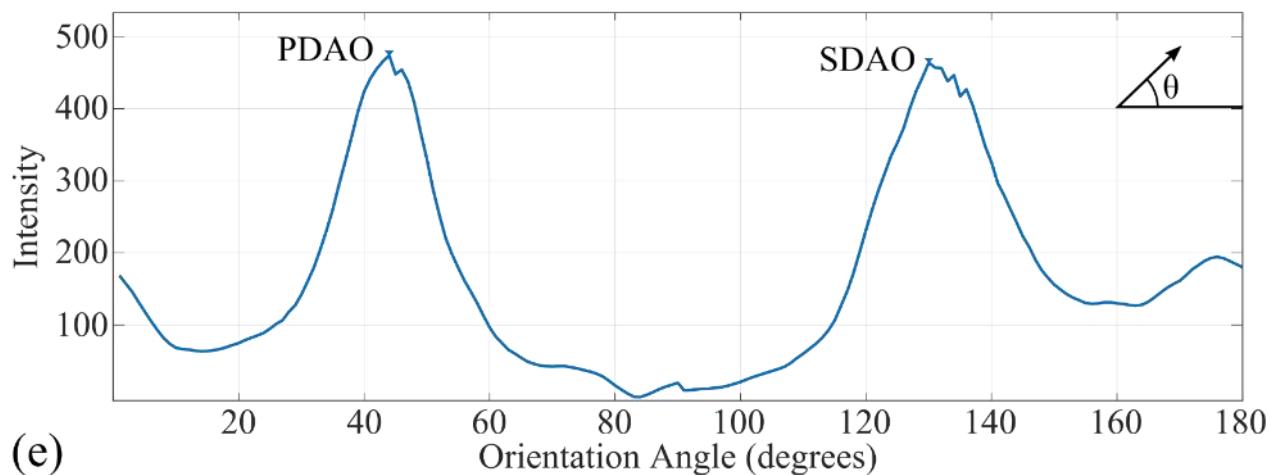
(b)



(c)



(d)



(e)

(f)

SDAS Calculation from Two-point Correlation

