



Entrapped Oxide Particles: FSW in Air vs. Argon

Kati Savolainen and Tapio Saukkonen
Aalto University - School of Science and Technology
Laboratory of Engineering Materials



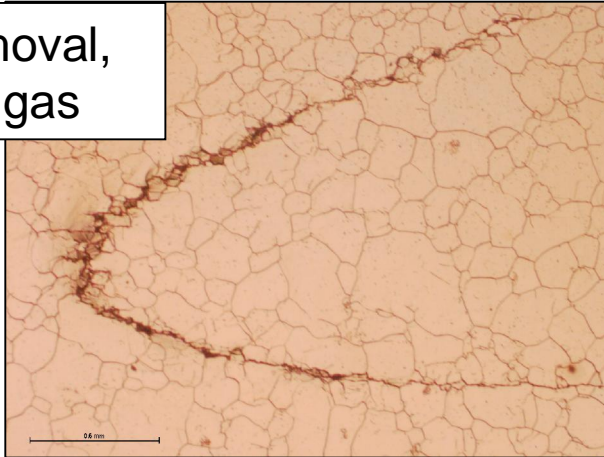
Introduction

- 50 mm thick Cu-OFP FSW welds
- Welded in air or in argon, 4 samples
- Study the amount and location of oxides

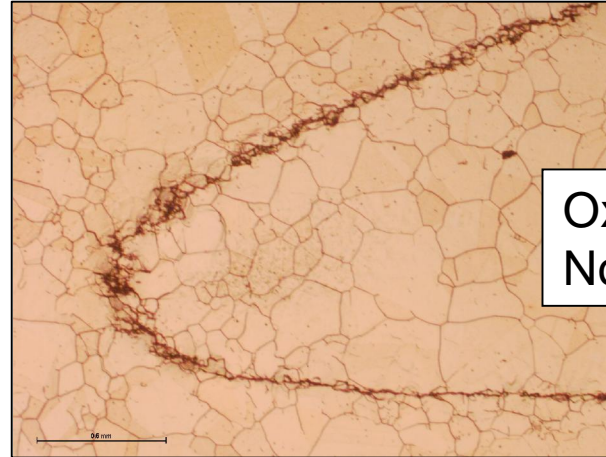
A!

Background

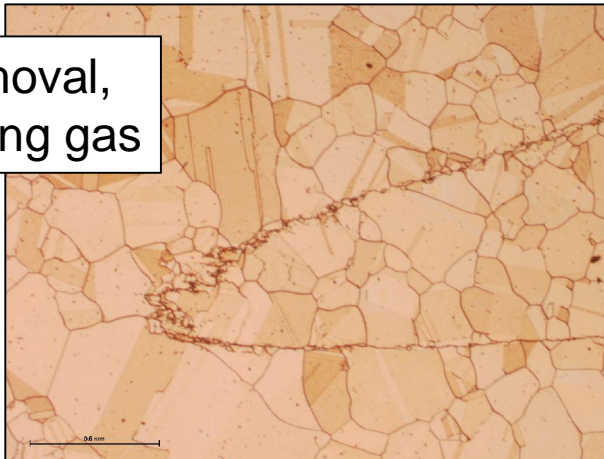
No oxide removal,
No shielding gas



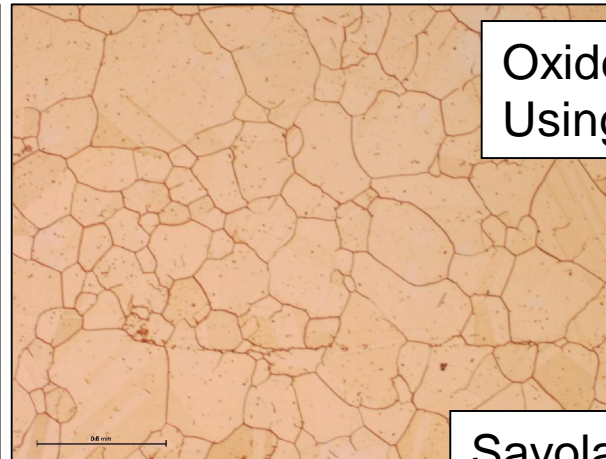
Oxide removal,
No shielding gas



No oxide removal,
Using shielding gas



Oxide removal,
Using shielding gas



Savolainen et al. 2008



Samples

- Sample 8: Welded in air with joint surfaces probably less good cleaning.
- Sample 51: Welded in argon gas with shielding of both outer and inner surfaces.
- Sample 75: Welded in air with joint surfaces good cleaned.
- Sample 77: Welded in argon gas with shielding of outer surface only.

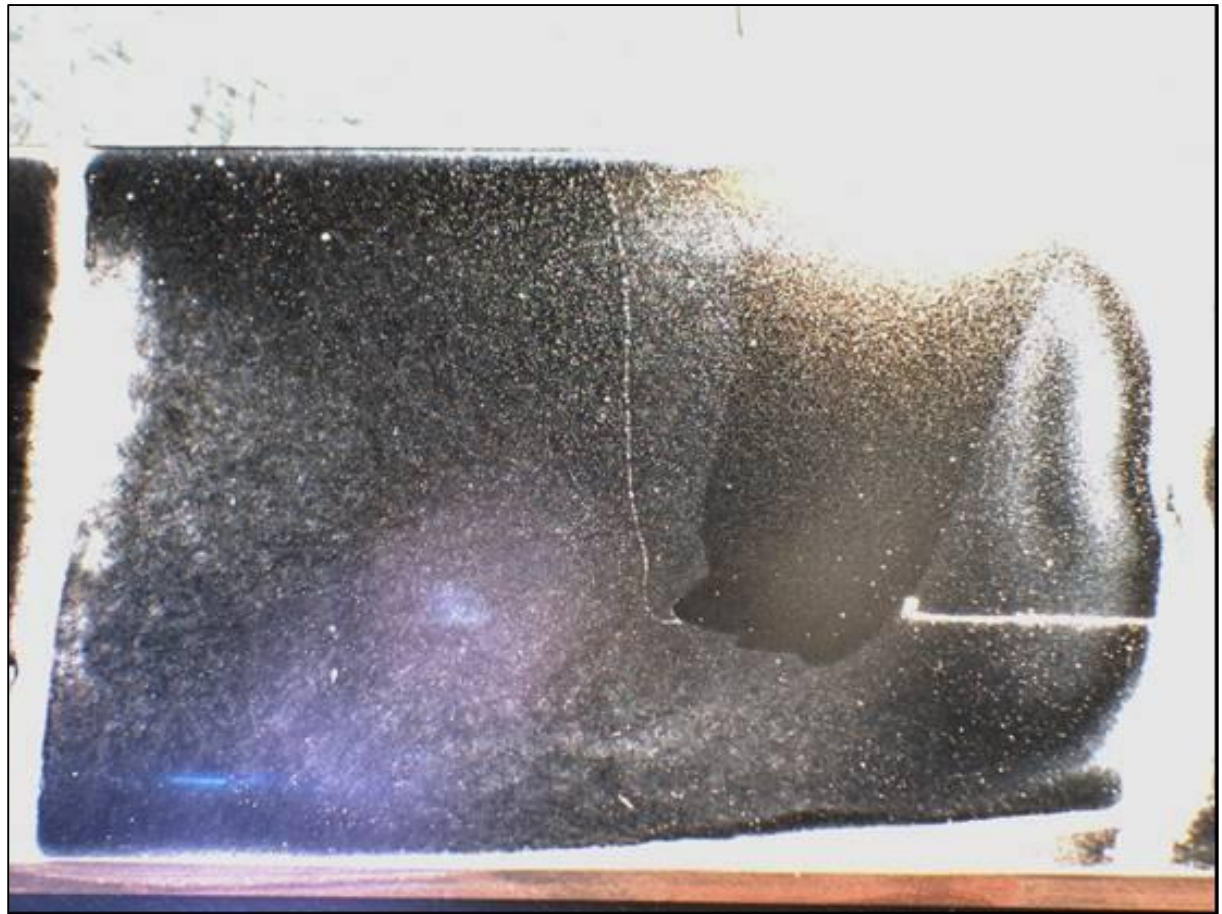
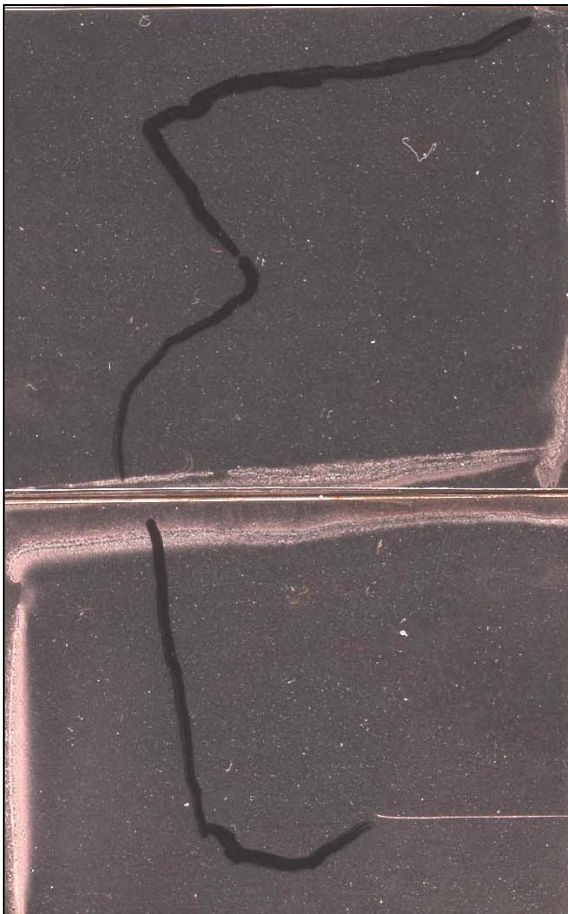


Experimental

- Hydrogen annealing at 850 °C for 30 min
- Gas: 20 % hydrogen and 80 % argon
- As-welded and hydrogen annealed samples, mirror images of each other
- Samples studied using light optical microscopy and SEM/EBSD

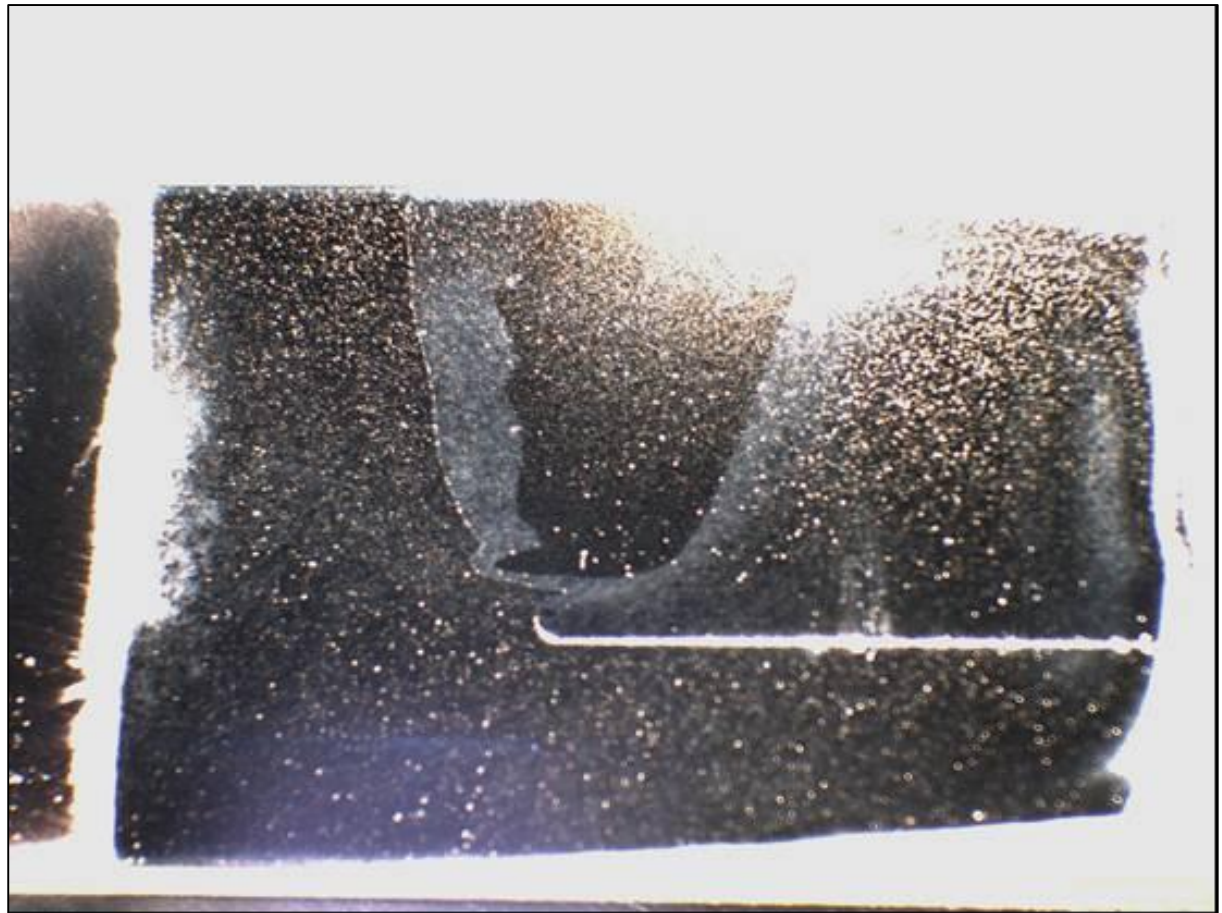
A!

Sample 8



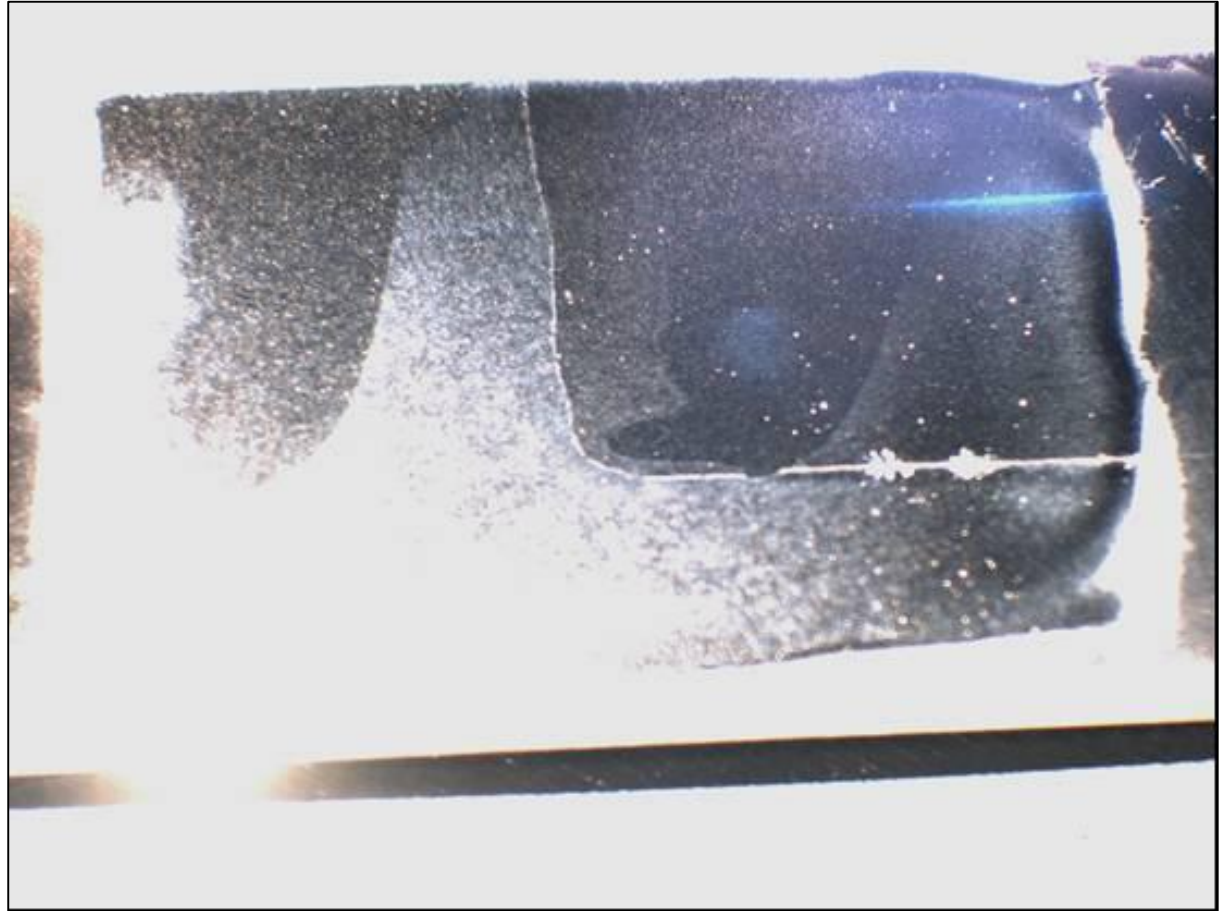
A!

Sample 51



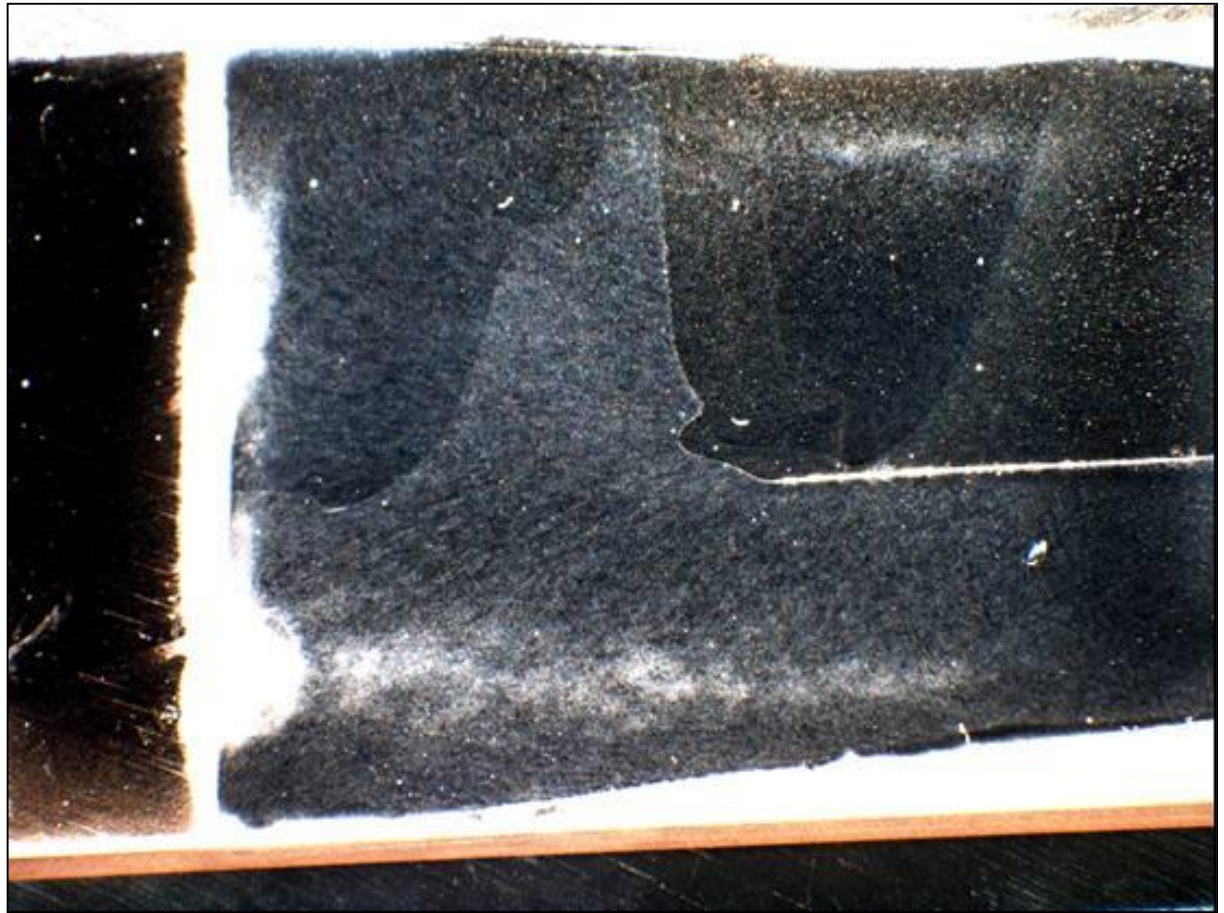
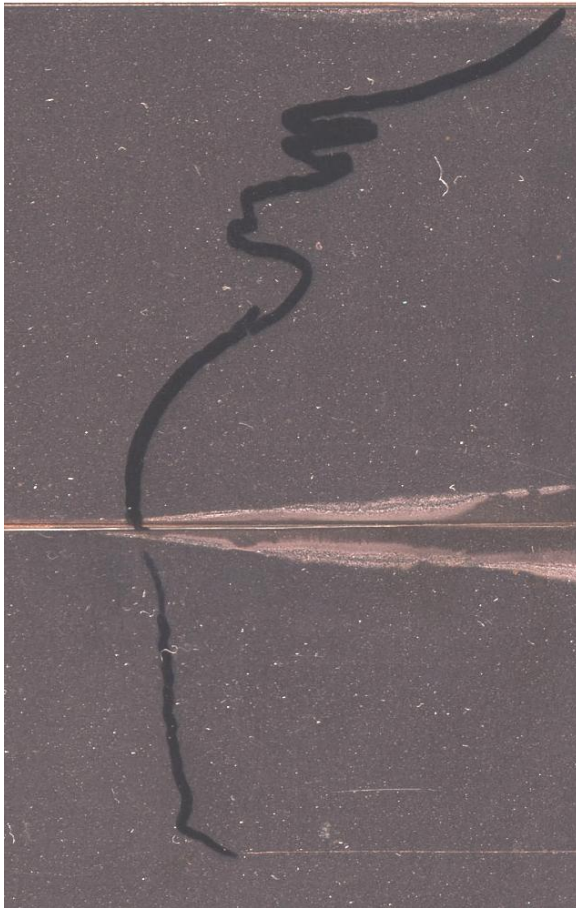
A!

Sample 75



A!

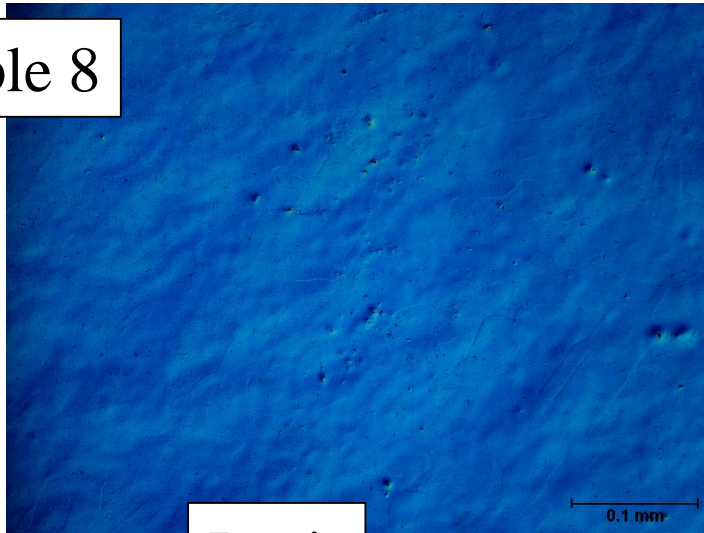
Sample 77



A!

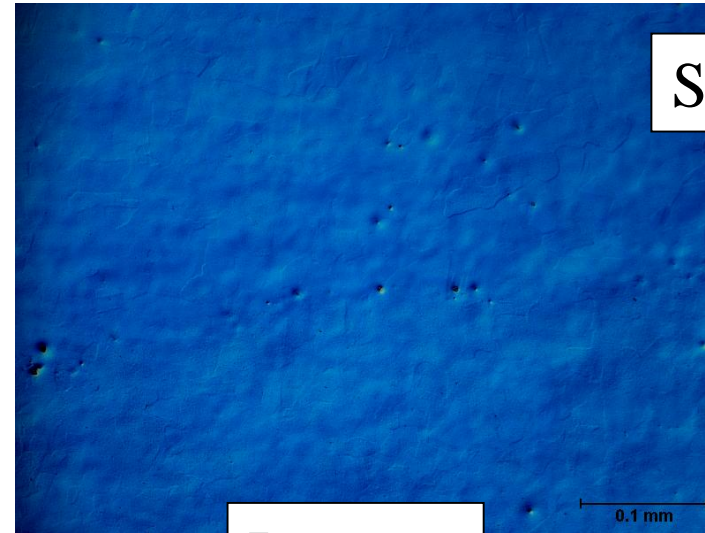
Least Amount of Oxide Particles

Sample 8



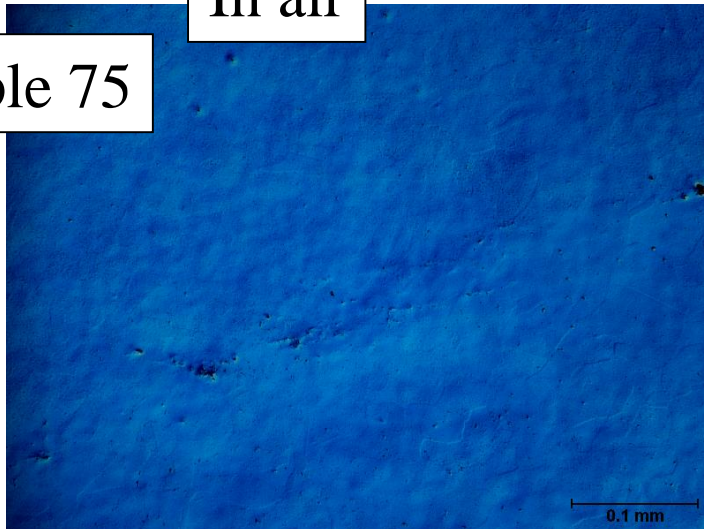
In air

Sample 51

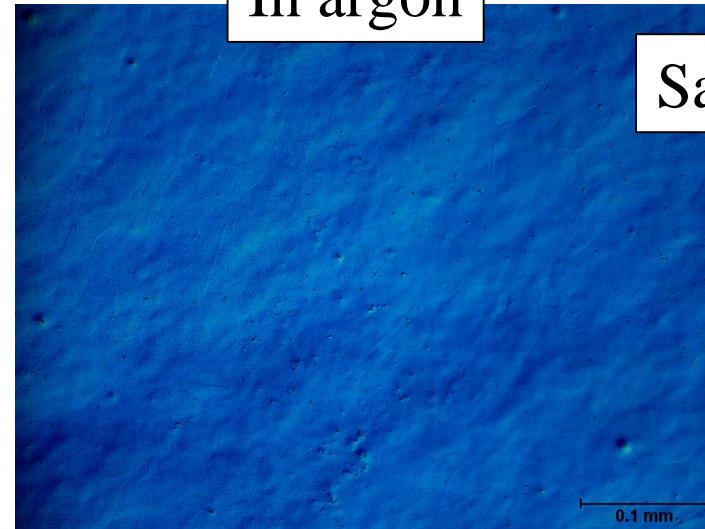


In argon

Sample 75



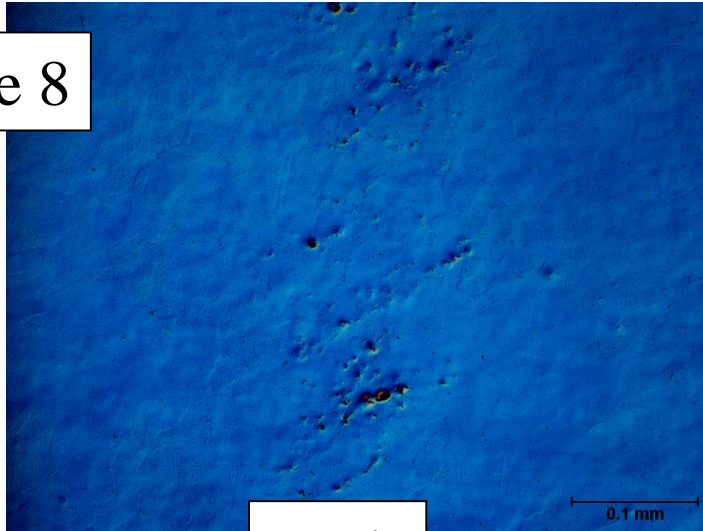
Sample 77



A!

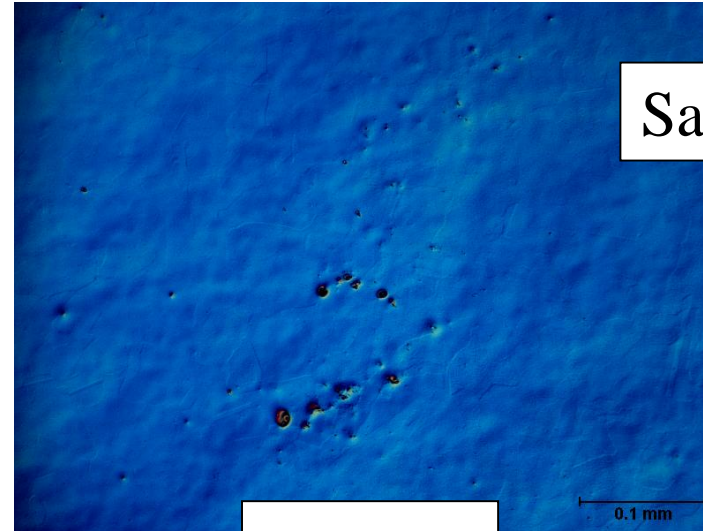
Highest Amount of Oxide Particles

Sample 8



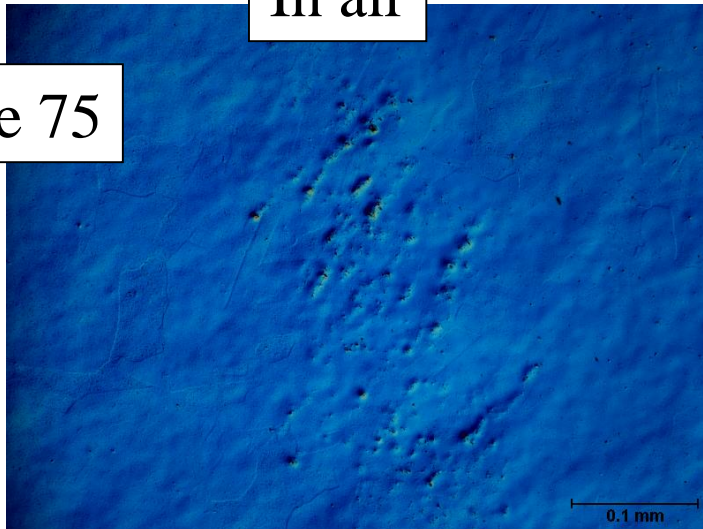
In air

Sample 51

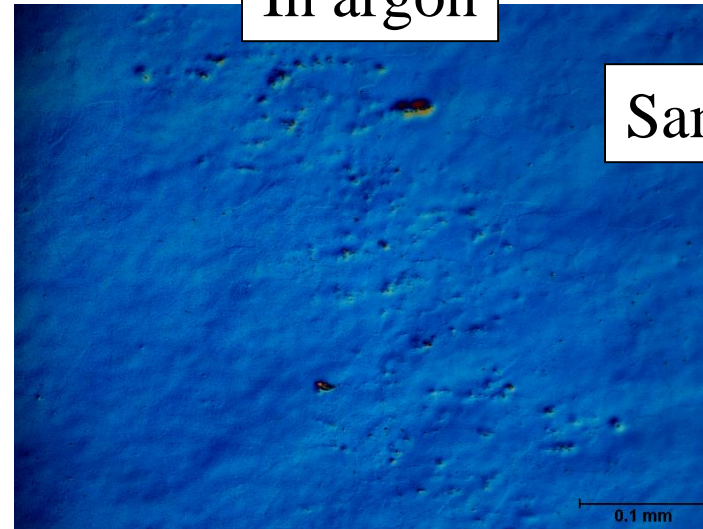


In argon

Sample 75



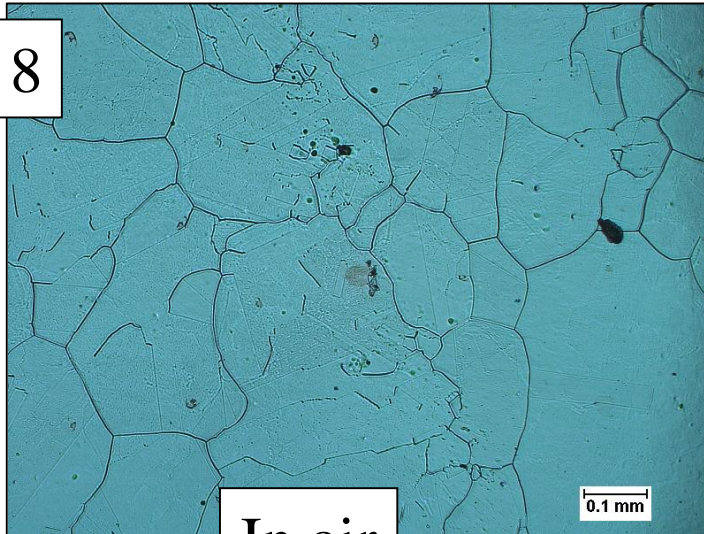
Sample 77



A!

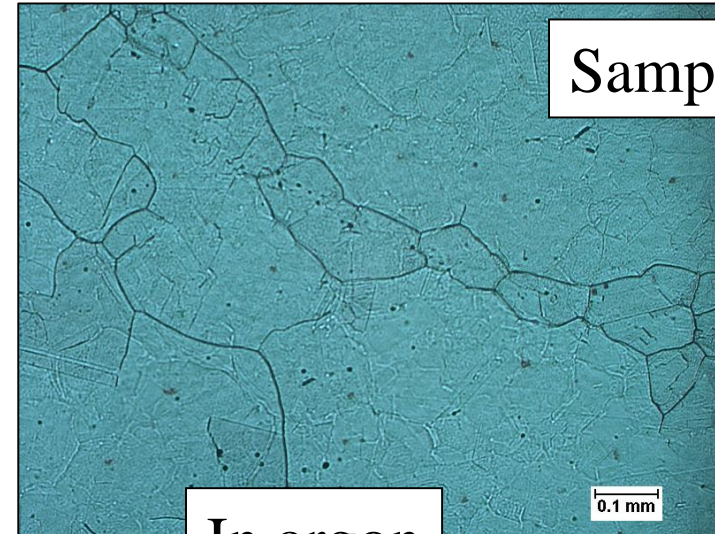
Hydrogen Annealed

Sample 8



In air

Sample 51

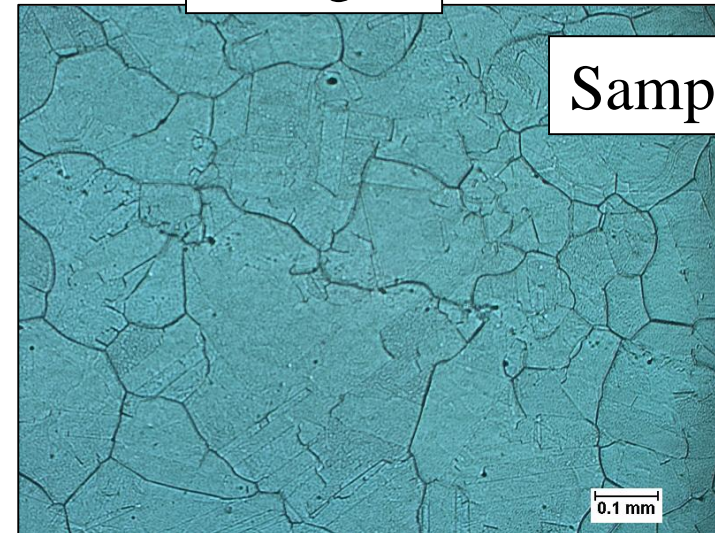


In argon

Sample 75

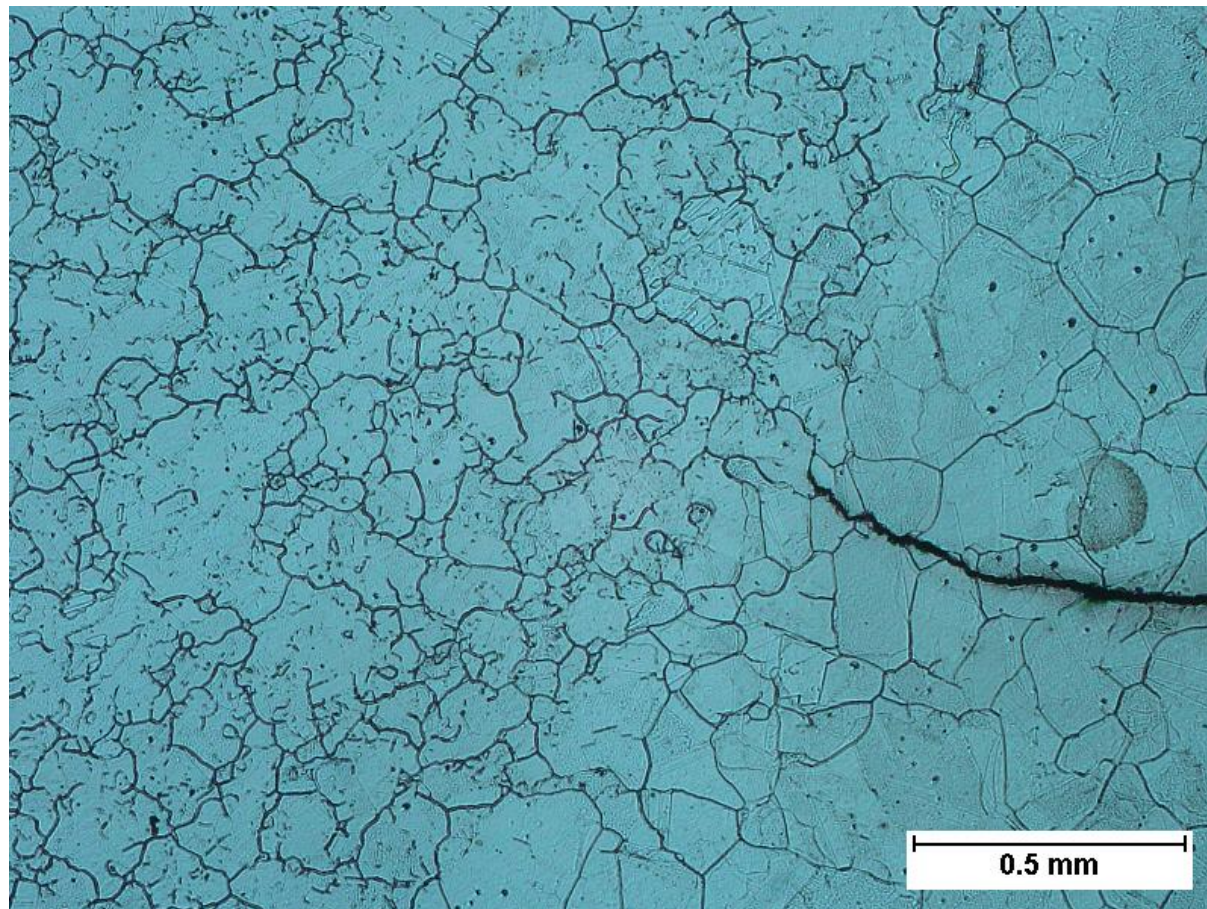


Sample 77



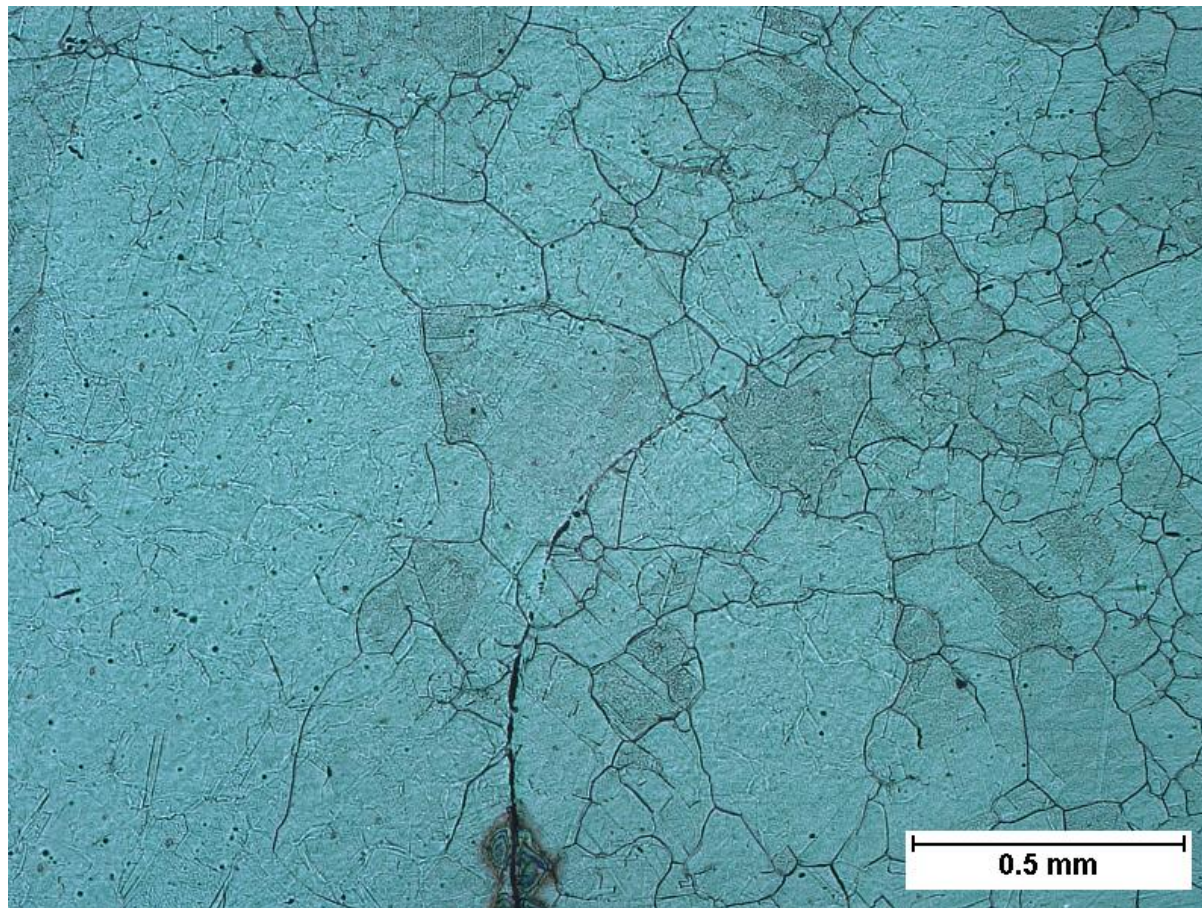
A!

Sample 8, Tip



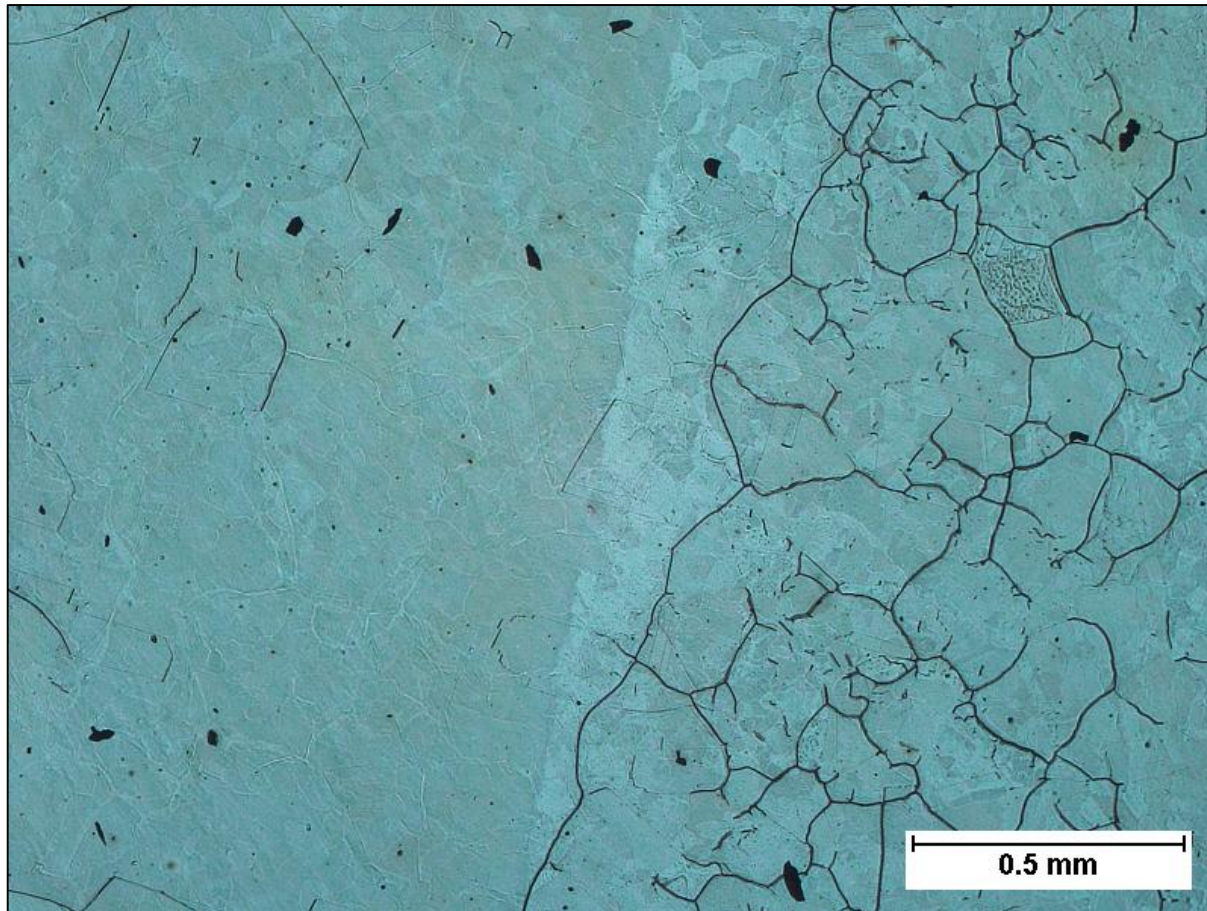
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Sample 51, Tip



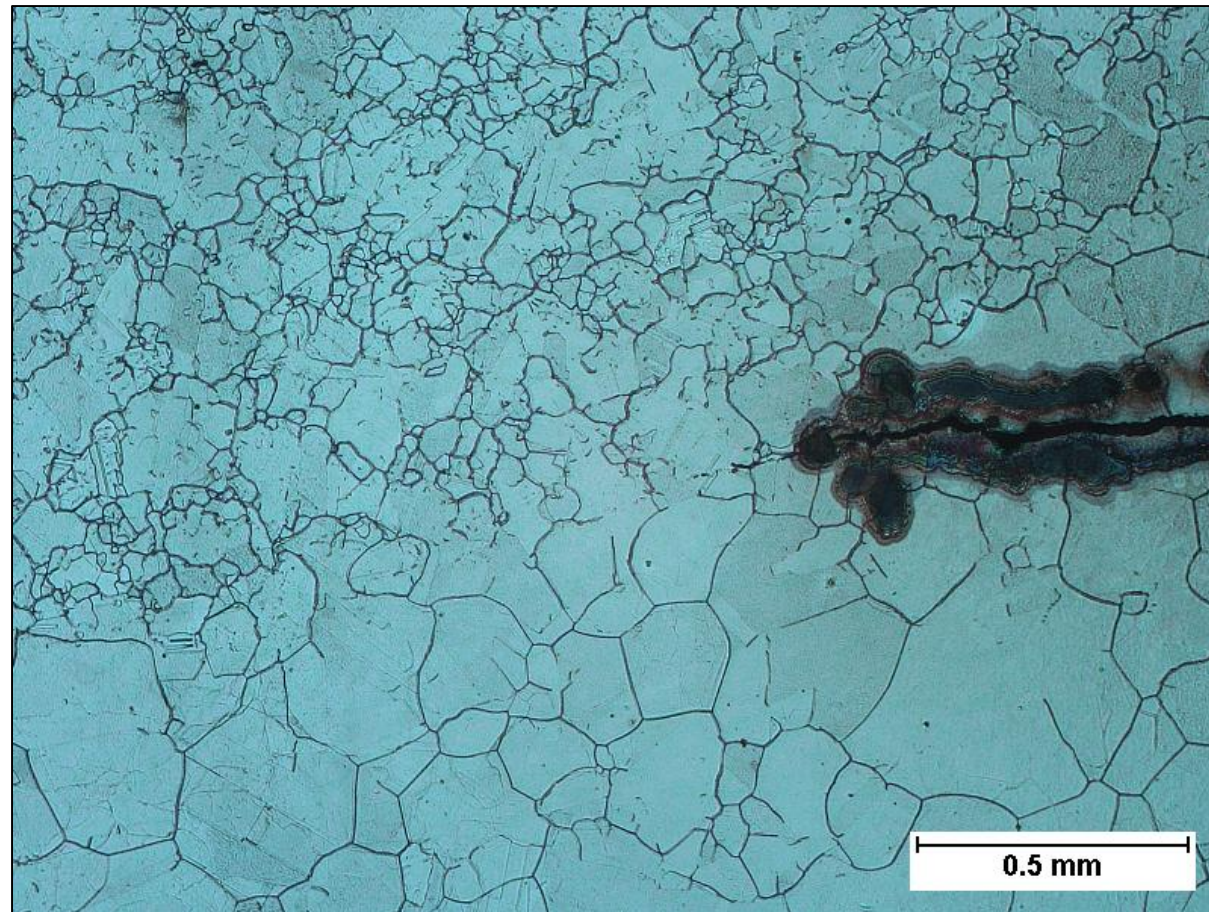
A!

Sample 51, Top Part



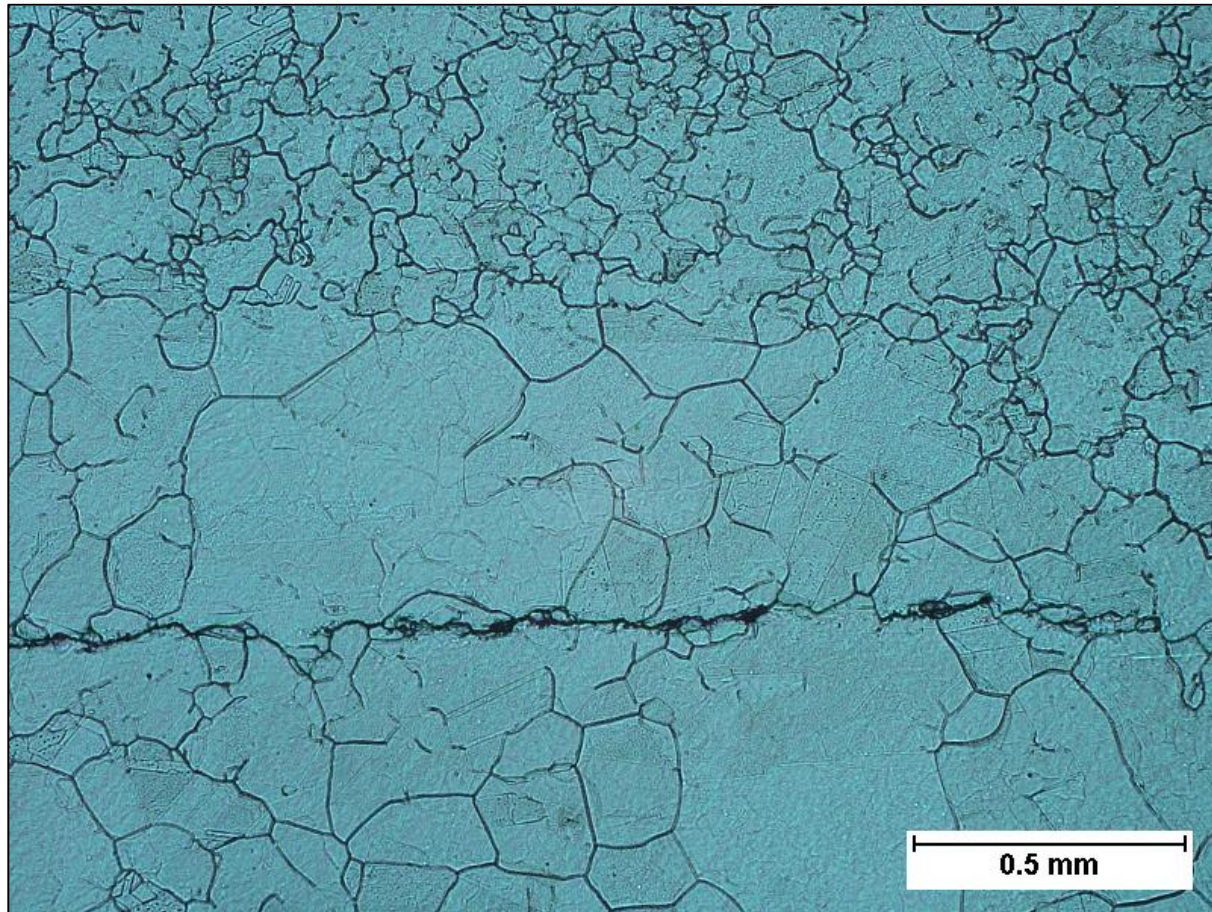
A!

Sample 75, Tip



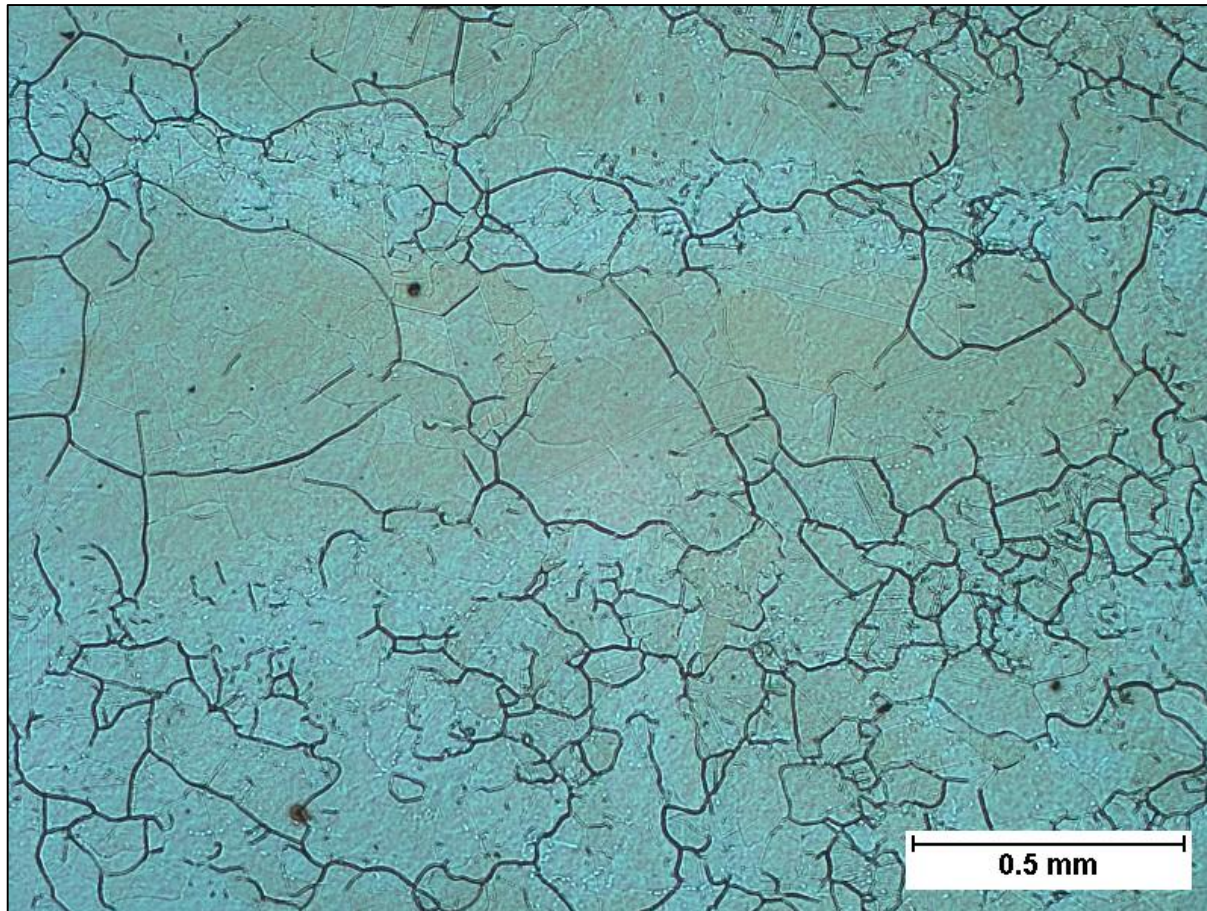
A!

Sample 75, Oxide Line Bottom



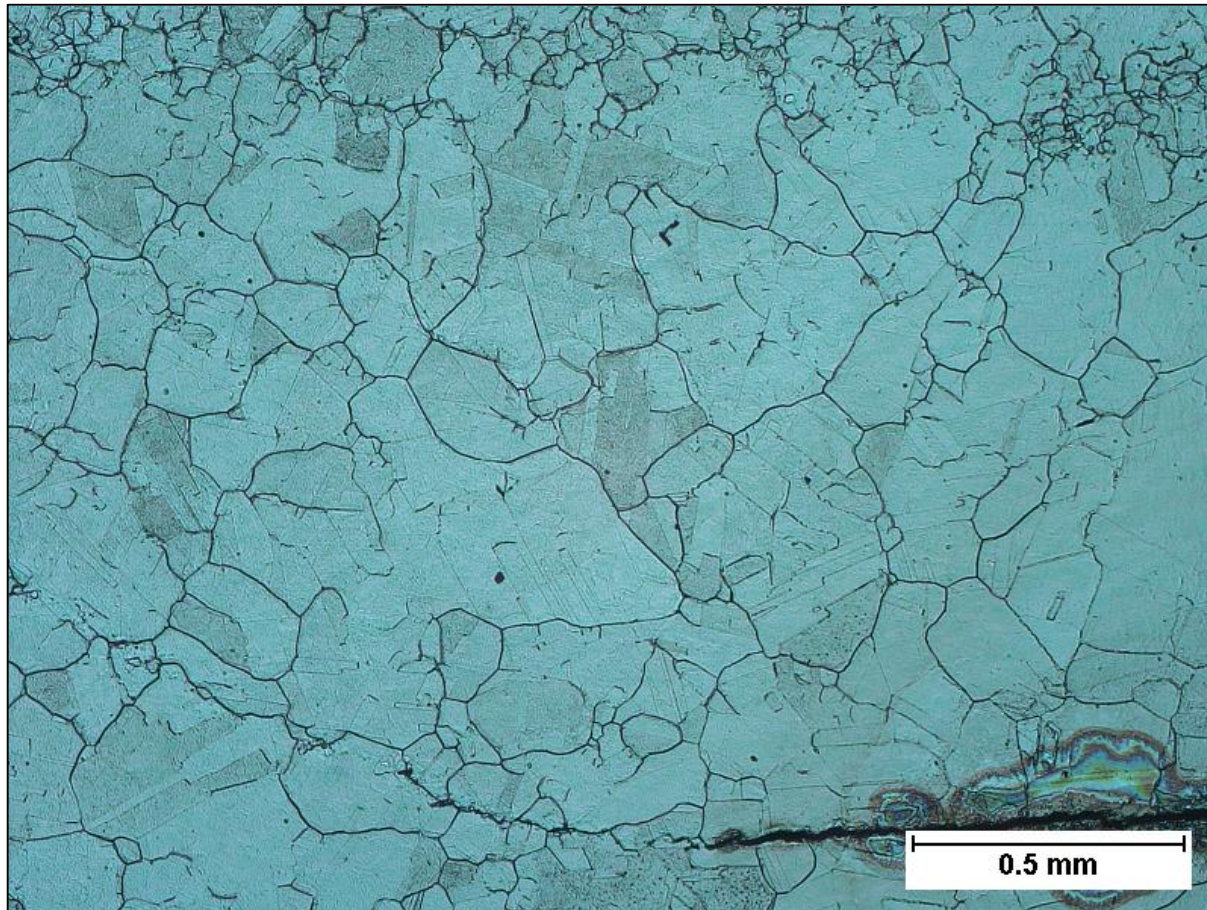
A!

Sample 75, Top Part



A!

Sample 75, Tip



A!

Fracture Location

Tube material



Lid material



Conclusions

- Samples were welded using different tools etc., thus, it is difficult to compare them to each other
- Oxide particles are located on one line
- Relatively small differences between samples in regard to oxide particles
- Samples welded with shielding gas have less oxides



Conclusions

- In Sample 8 the oxides at the bottom of the weld have been dispersed too finely to be seen (longer tool probe or larger plunge depth)

A!

Thank you!

Questions?