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Relating Corrosive Pit Morphology to Microstructure in Pure Al Exposed to Salt Water Environments

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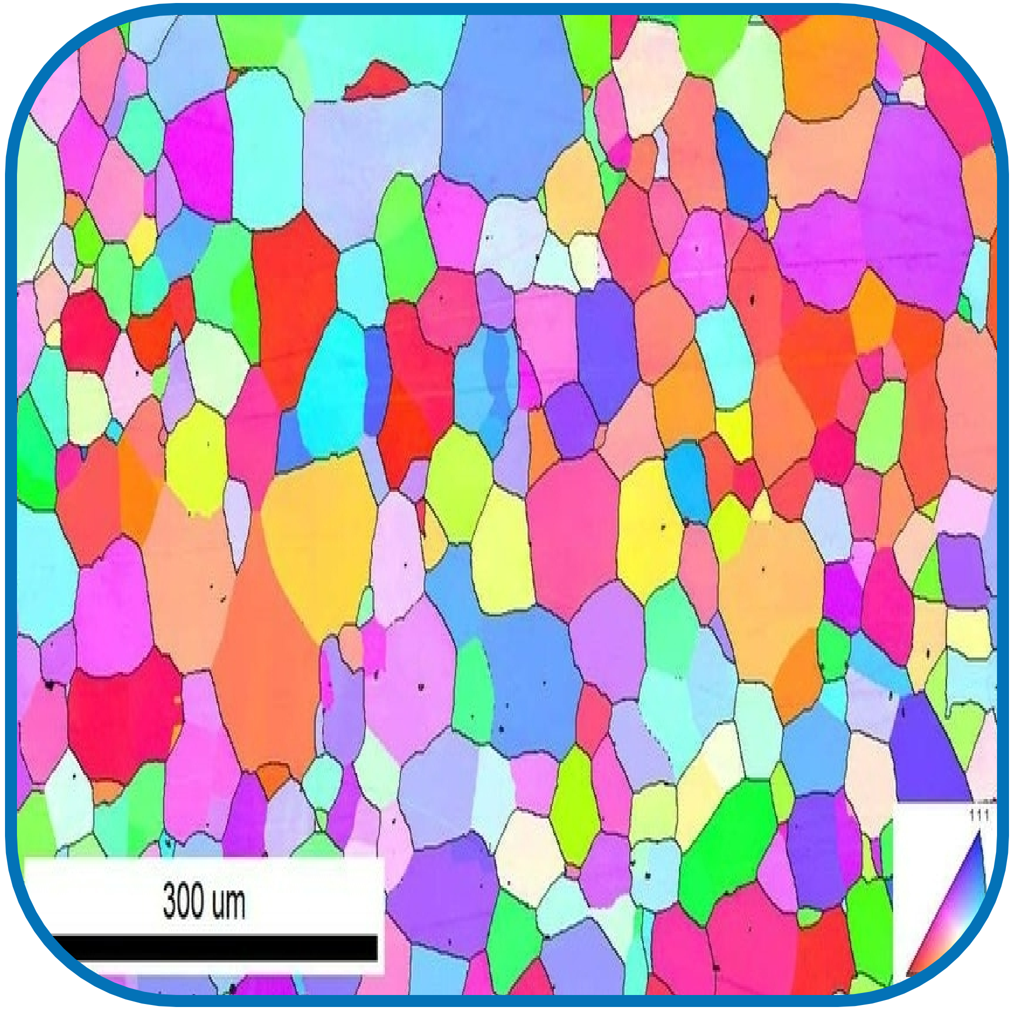
TMS 2022 150TH ANNUAL MEETING & EXHIBITION

Microstructure focus

1. What kind of corrosive pits are forming?

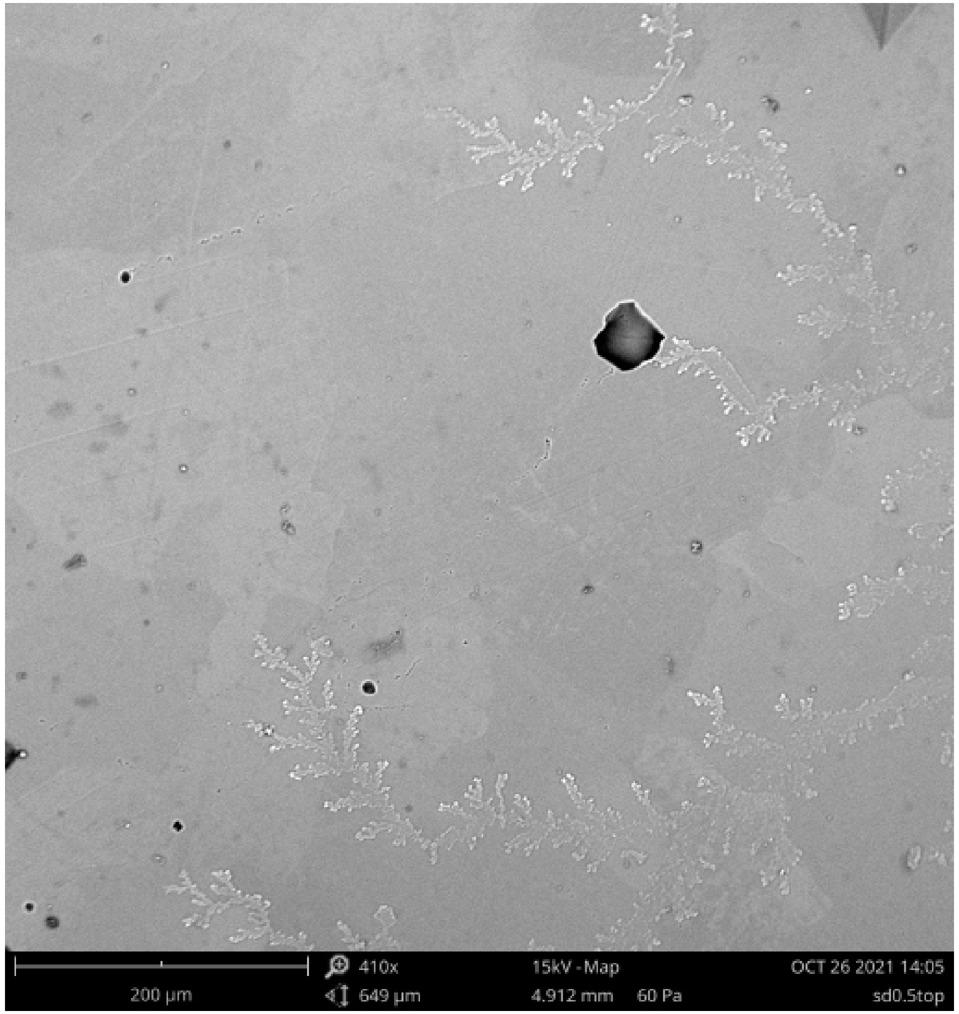
2. Where are the pits preferentially forming?

3. Does a difference in microstructure change pit growth?



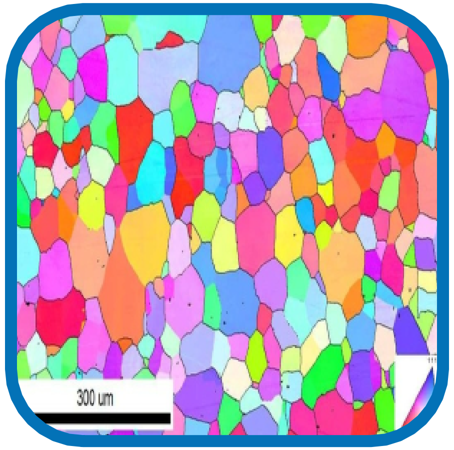
Determining our approach

- Initially corroded aluminum samples in salt water.
- Salt water and H_2O_2 consistently created corrosive pits.
- Corrosive pits verified using SEM imaging.

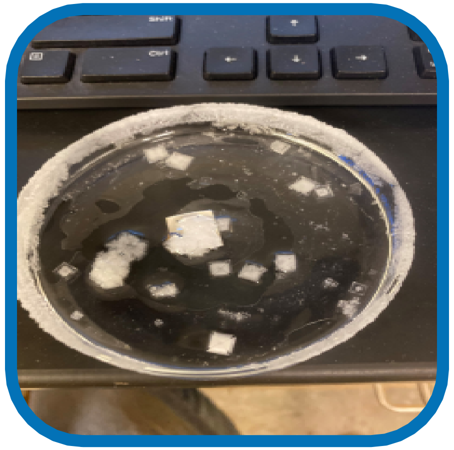


Our approach

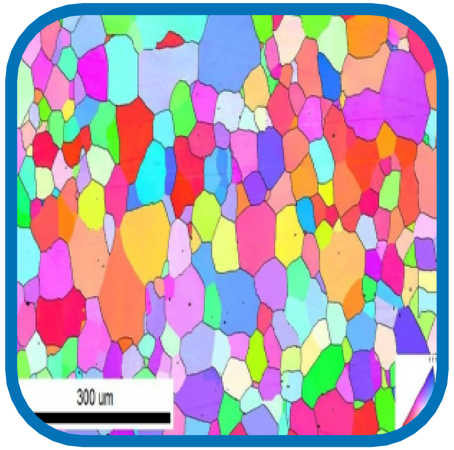
Test 99.9% pure aluminum



Map grain structure before corrosion



Corrode in salt water and hydrogen peroxide solution



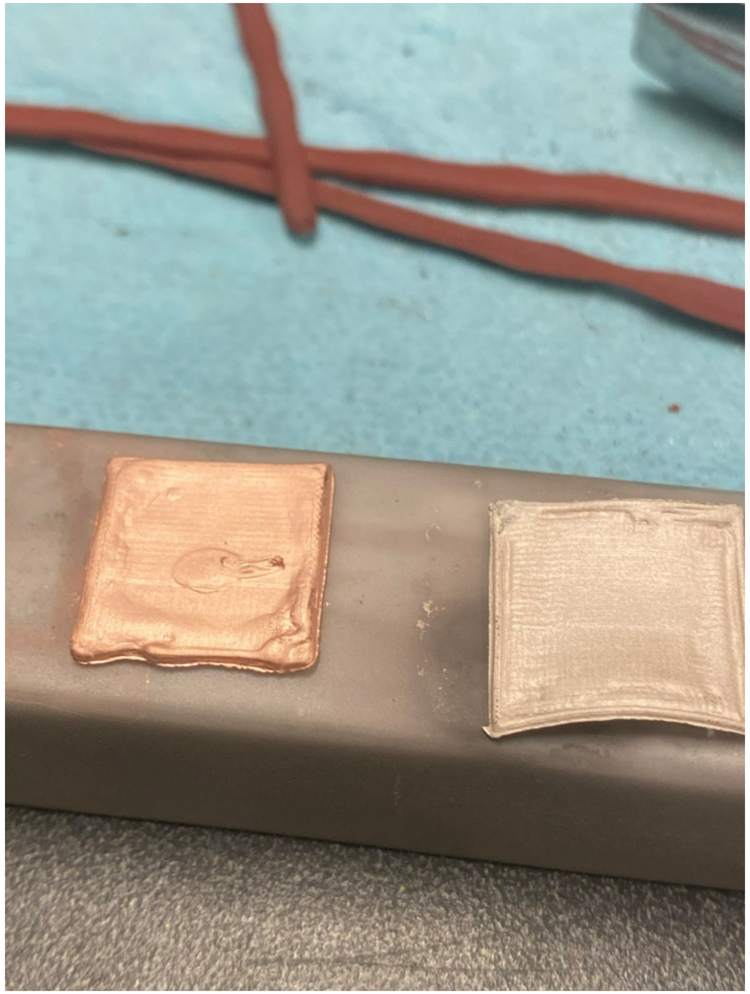
Map grain structure after corrosion

Specifically

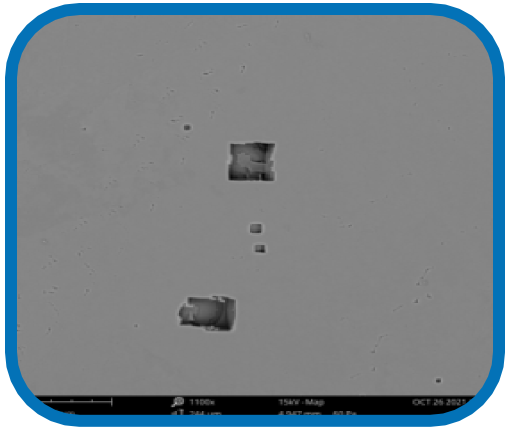
Samples characterized
– Cross sections of pure aluminum wire 99.9% pure
– Flat face of aluminum square 99.99% pure

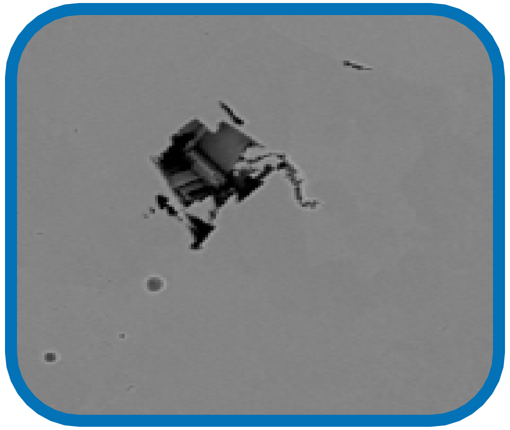
Solution
– 3M NaCl solution with 1:15 volume ratio of 30% H2O2 to NaCl solution

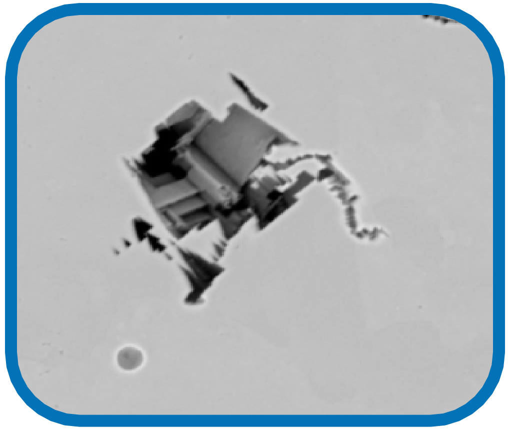
Time spent corroding
– 5 hours

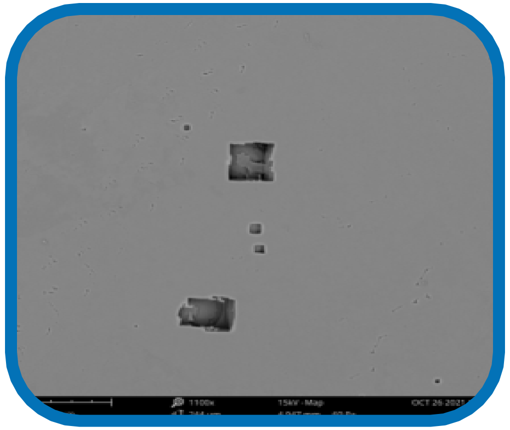


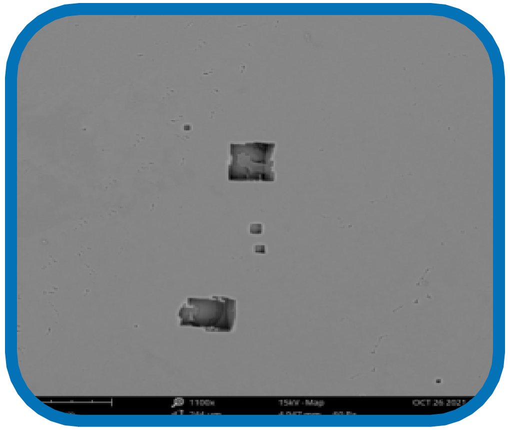
Corrosive pits are etched along crystal lattice

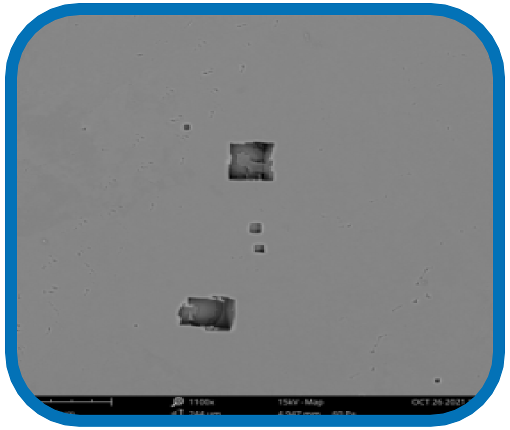


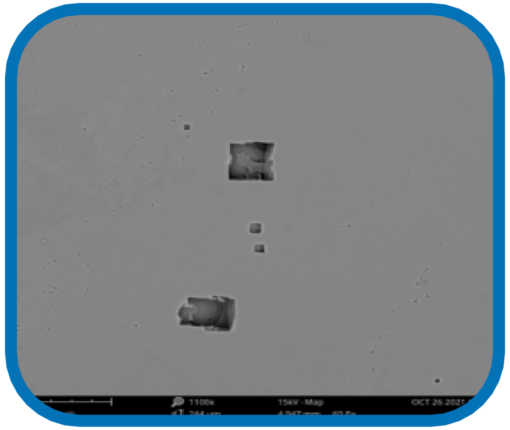


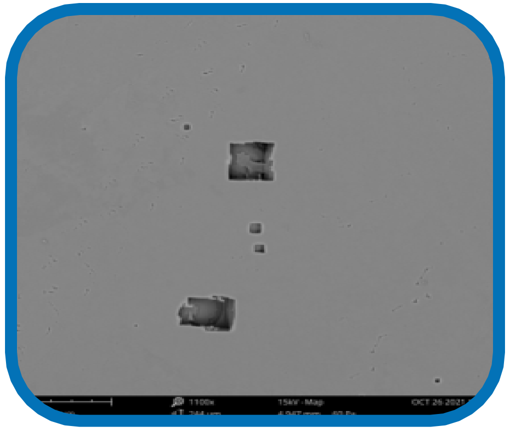




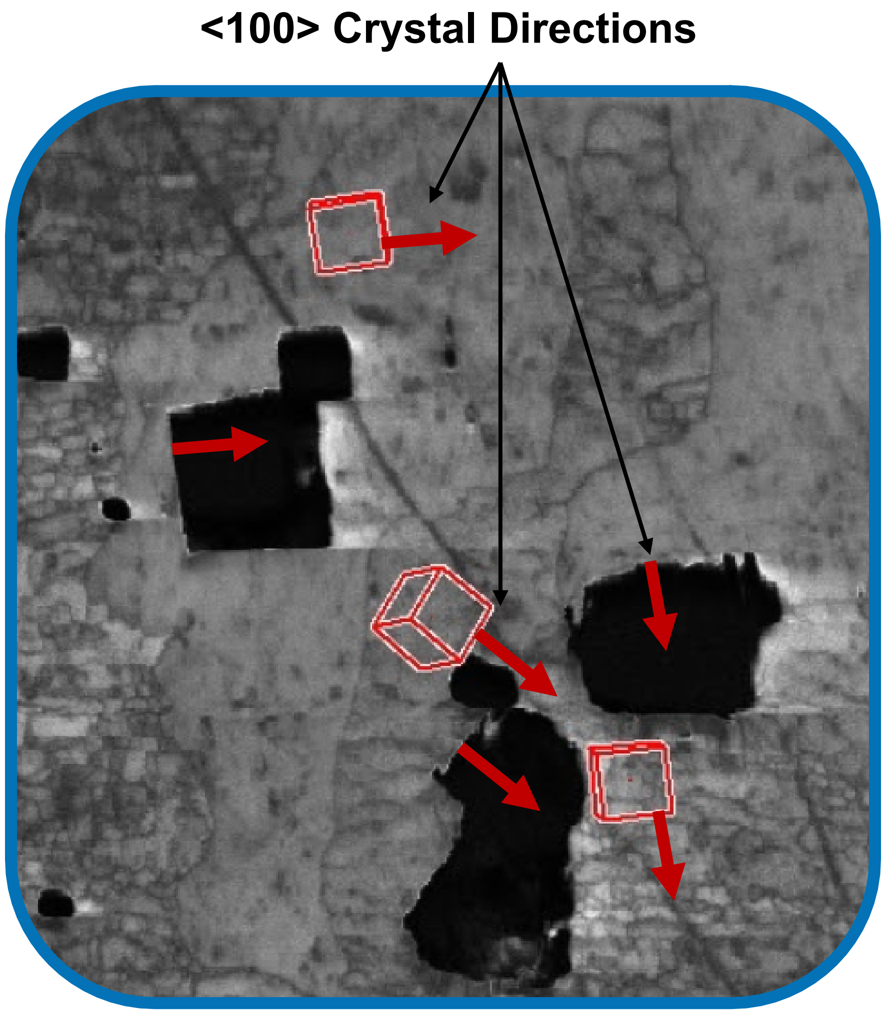




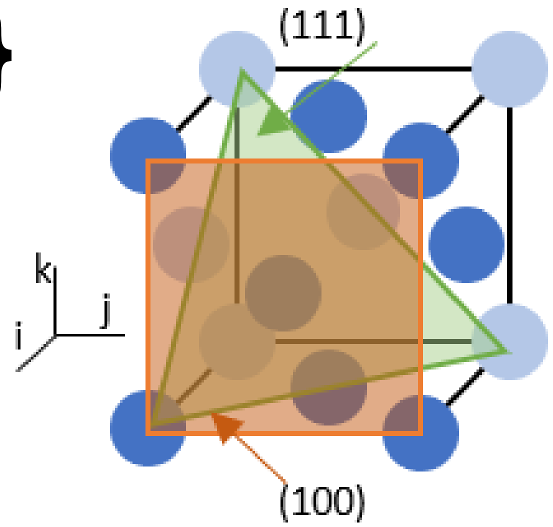




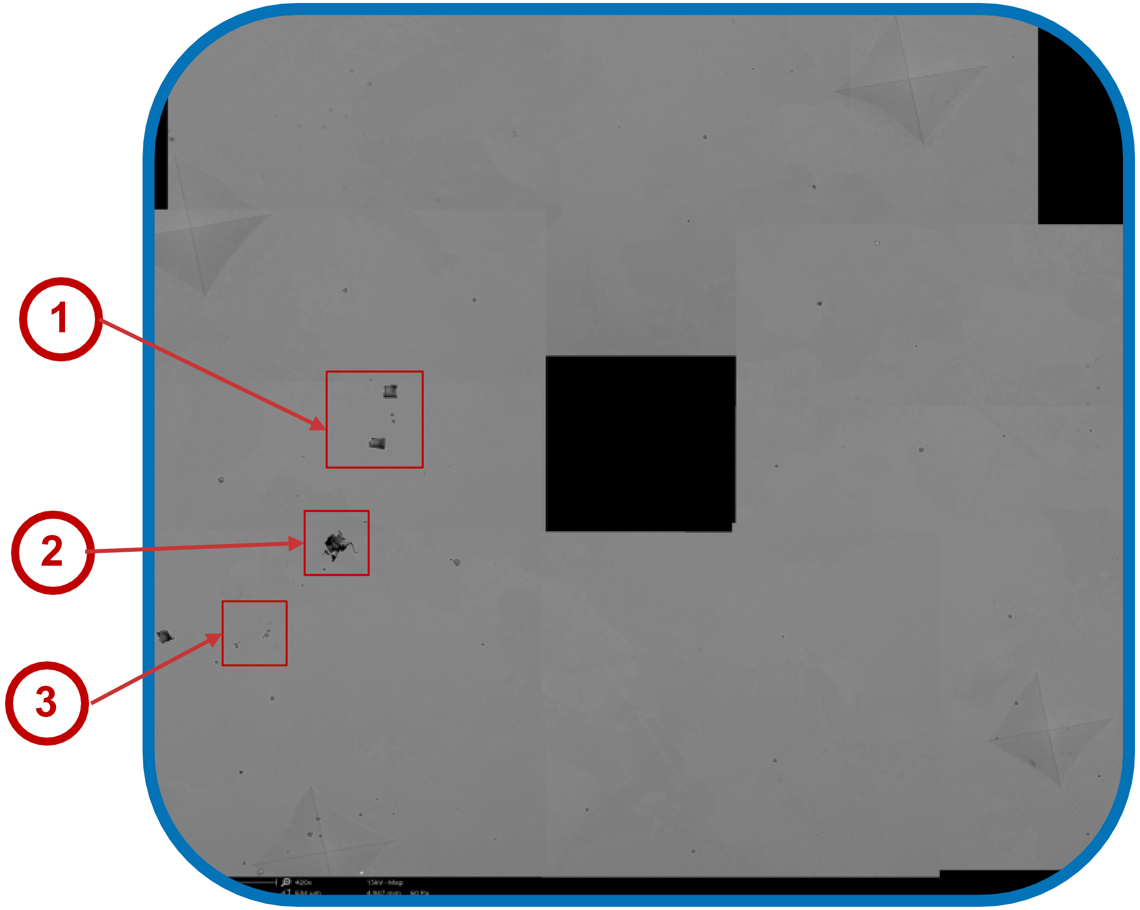
Pit formation preferentially attacks {100}



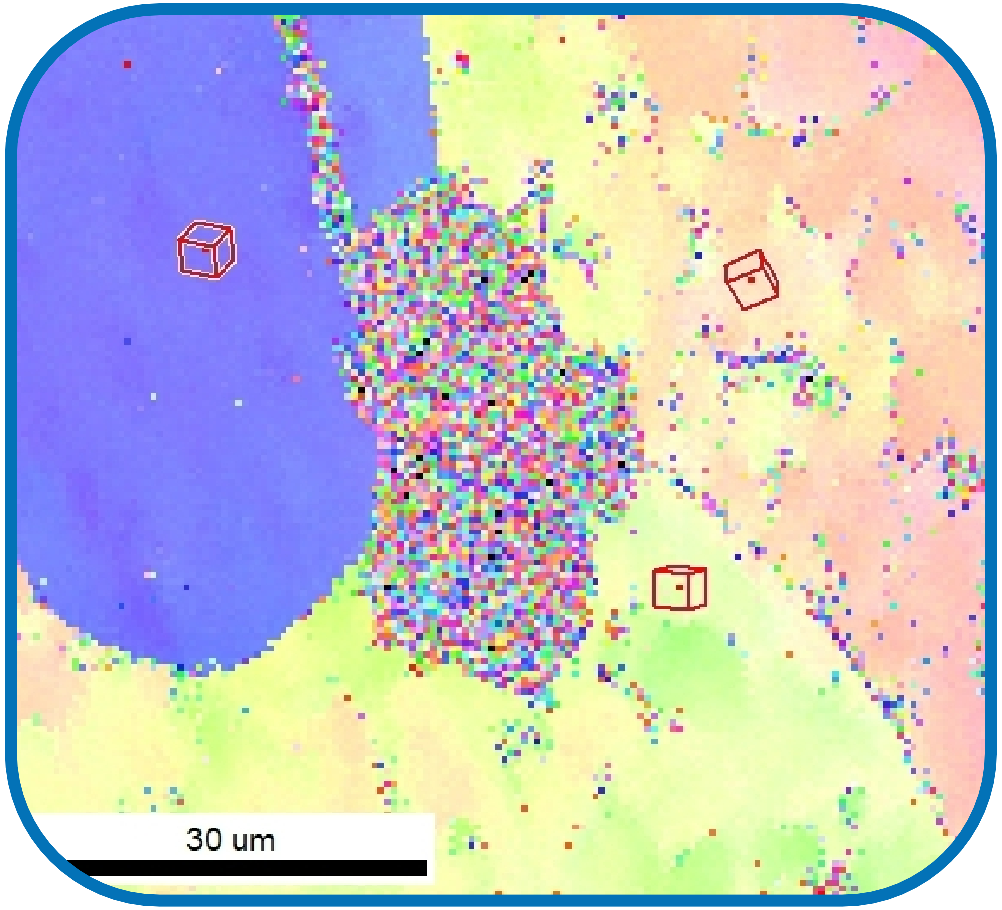
IQ from EBSD



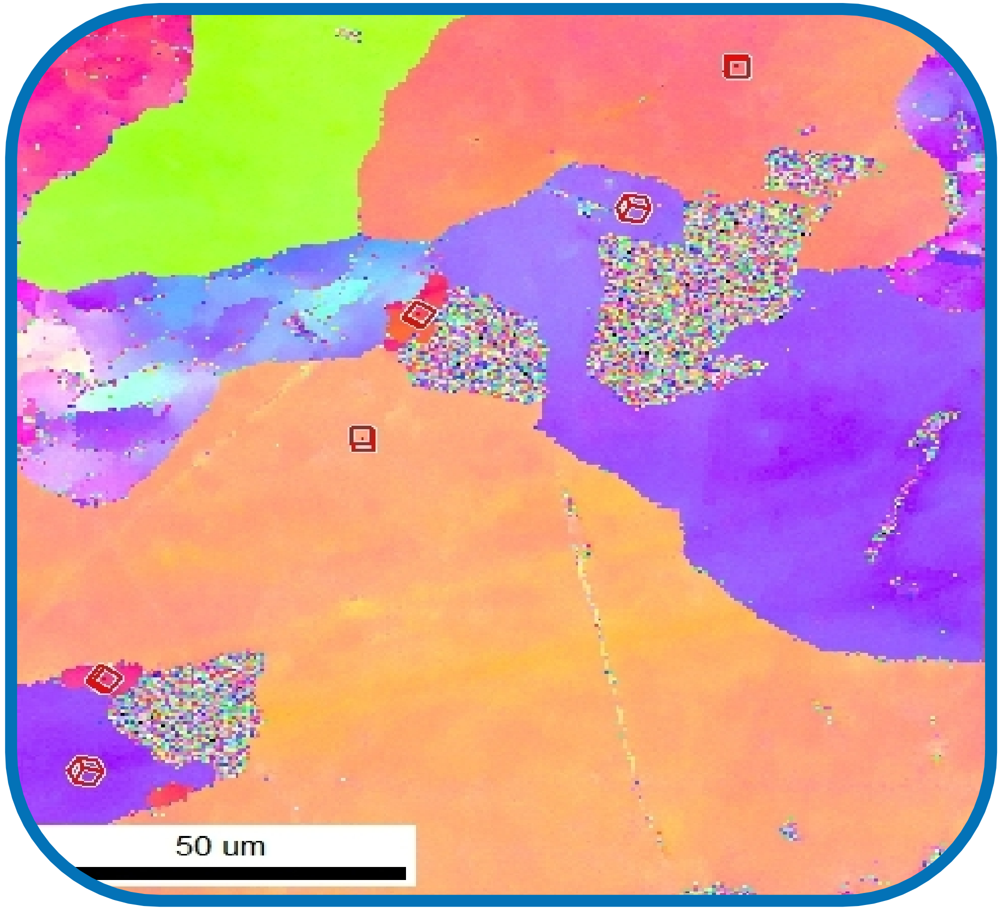
Pits preferentially form on grain boundaries and not fully recrystallized grains



Region 1



Region 2



Region 3

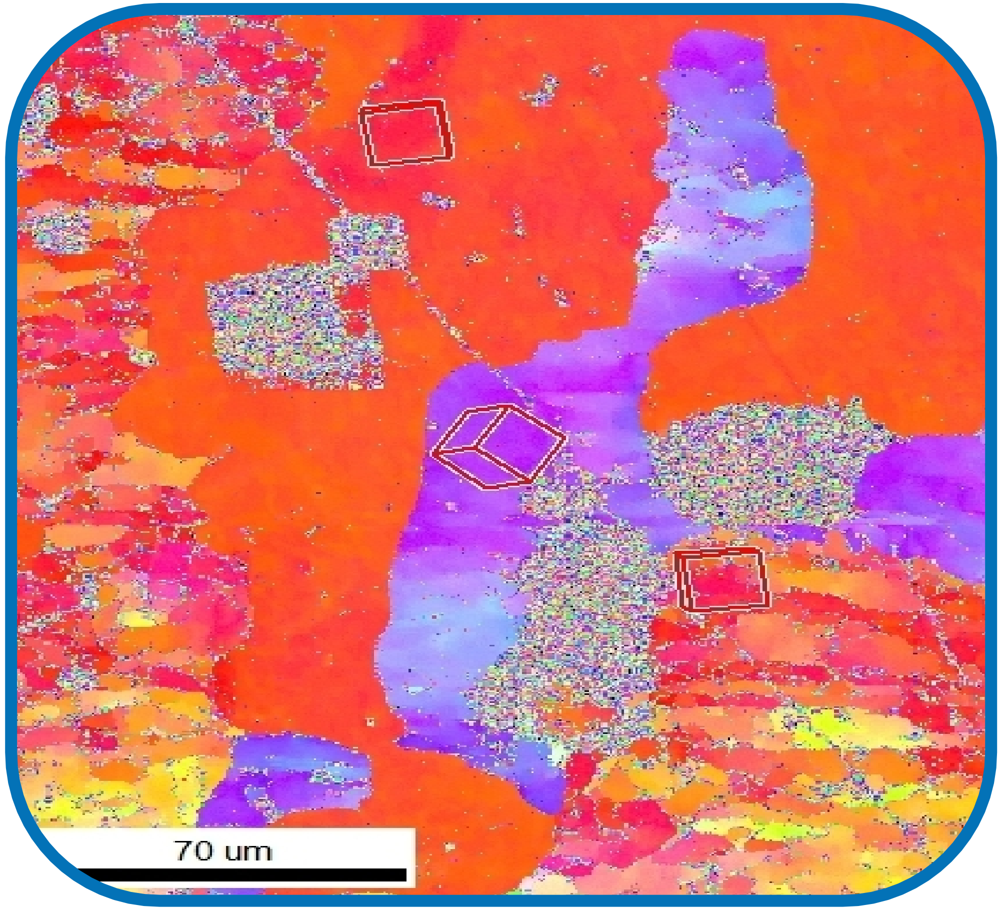
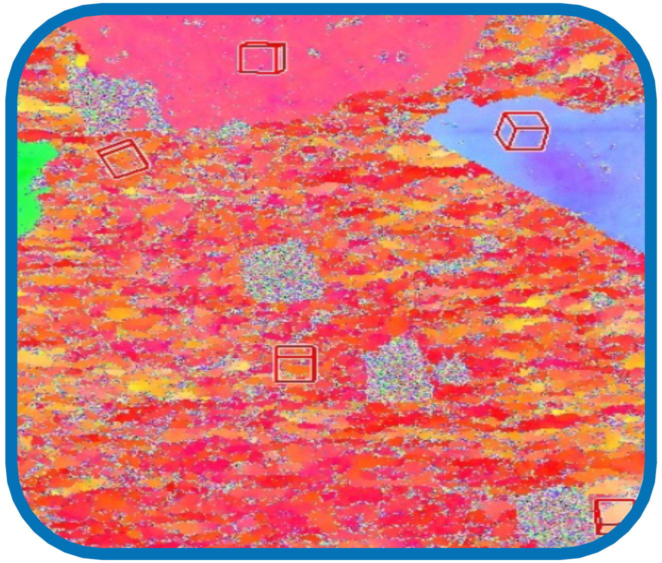
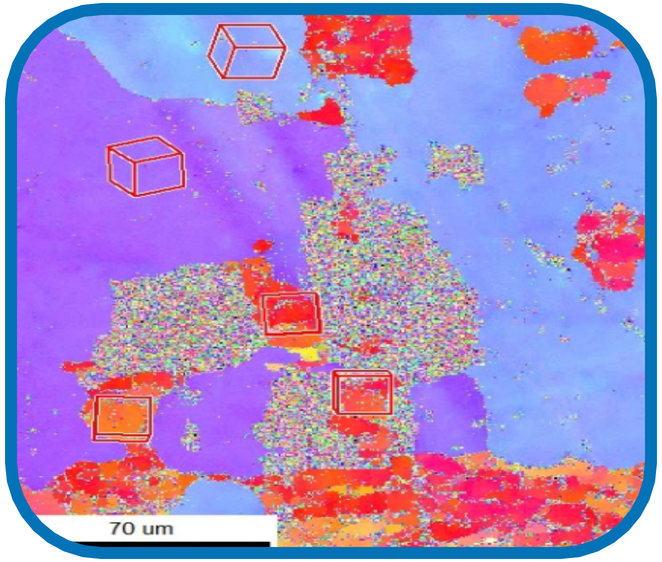
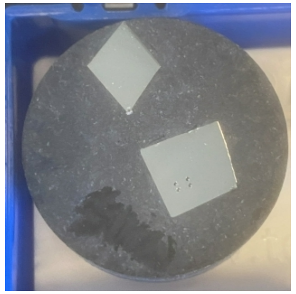


Plate grain sizes are about 100x larger than wire grains





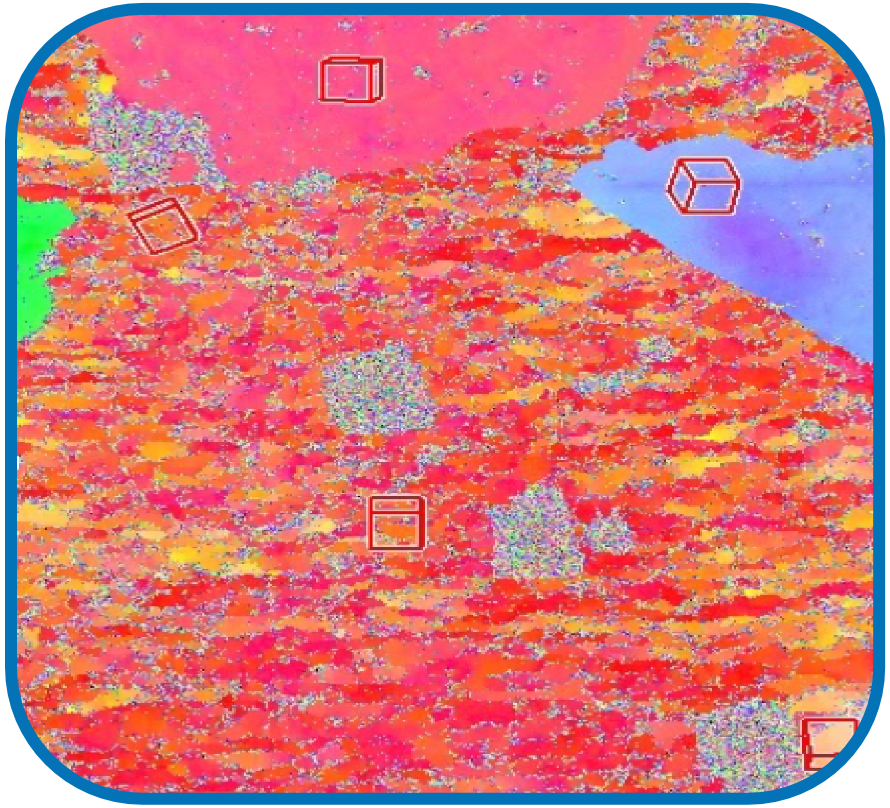
Wire



Plate

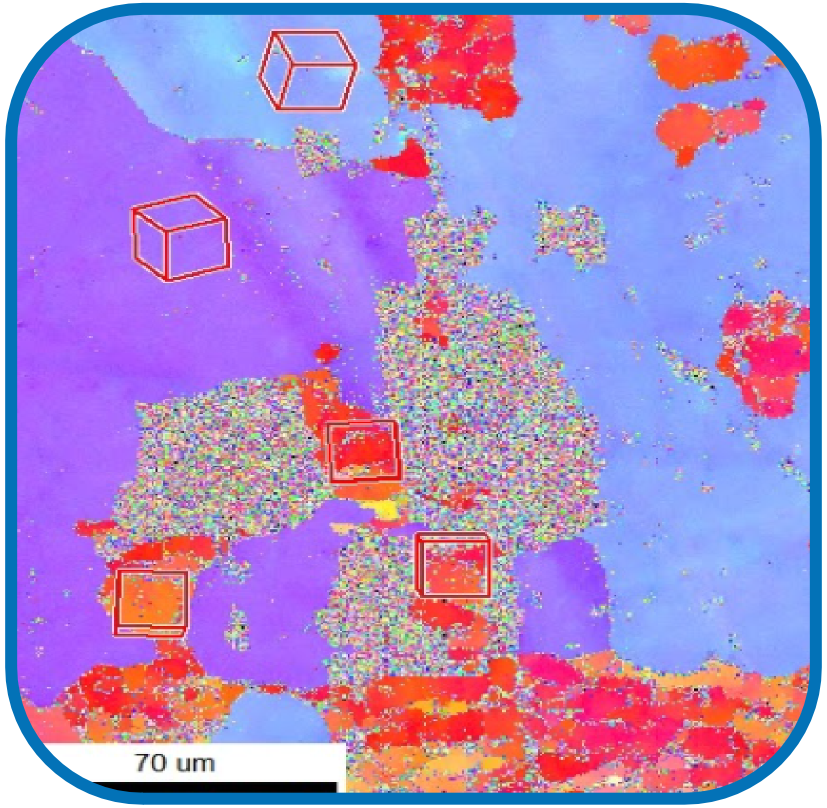
Pit density increases with smaller grains

Wire



Pit density: x
Average grain area: z

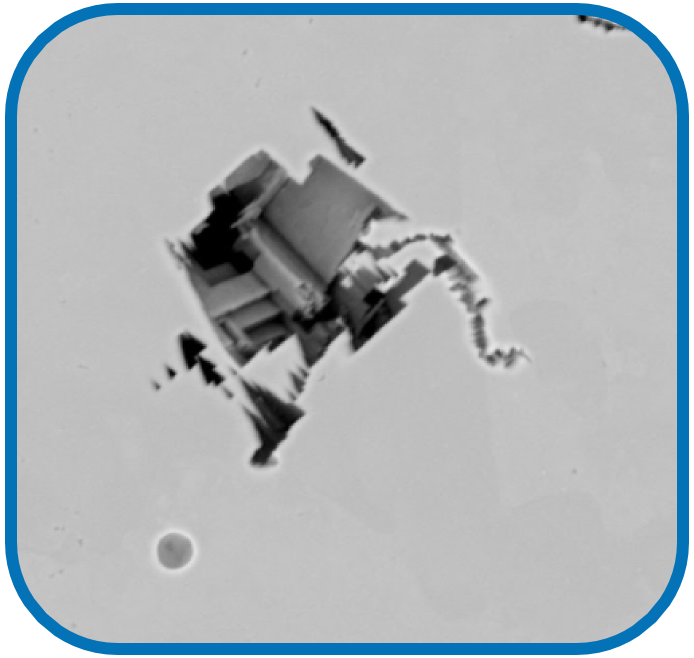
Plate



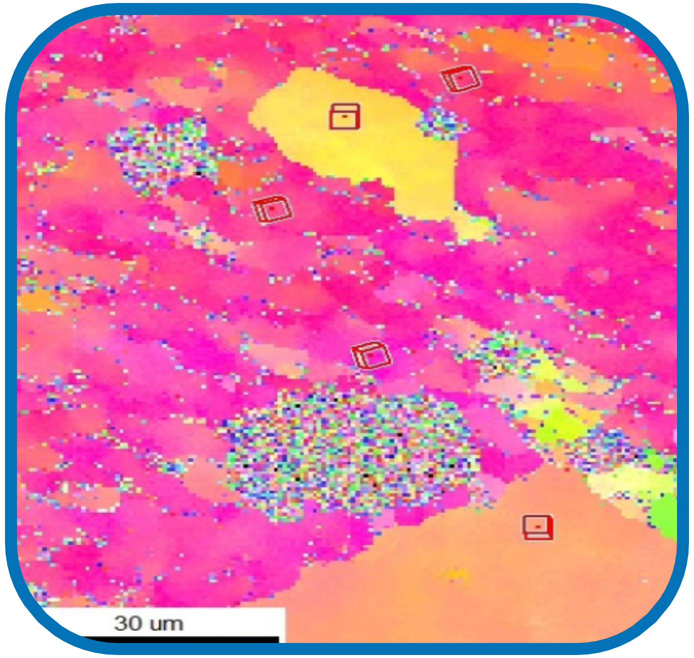
Pit density: y
Average grain area: w

What did we learn about the role of microstructure in pit growth?

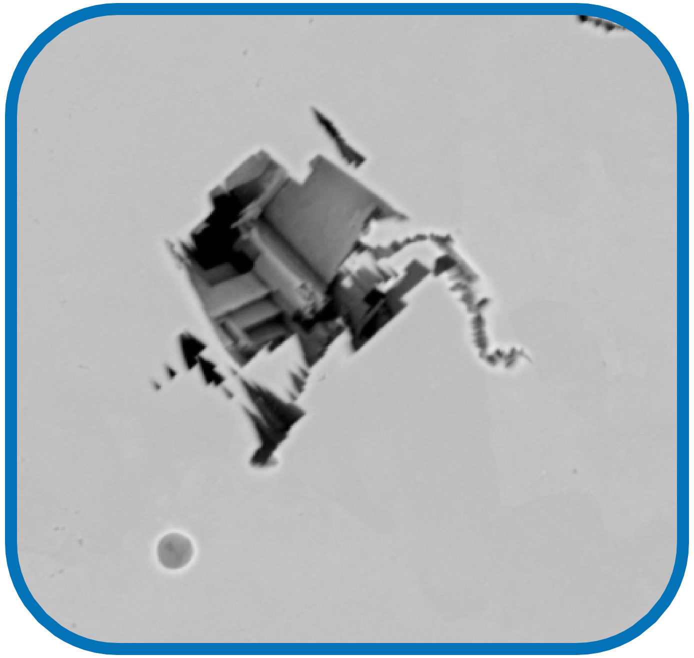
Grain orientation, boundaries, and size affect pit formation and growth



Pits attack {100} family



Pit nucleation spots on grain boundaries



Pits attack {100} family

Questions?

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Bonus Slides

Corrosive pit morphology is difficult to predict