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Effect of Melt Pool Boundaries on Repassivation of Selective Laser Melted Stainless Steel

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242nd ECS meeting, Critical Factors in Pitting corrosion: In honor of Gerald Frankel

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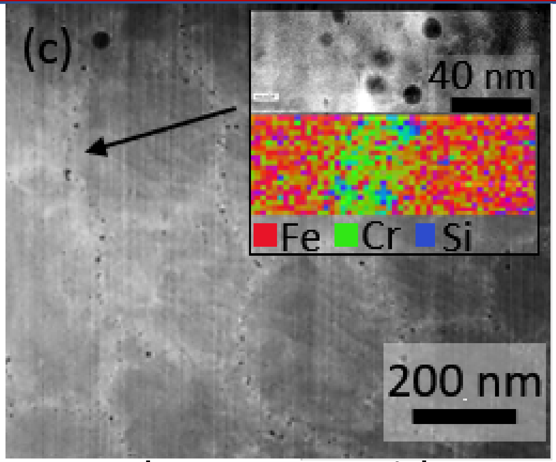
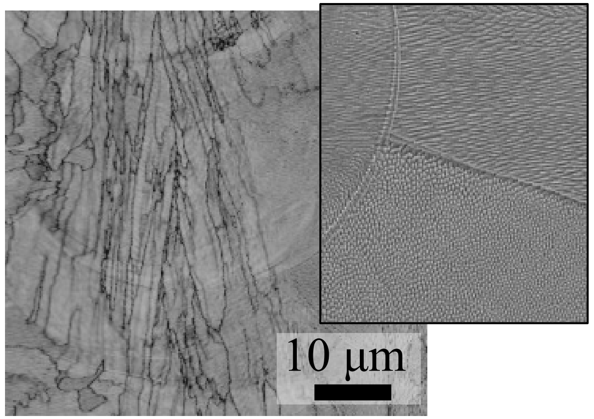
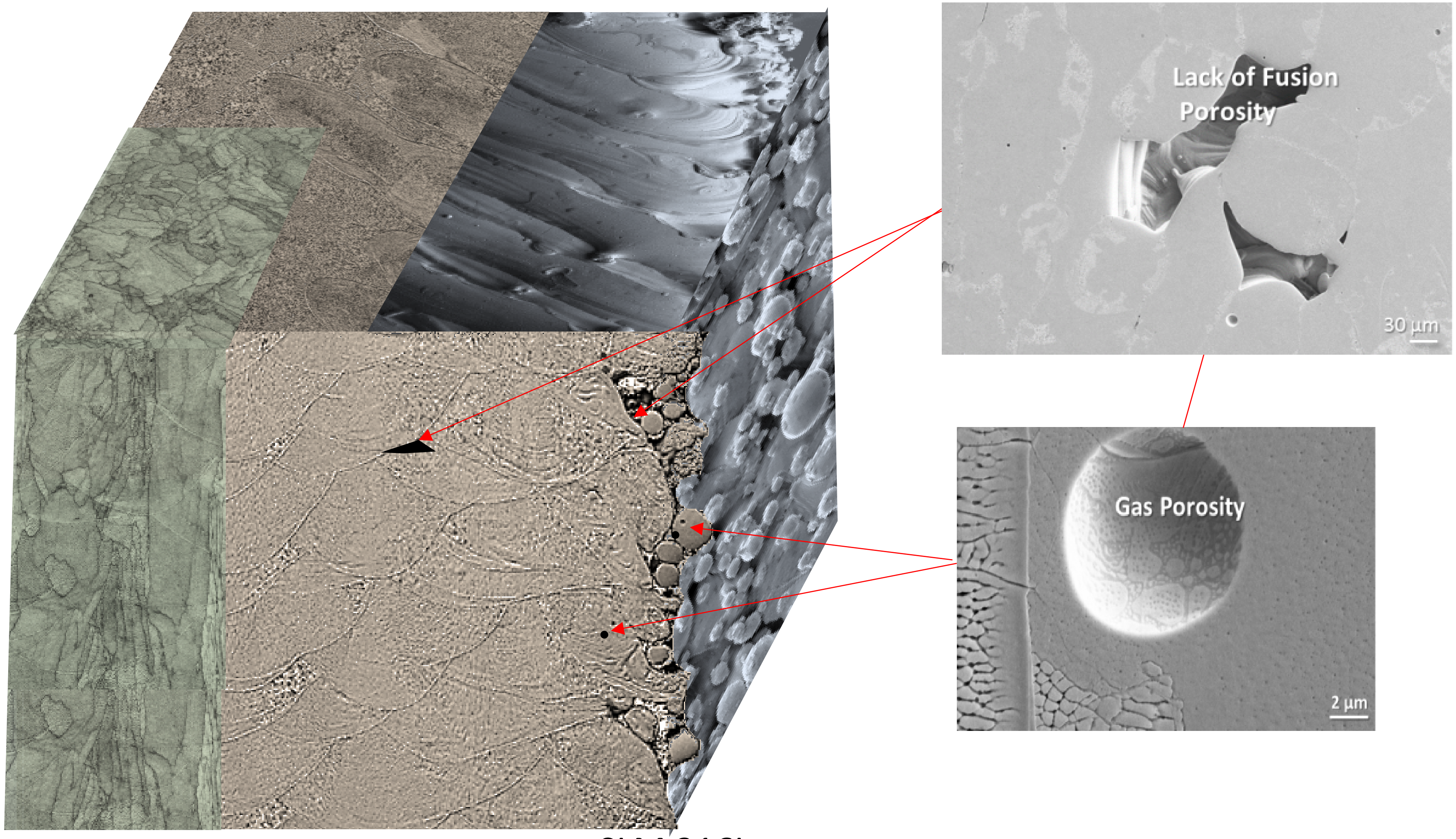
Heterogeneities in SLM Stainless steels across length scales



substructure with nanoscale inclusions



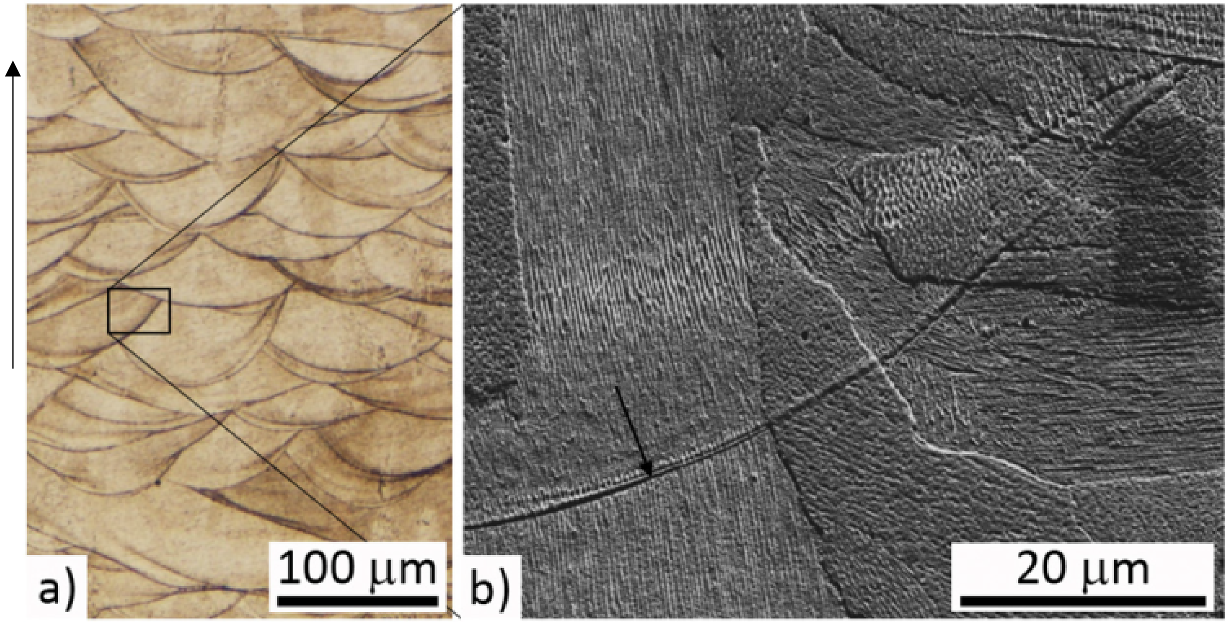


SLM 316L

Schindelholz, Melia, Rodelas, *Corrosion*, 2021

Melt pool boundaries are selectively attacked in oxidizing and acidic conditions

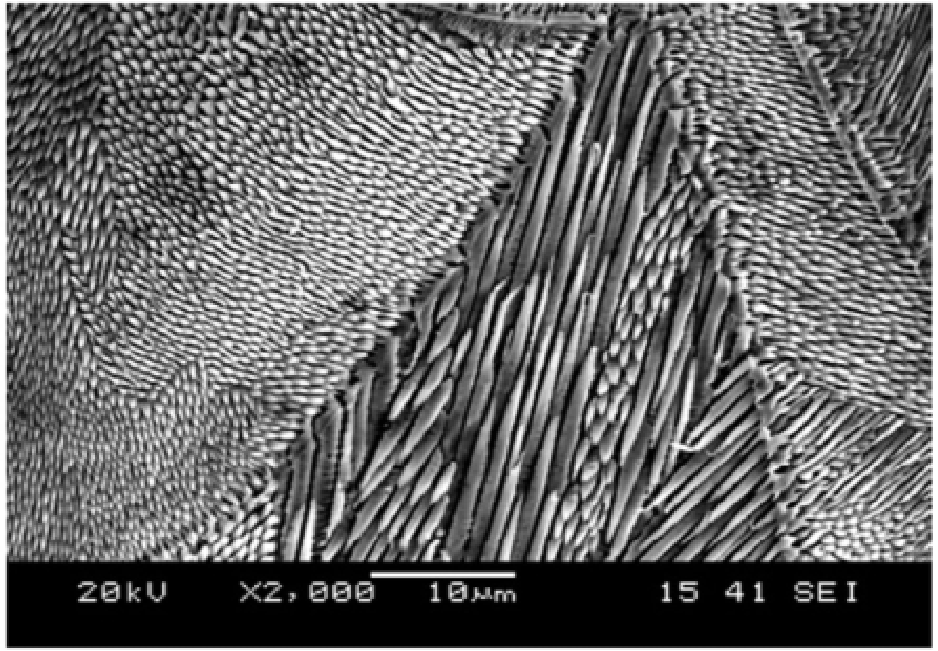
SLM 316L



glycerine aqua regia etchant

Godec et al., *Mat. Charact., 2020*

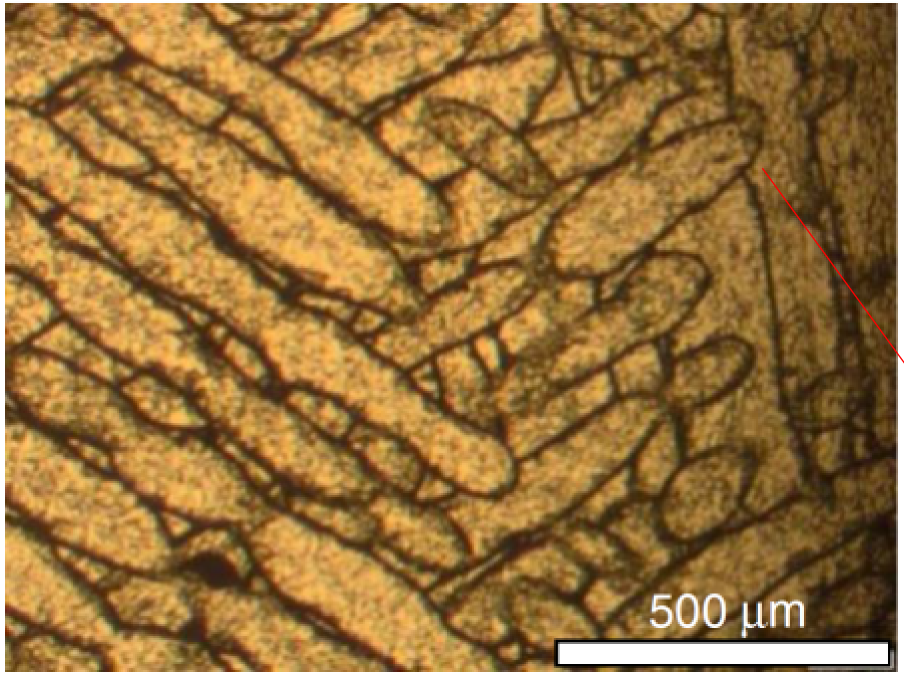
SLM 316L



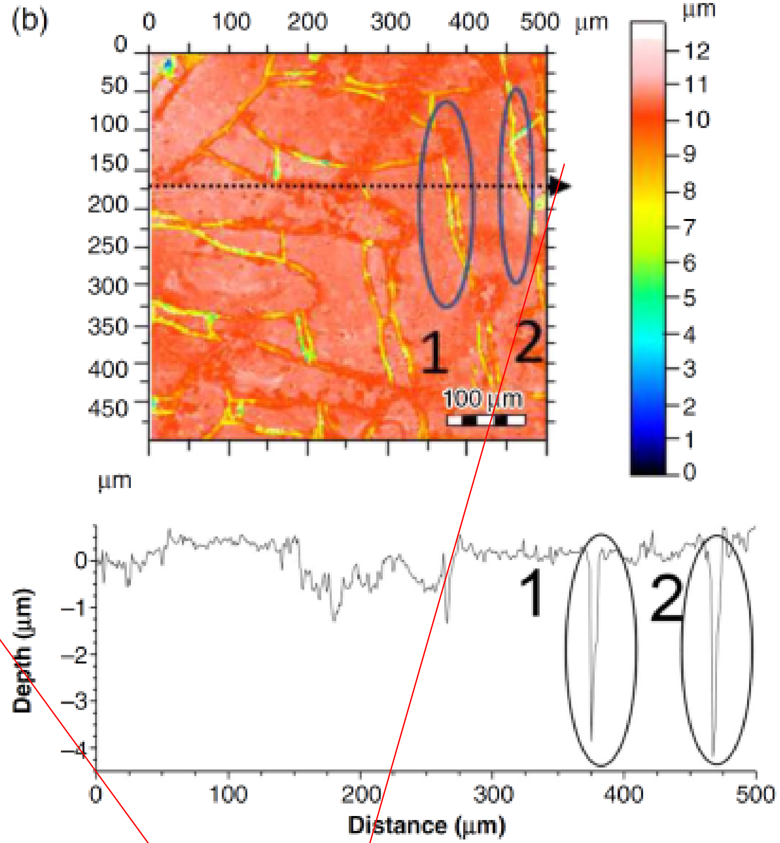
Oxalic acid, electrolytic etch

Pham, Dovgyy, Hooper, *Mat. Sci. Eng. A, 2017*

Melt pool boundaries are selectively attacked in oxidizing and acidic conditions



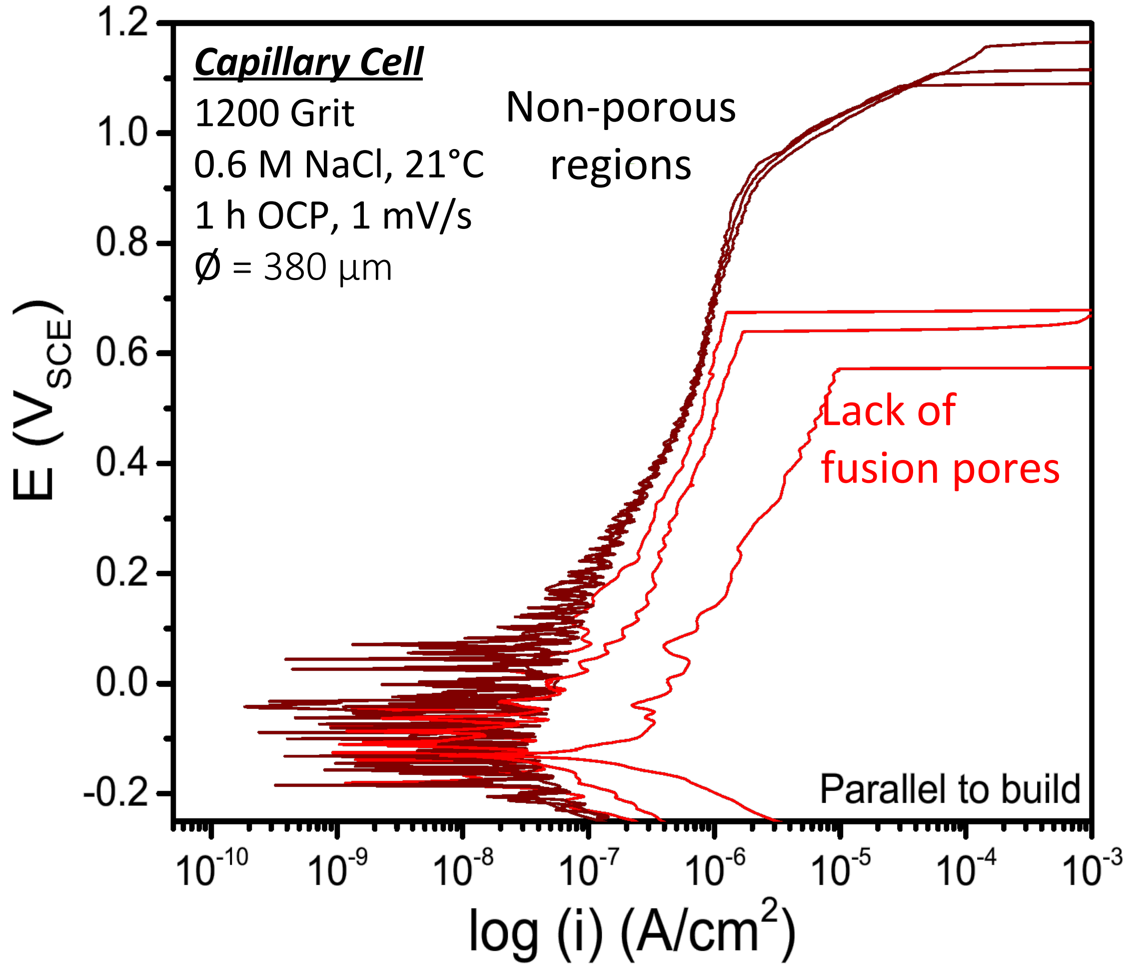
SLM 316L after electrolytic persulfate etching sensitization test (ASTM A262)



Melt pool boundary

Macatangay et al., *Corr. J.,* 2017

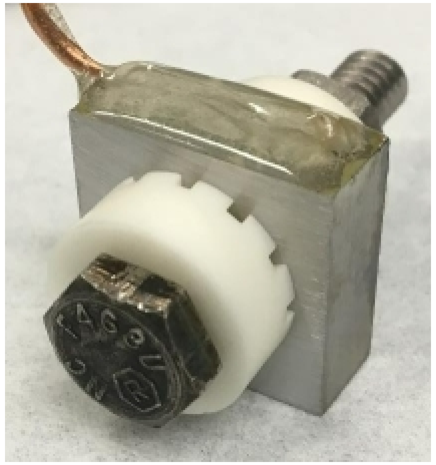
Porosity largely controls the Pitting potential



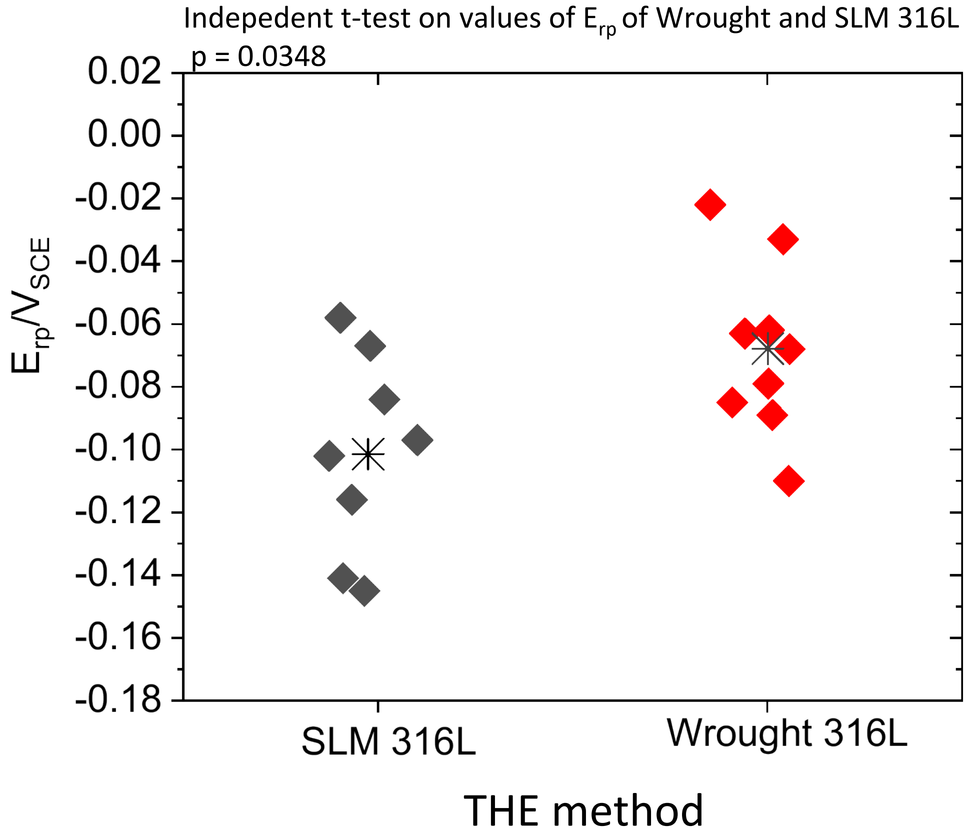
Significant change in breakdown potential between non-porous regions(black curves) and near LOF pores(red curves)

Schaller, Rodelas, Schindelholz, *J. Electrochem. Soc.*, 2018

Measured E_{rp} of SLM-316L is only slightly lower in comparison with wrought 316L

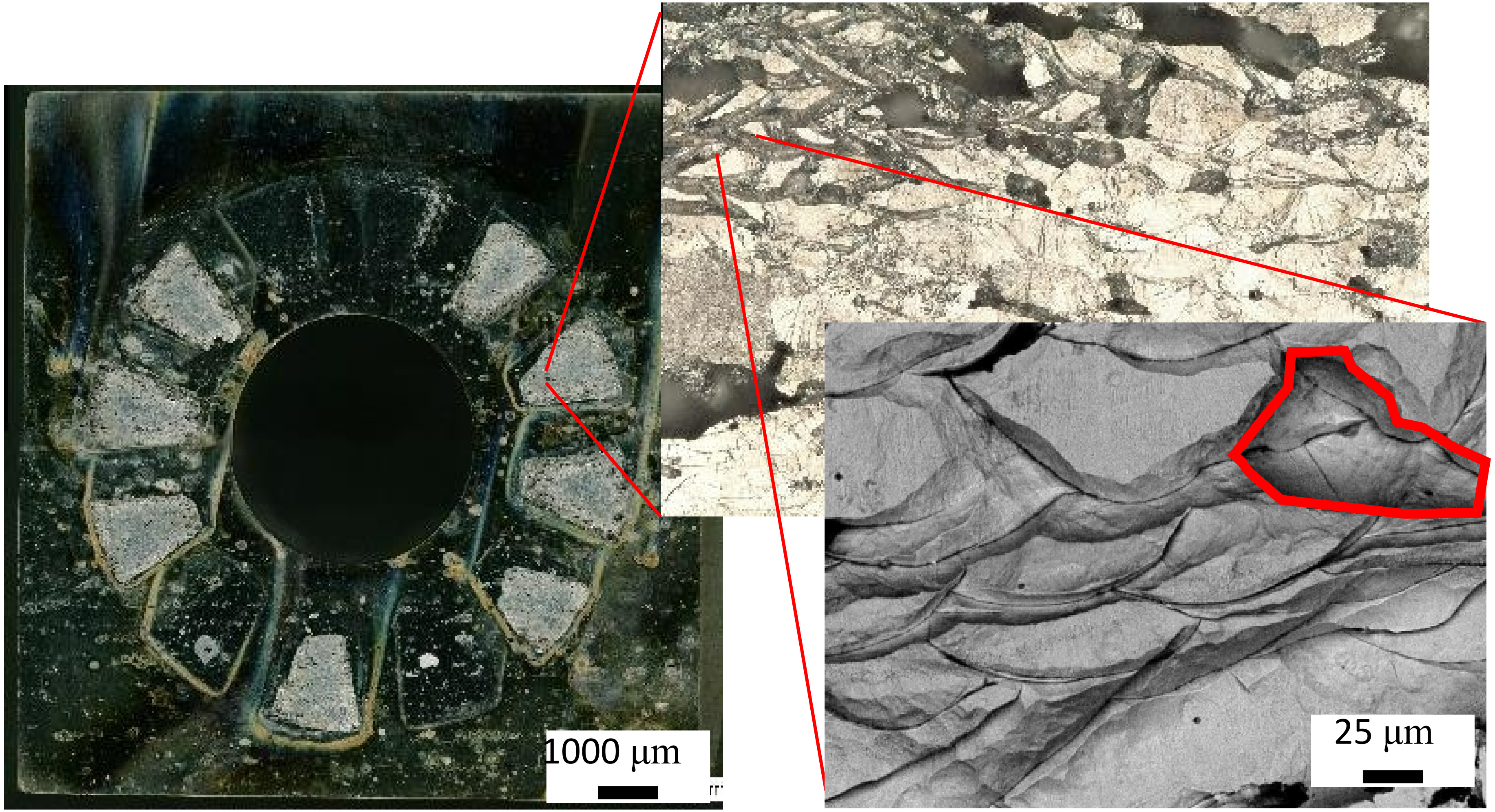


Crevice setup as per ASTM G192

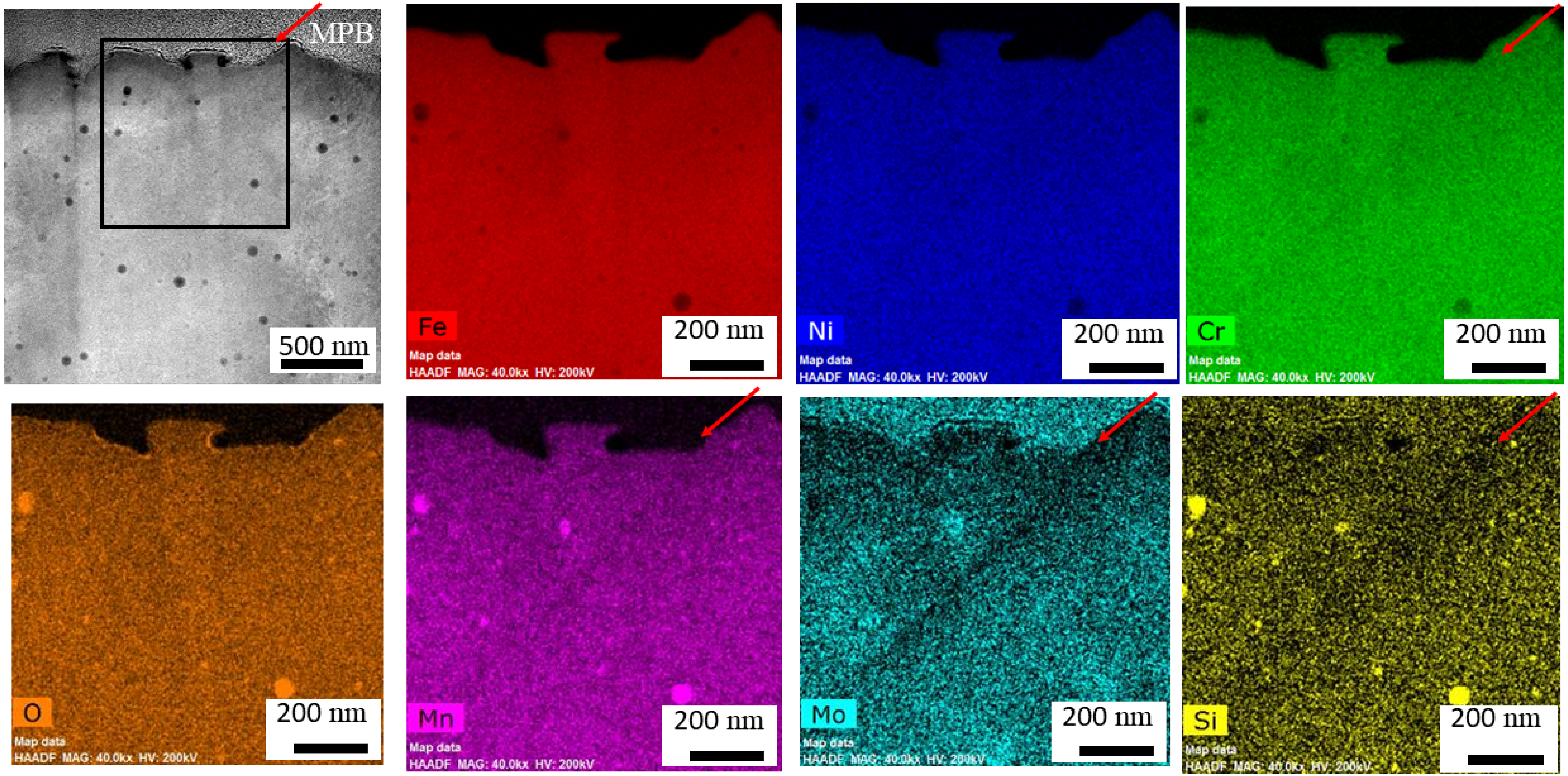


Statistically different but only with significant overlap

Post-corrosion characterization of crevice shows severe attack along MPBs, potentially leading to fall-out



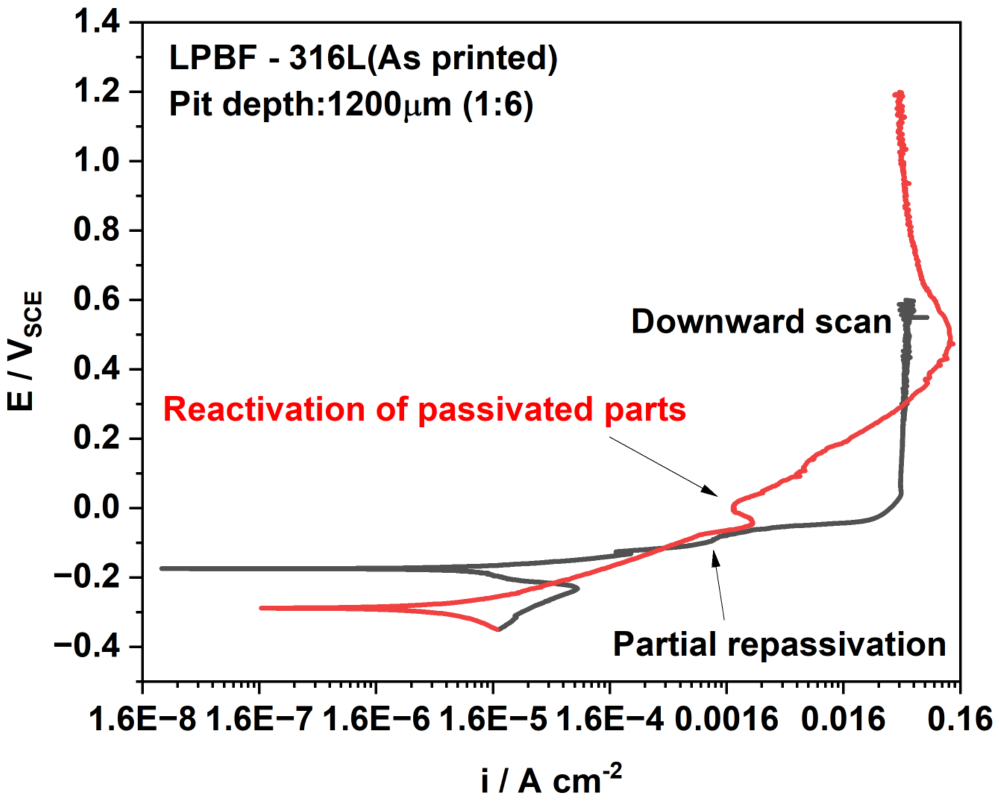
STEM-EDX map of FIB section of SLM-316L shows depletion of Cr,Mo at MPBs

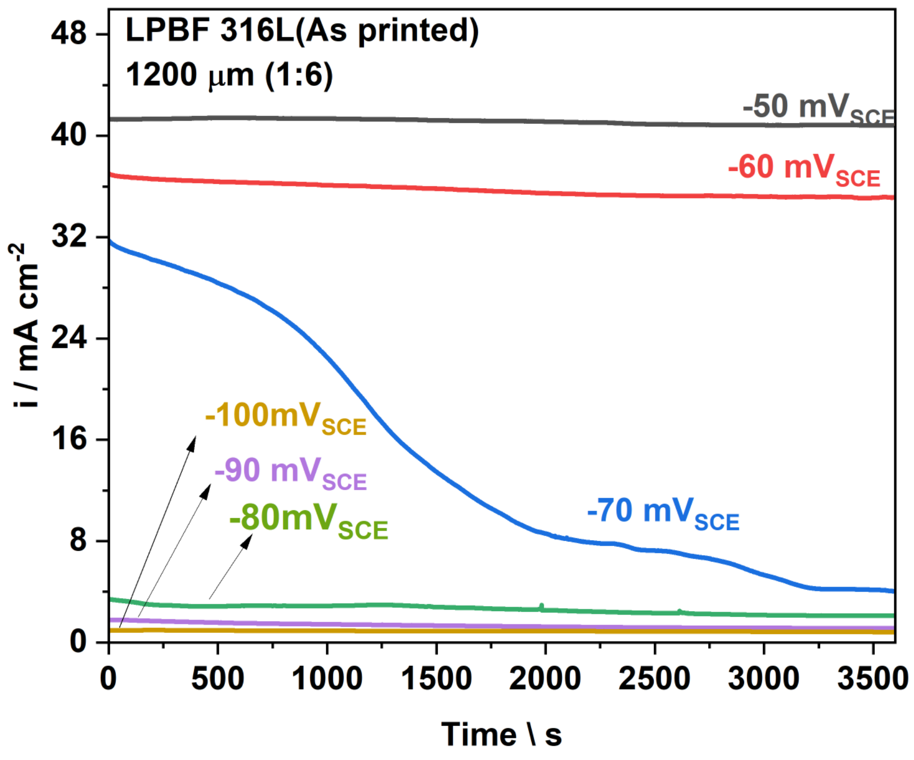


Key questions

- ❑ Can this selective attack along MPBs be replicated during long-term potentiostatic hold of SLM-316L near critical pit chemistry using artificial 1D pits?
- ❑ Does the repassivation potentials measured through methods that are designed specifically for wrought alloys hold for AM alloys?

Electrochemical evidence showing absence of complete repassivation in SLM-316L SS

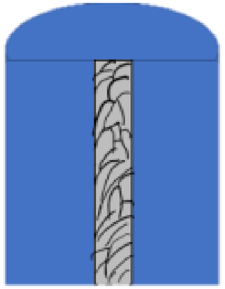




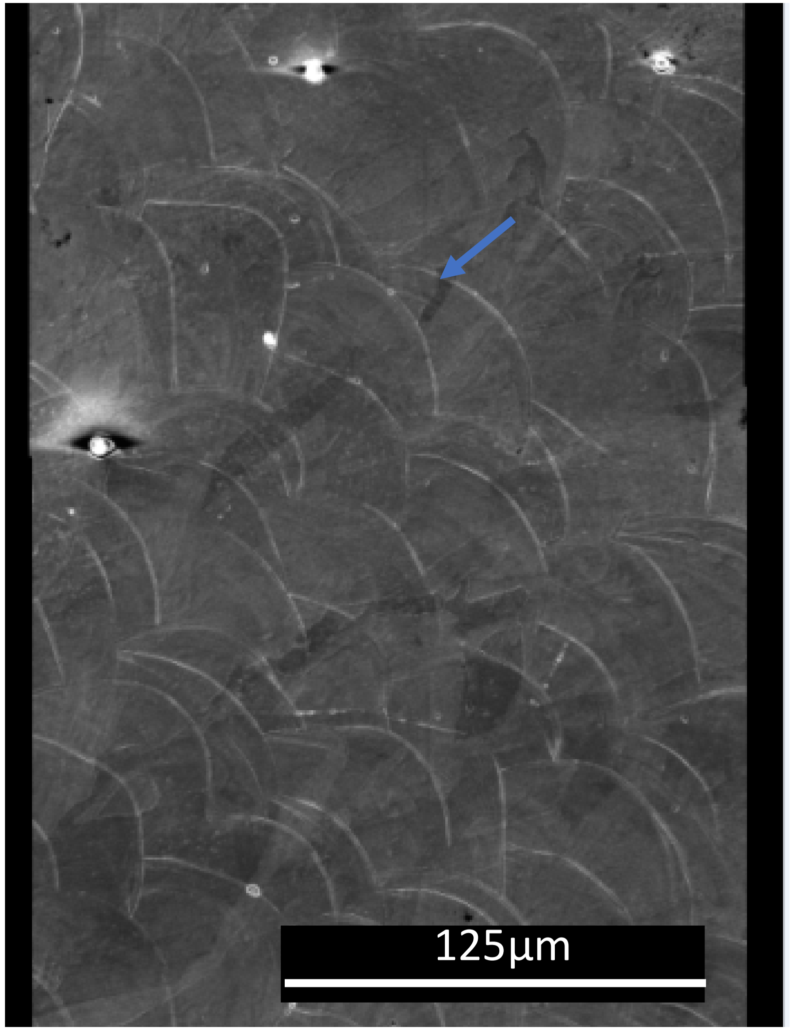
Modified-THE

SEM morphological evidence for sustained attack along MPBs near-critical pit chemistry

(a)

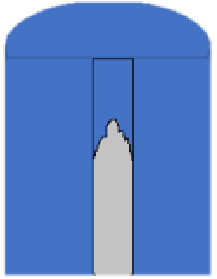


Schematic of etched 1D pit cross-section pre-corrosion

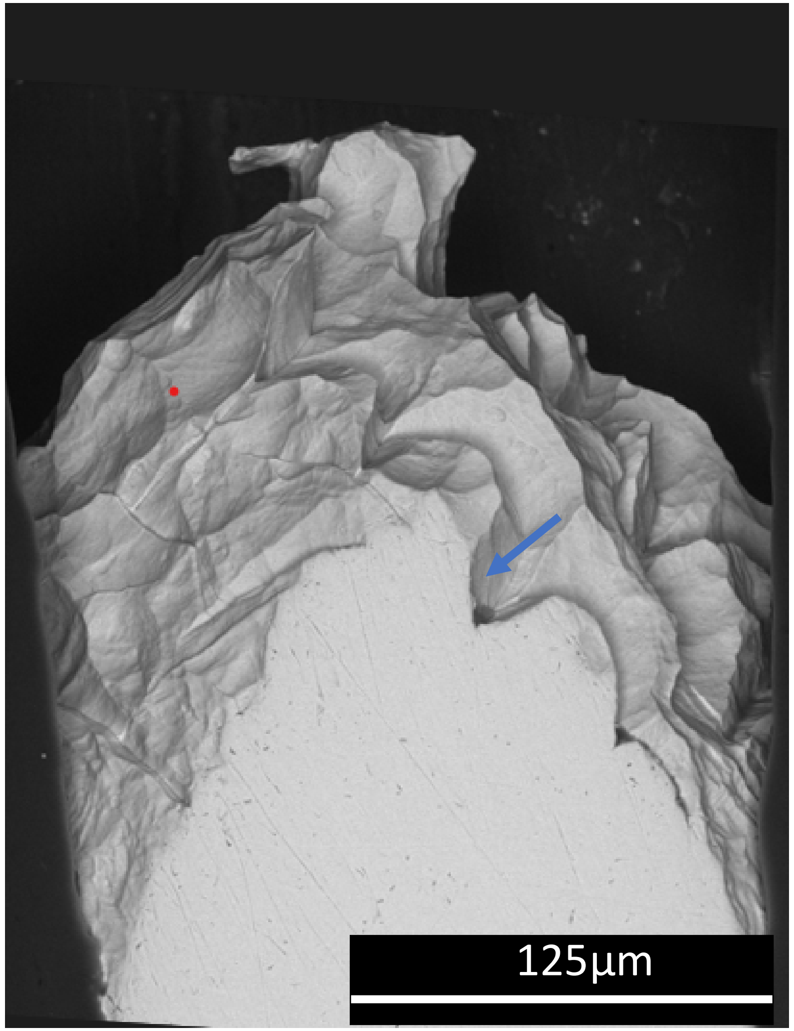


Etched cross-section of uncorroded 1D pit electrode

(b)



Schematic of 1D pit cross-section post-corrosion



Post-corrosion cross-section of 1D pit bottom

Takeaways

1. MPBs are selectively attacked during long-term potentiostatic experiments on 1D pits near-critical pit chemistry
2. Selective corrosion propagation along MPBs near critical conditions seems to be linked to the Cr/Mo depletion at these features.
3. The SLM-316L appears to undergo partial repassivation at the measured repassivation potential(critical potential) as indicated by the unusually high currents at critical potential
4. Considering the elevated susceptibility of MPBs, the partial repassivation events are most likely linked to MPBs not undergoing repassivation at the measured repassivation potential