Impact of Nitrogen on Pitting and Crevice Corrosion Mechanisms in Additively Manufactured Stainless Steels

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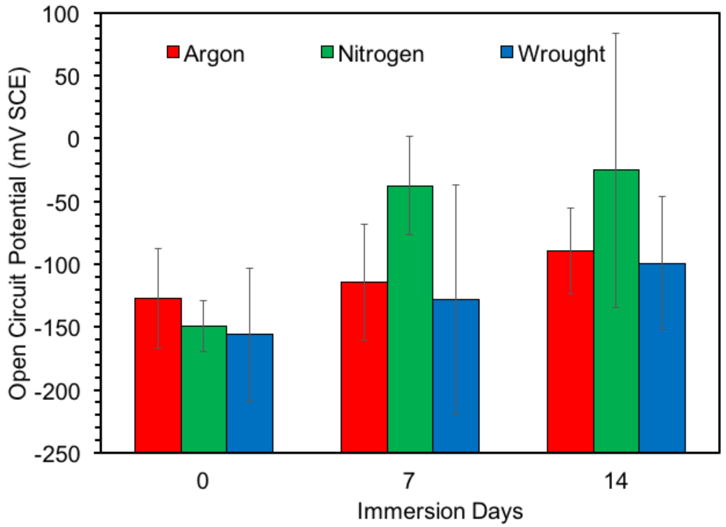
Objectives of Research

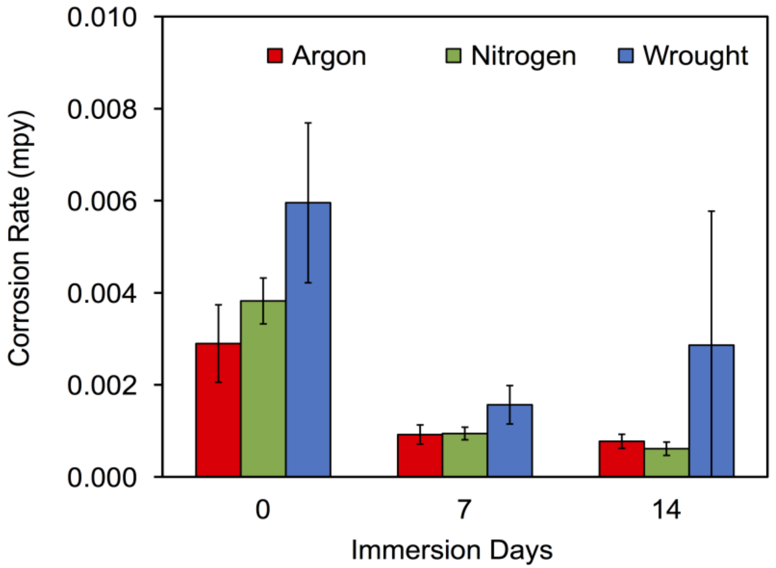
The goal of the proposed one year ONR Science & Technology effort is to:

1) Obtain pitting and crevice corrosion data on 316L AM alloys (produced primarily through powder bed fusion AM processes on alloys with a minimum of process related defects (<10 μm)
2) Use this data to begin to elucidate mechanistic information about these localized corrosion processes that will allow the development of better AM alloys.
3) Compare the performance of two AM 316L alloys that contain nitrogen concentrations ranging over approximately one order of magnitude (around 0.01 wt% N for the **argon atomized 316L powder** to around 0.07 wt% N for the **nitrogen atomized powder**).
4) See if the versatility of AM can be exploited to enhance the localized corrosion resistance of 316L stainless steel.

Open Circuit Potentials and Corrosion Rates in ASW as a Function of Time

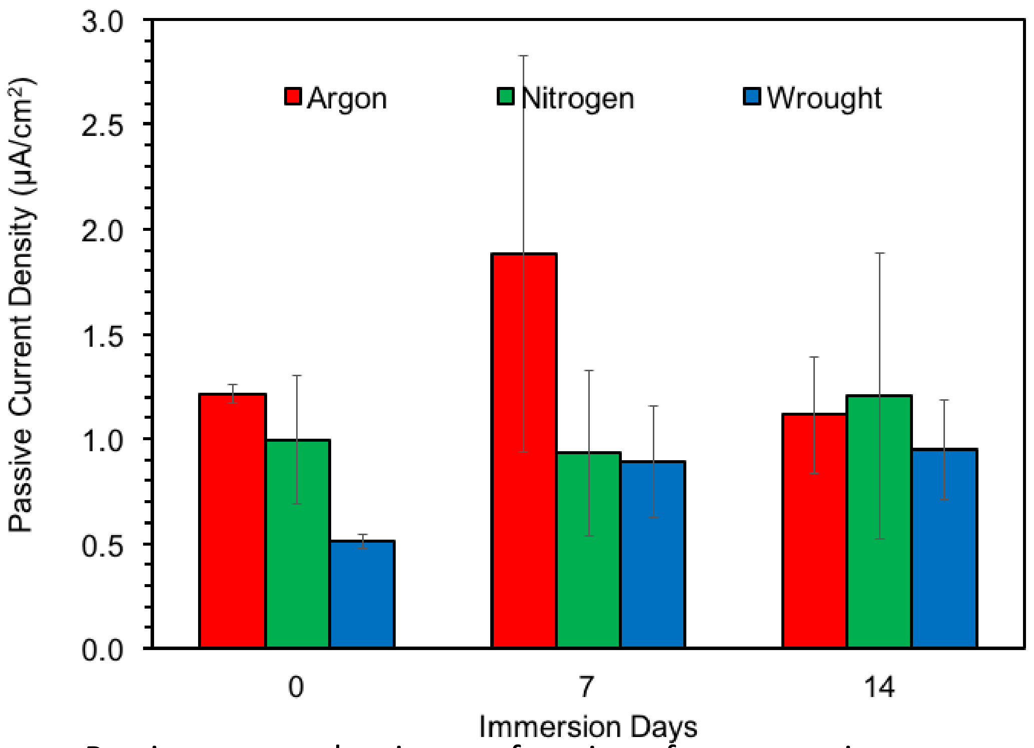


Average open circuit potentials measurements as a function of exposure time for the two AM 316L stainless steel alloys compared to wrought 316L in quiescent (not aerated or deaerated, and not stirred) artificial seawater at ambient lab temperature of approximately 23°C.

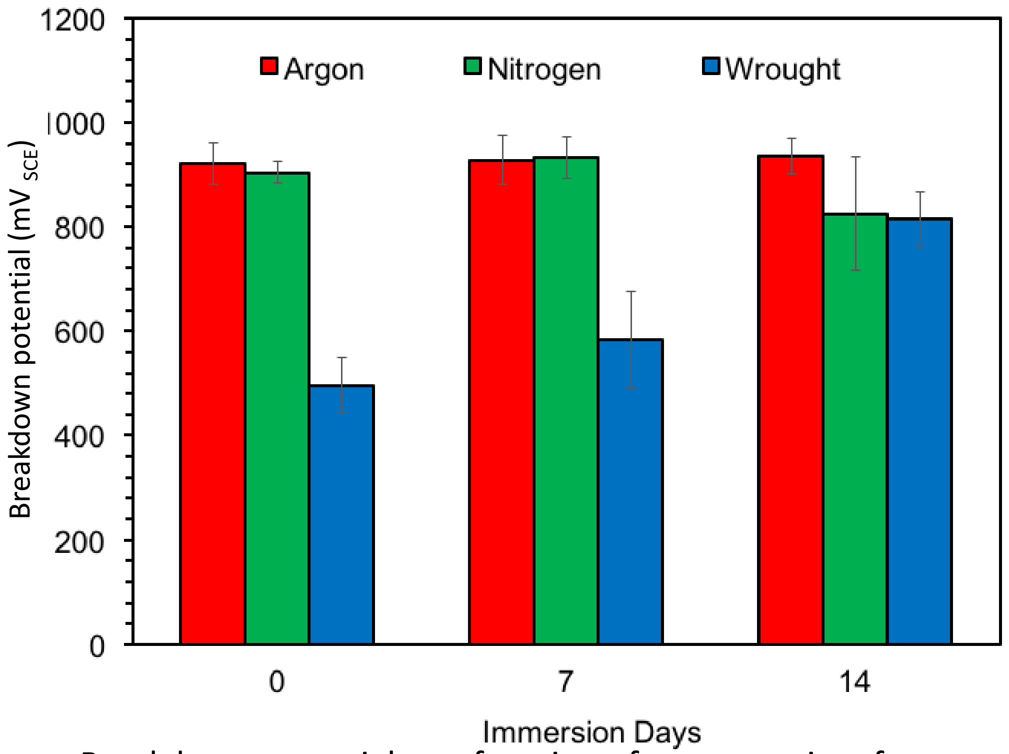


Uniform corrosion rates for AM 316L stainless steel compared to wrought 316L in quiescent (not aerated nor deaerated, and not stirred) artificial seawater at ambient lab temperature of approximately 23°C.

Passive Current Density and Breakdown Potenital in ASW as a Function of Time

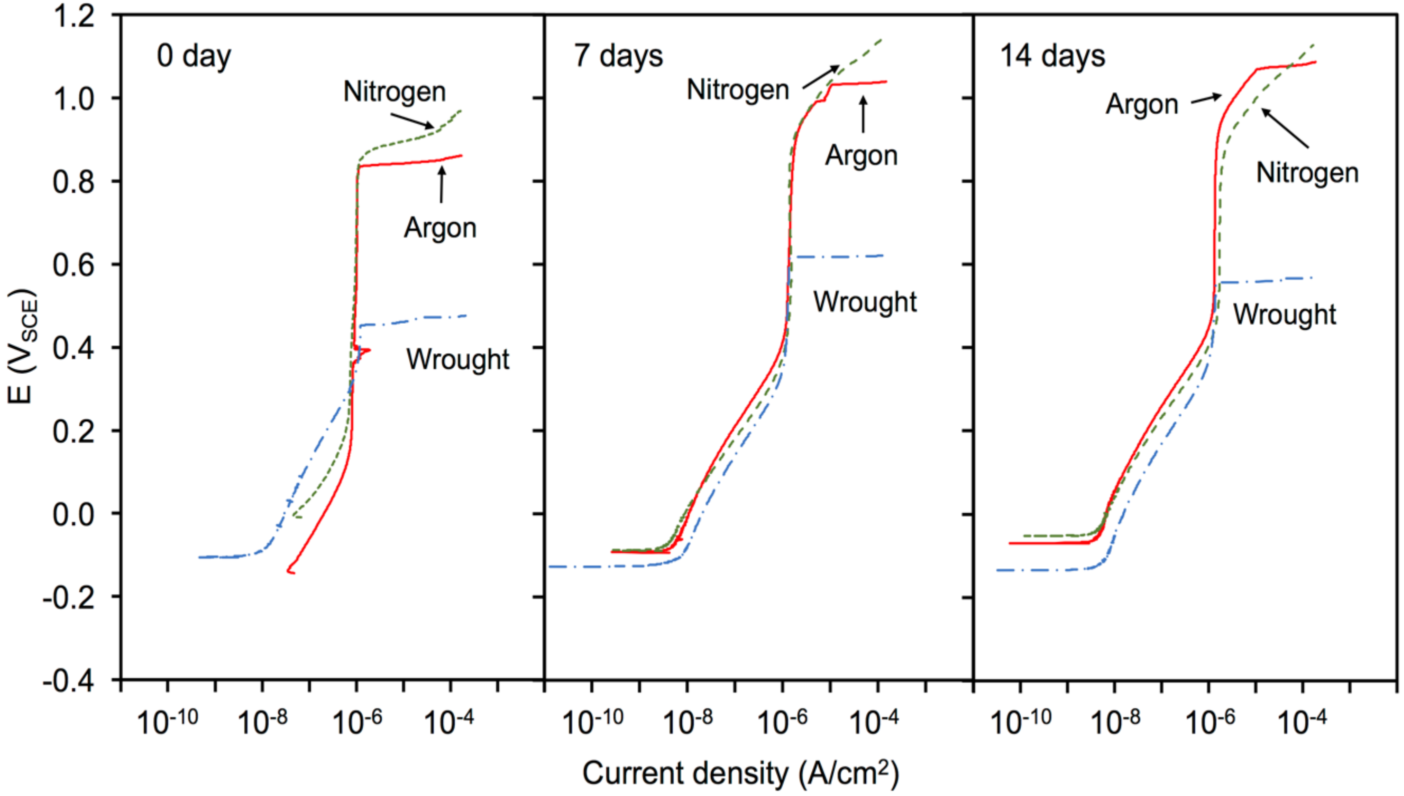


Passive current density as a function of exposure time for the two AM 316L stainless steel alloys compared to wrought 316L in quiescent (not aerated or deaerated, and not stirred) artificial seawater at ambient lab temperature of approximately 23°C.

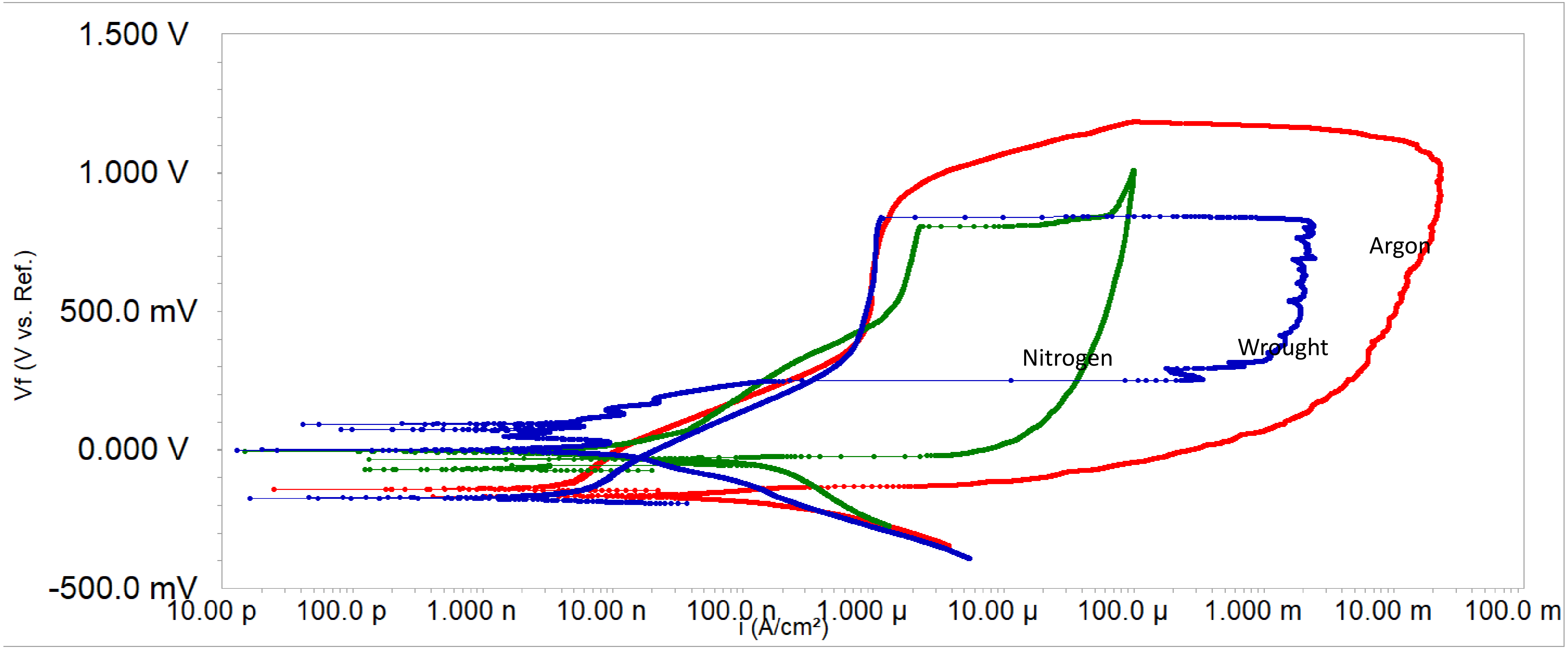


Breakdown potential as a function of exposure time for the two AM 316L stainless steel alloys compared to pitting potential wrought 316L in quiescent (not aerated or deaerated, and not stirred) artificial seawater at ambient lab temperature of approximately 23°C.

Long-term Anodic Polarization Behavior in ASW

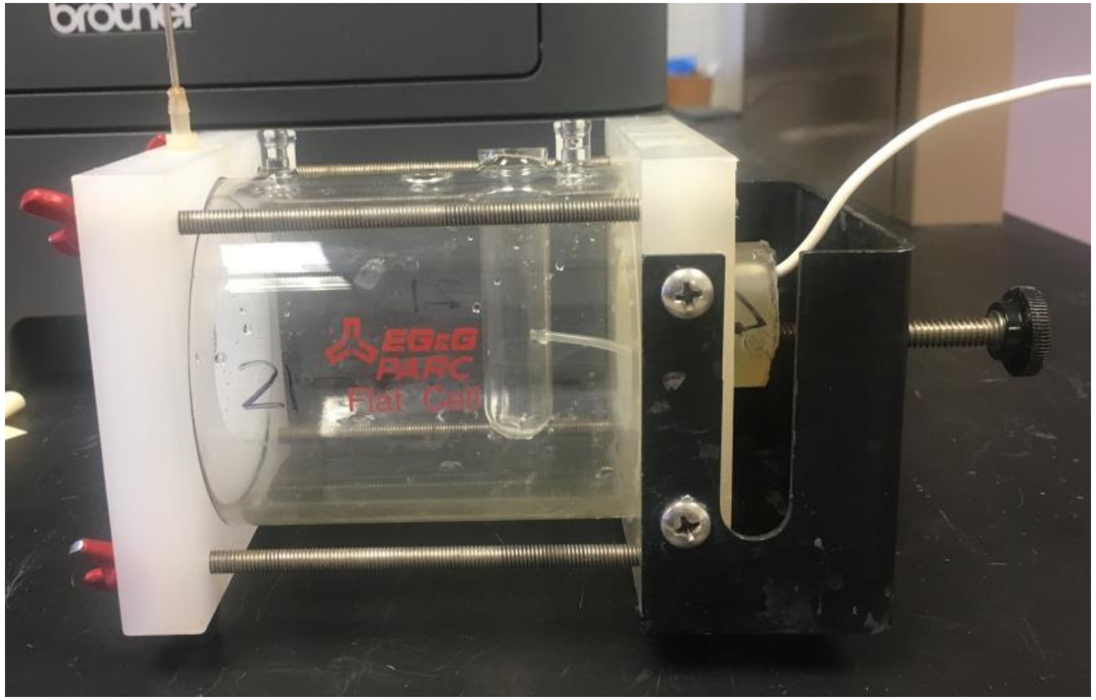


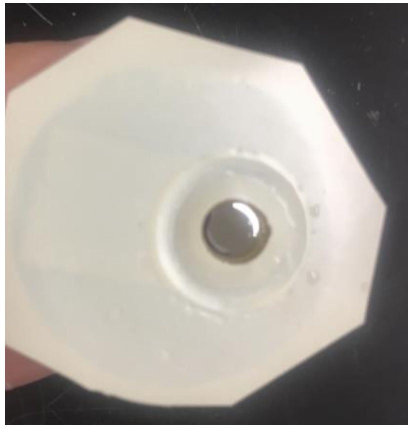
Long-term Cyclic Polarization Behavior after 14 Days of ASW Exposure

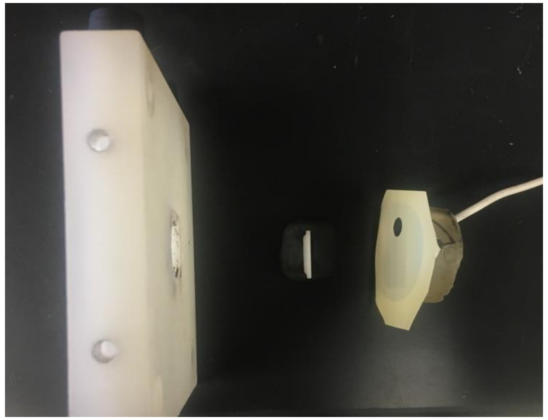


Test Set-up for Crevice Corrosion Tests

Potentiostatic Crevice Tests with different crevice arrangement



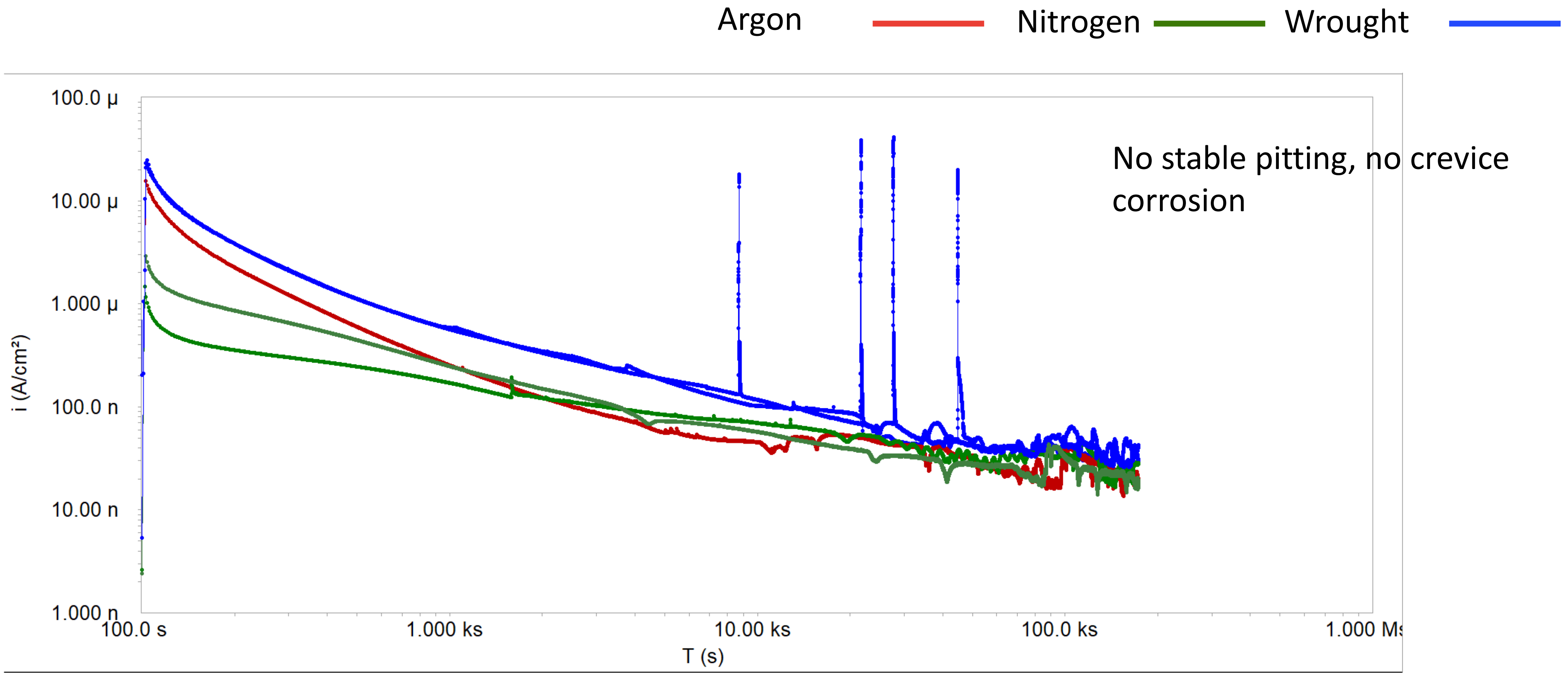




Teflon Crevice Former pushing down on tape

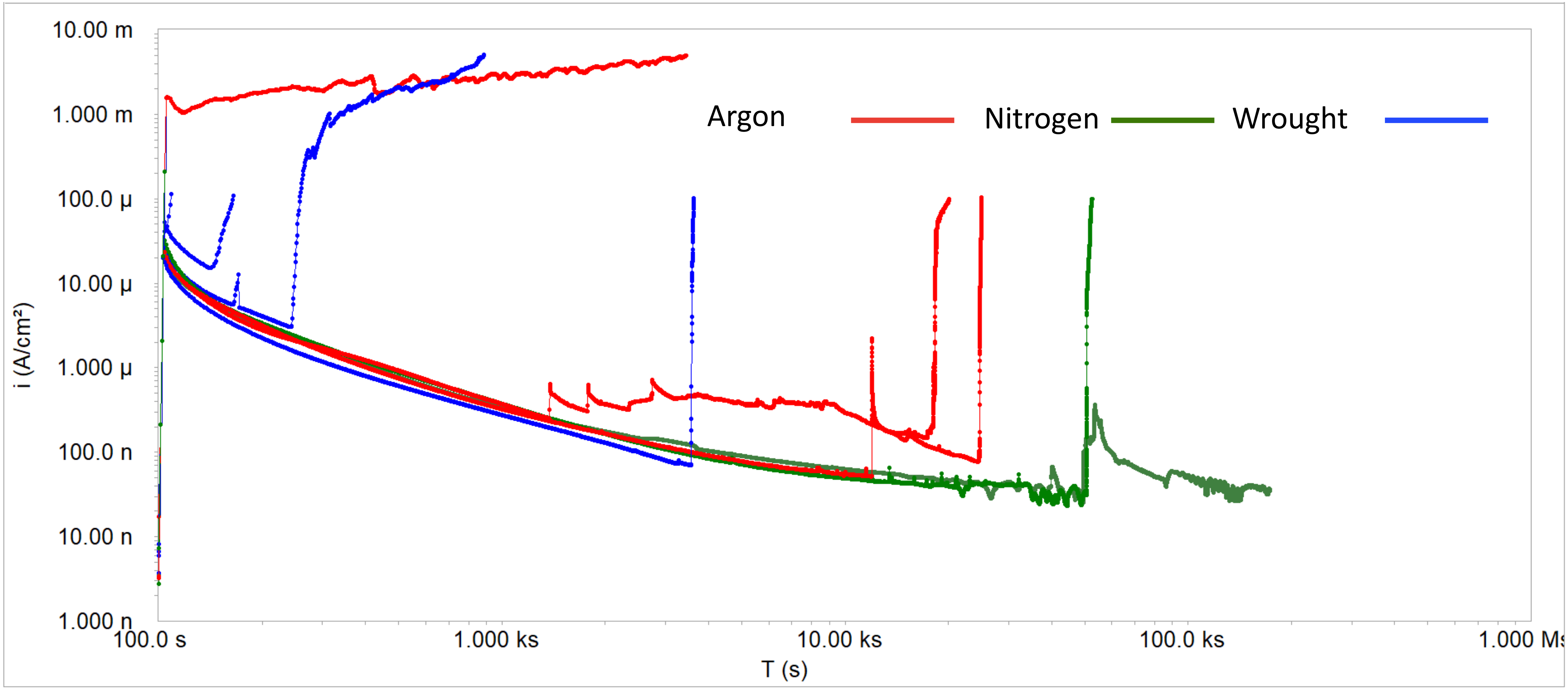
Time to Initiate Crevice Corrosion

Potentiostatic Test in ASW at 0.3V vs. SCE



Time to Initiate Crevice Corrosion

Potentiostatic Tests in ASW at 0.5V vs. SCE



Conclusions to date

- In the experiments conducted in this investigation, the AM 316 L SS alloys showed a higher resistance to pitting corrosion than the wrought 316 L alloy. This may be due to the fact that manganese sulfide inclusions are not an issue in AM like they are in conventional 316L SS.
- At high anodic potentials (greater than 0 .300 V vs SCE) all the 316L specimens are subject to breakdown. This increase in current at higher potentials was due to: pitting for the wrought 316L and crevice corrosion for the AM 316 L (N).
- With exposure time, the breakdown potential (for the onset of crevice corrosion) for the AM (N) decreases.

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