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CREATING MORE REALISTIC CORROSION MODELS: EVALUATING THE INTERACTION BETWEEN MULTIPLE PITS

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U.S. DEPARTMENT OF ENERGY

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NNSA

OUTLINE

- Summer Research Project
  - What is corrosion?
  - Problem with current models.
  - How can more realistic models be made?
  - Model Results
  - ML model
  - ML Results
- Summer research experience

MY SUMMER RESEARCH

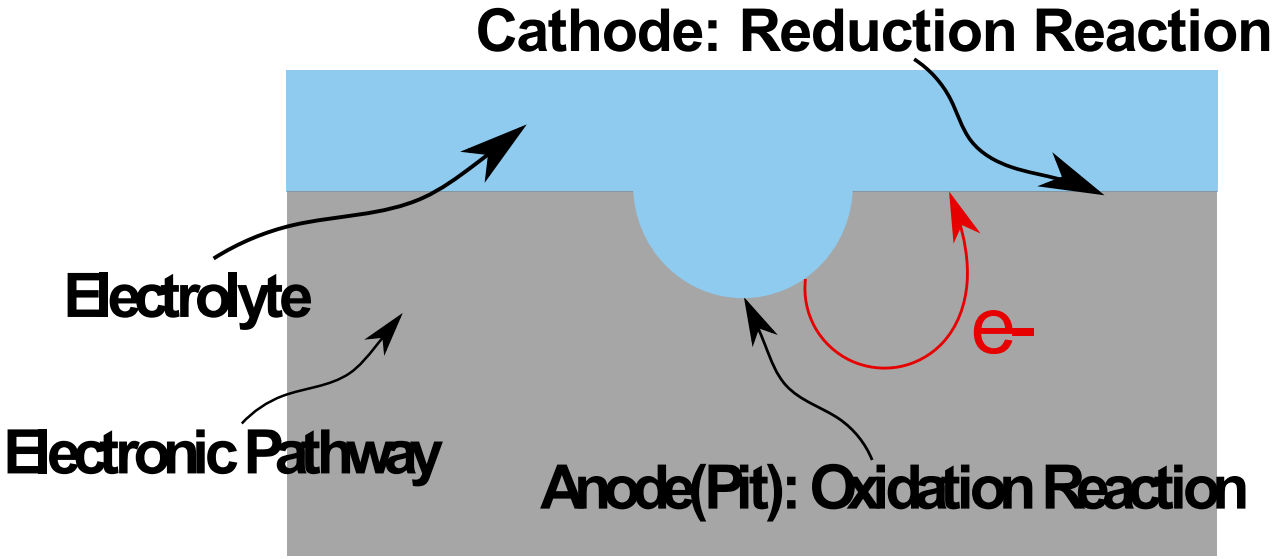
MOTIVATIONS

Metals exposed to a solution (atmospheric, full immersion), typically containing chloride, can be susceptible to degradation through corrosion.

What is needed for corrosion?

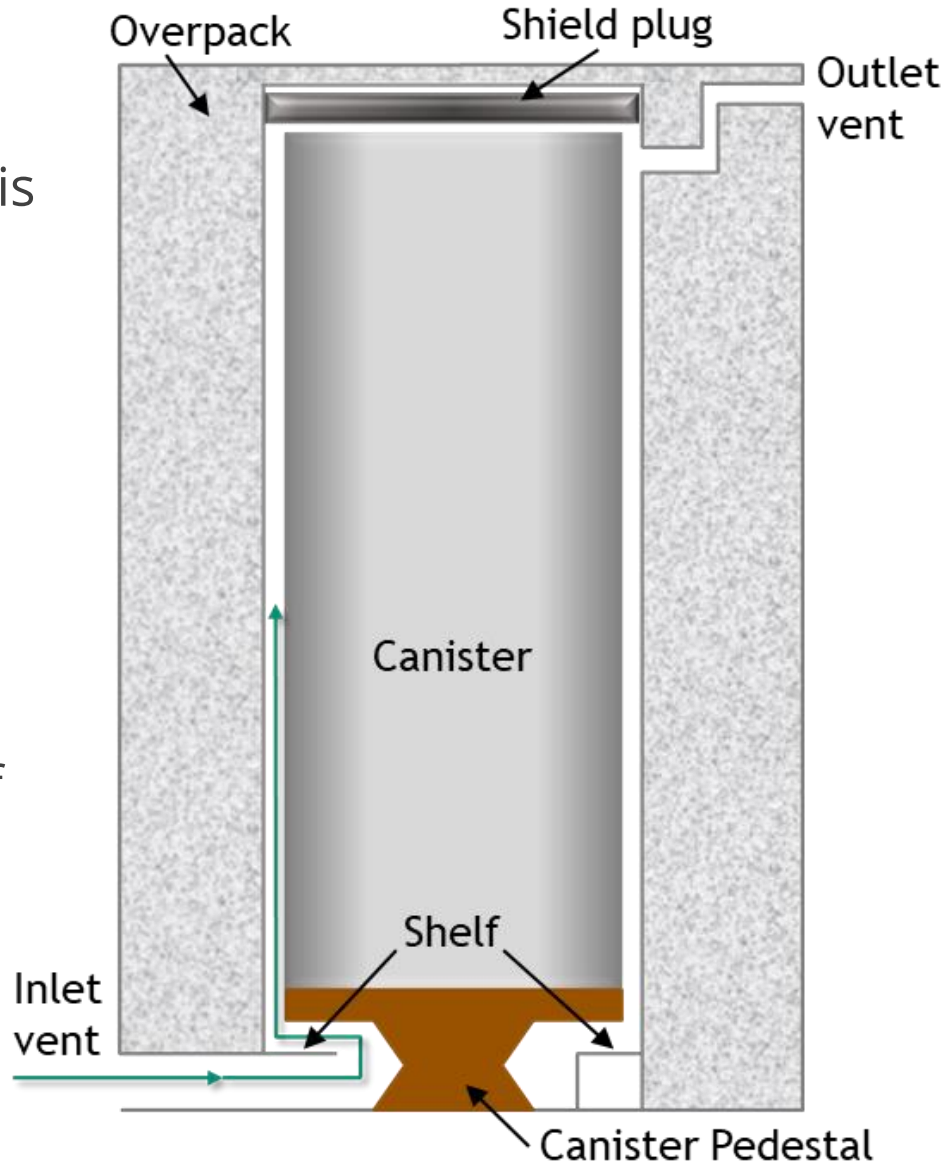
- **Ionic pathway**
- **Electronic pathway**
- **Anode**
- **Cathode**

What is corrosion?

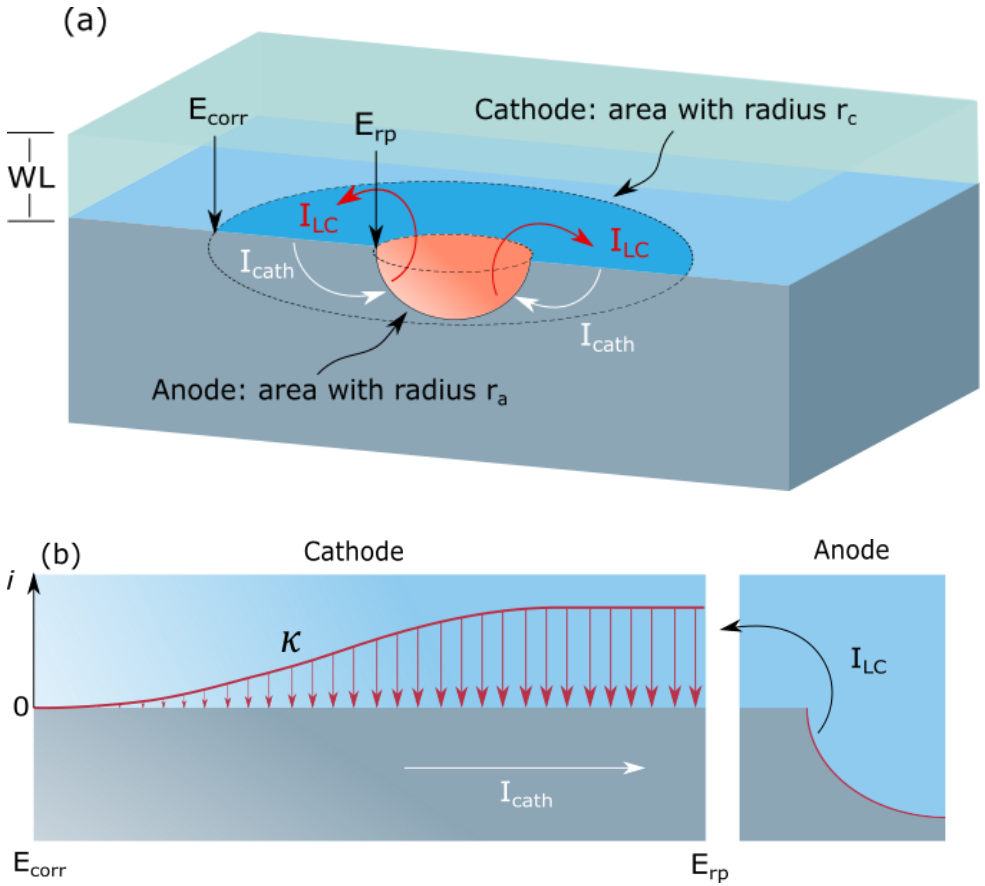


MOTIVATIONS

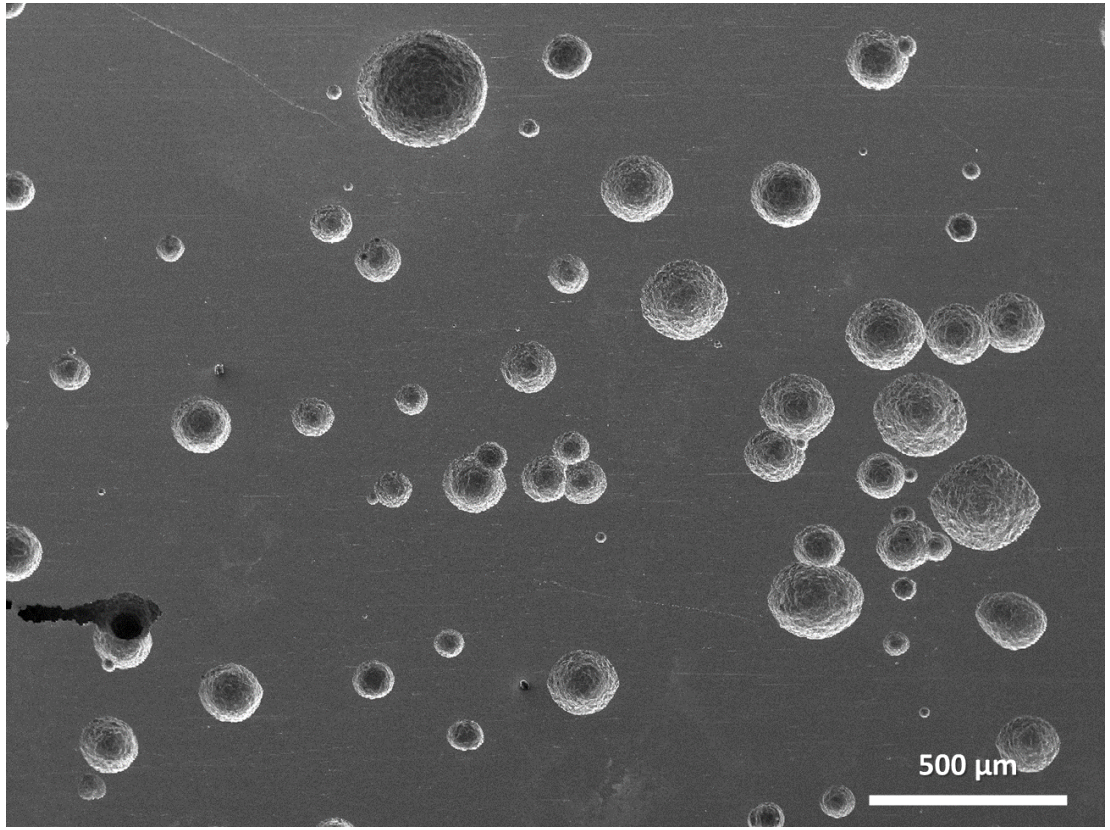
- Nuclear energy waste is stored in Stainless teel canisters
- Potential corrosion on spent fuel canisters
- If there is corrosion, canister can crack.
- Important to better study corrosion to better allow the use of nuclear energy.



Current Model



Exposures



HOW CAN MORE REALISTIC MODELS BE MADE?

An FEM model was created in COMSOL varying:

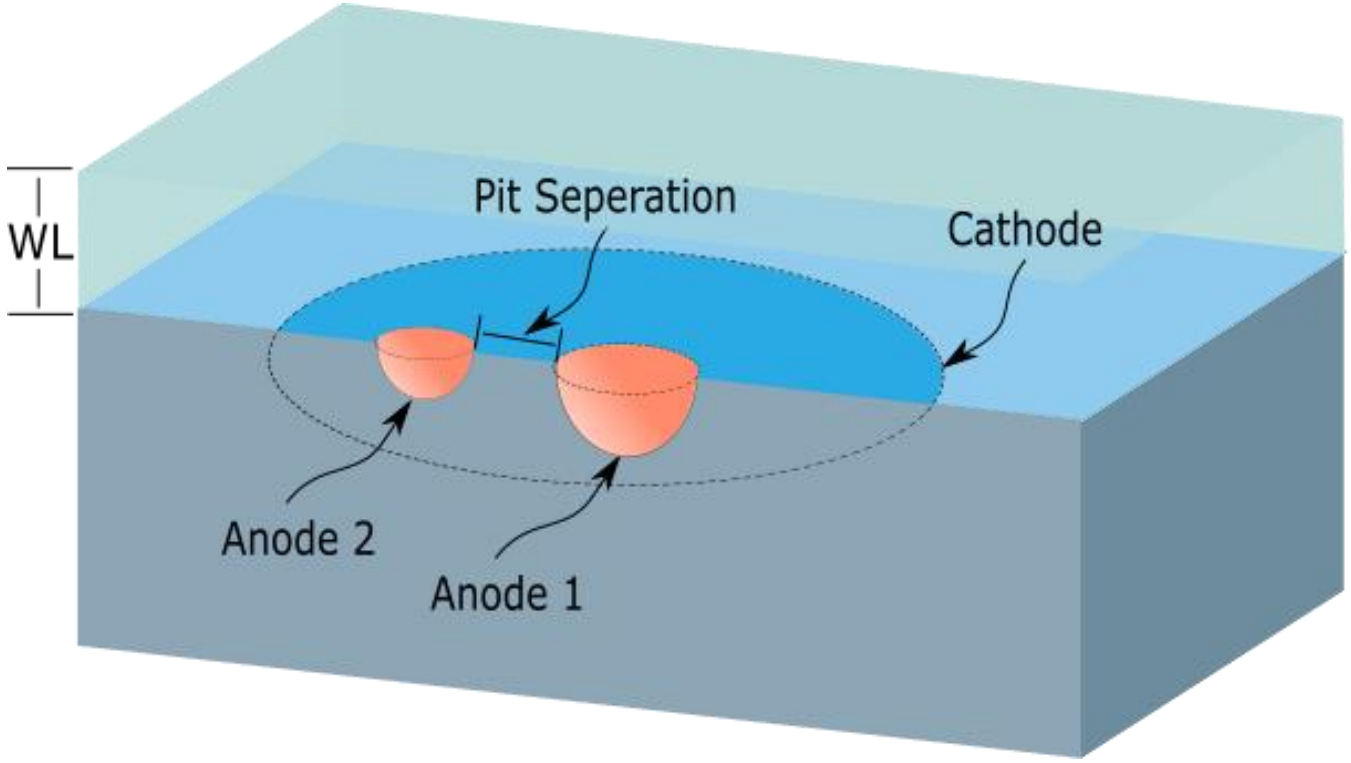
- Pit sizes
- Water layer Thickness
- Cathode size
- Distances between Pits
- Concentration of the Solution

Solving:

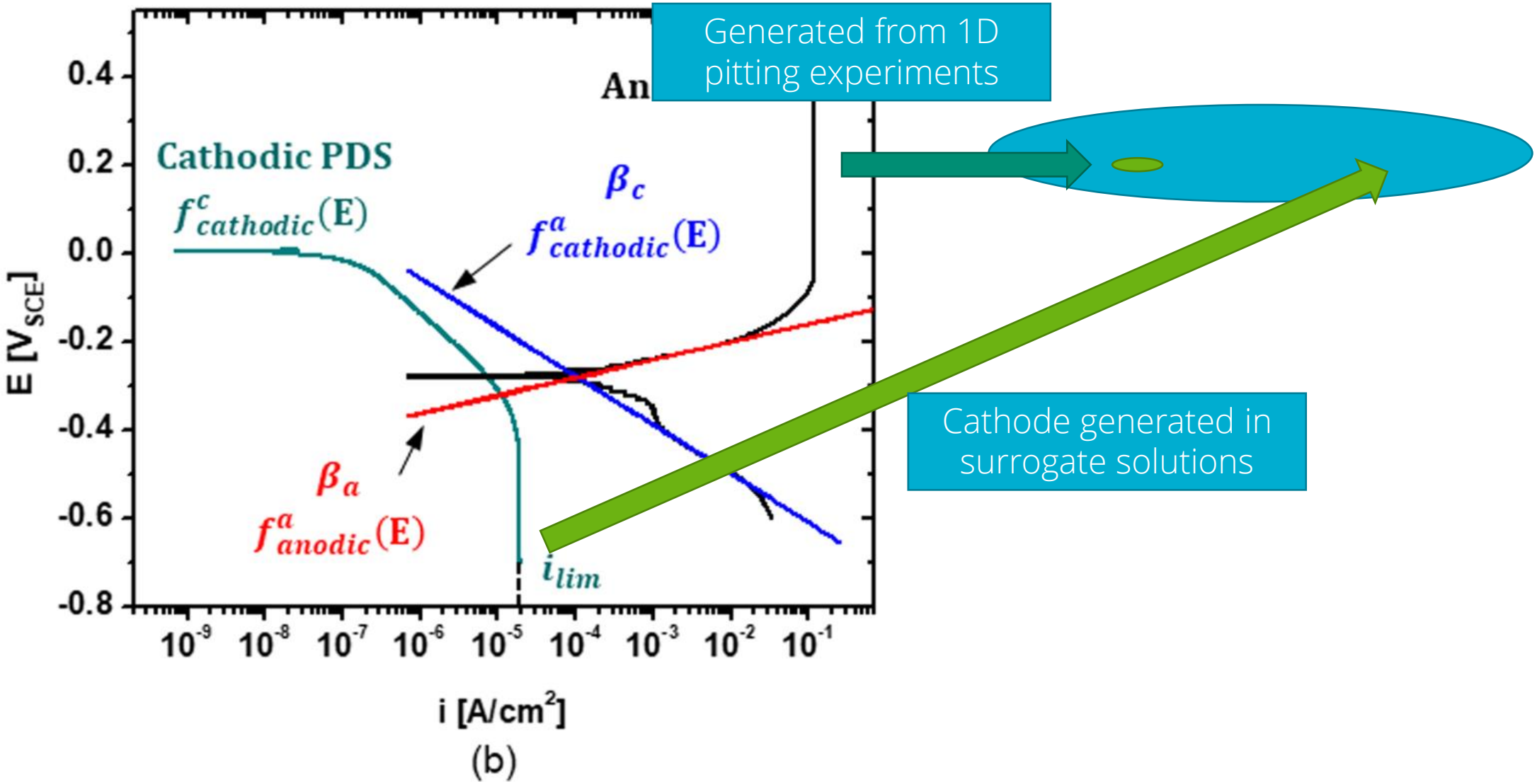
- The Laplace equation to model corrosion of stainless steel 304 in 3 M NaCl at 25 ˚C.

Metrics for comparison:

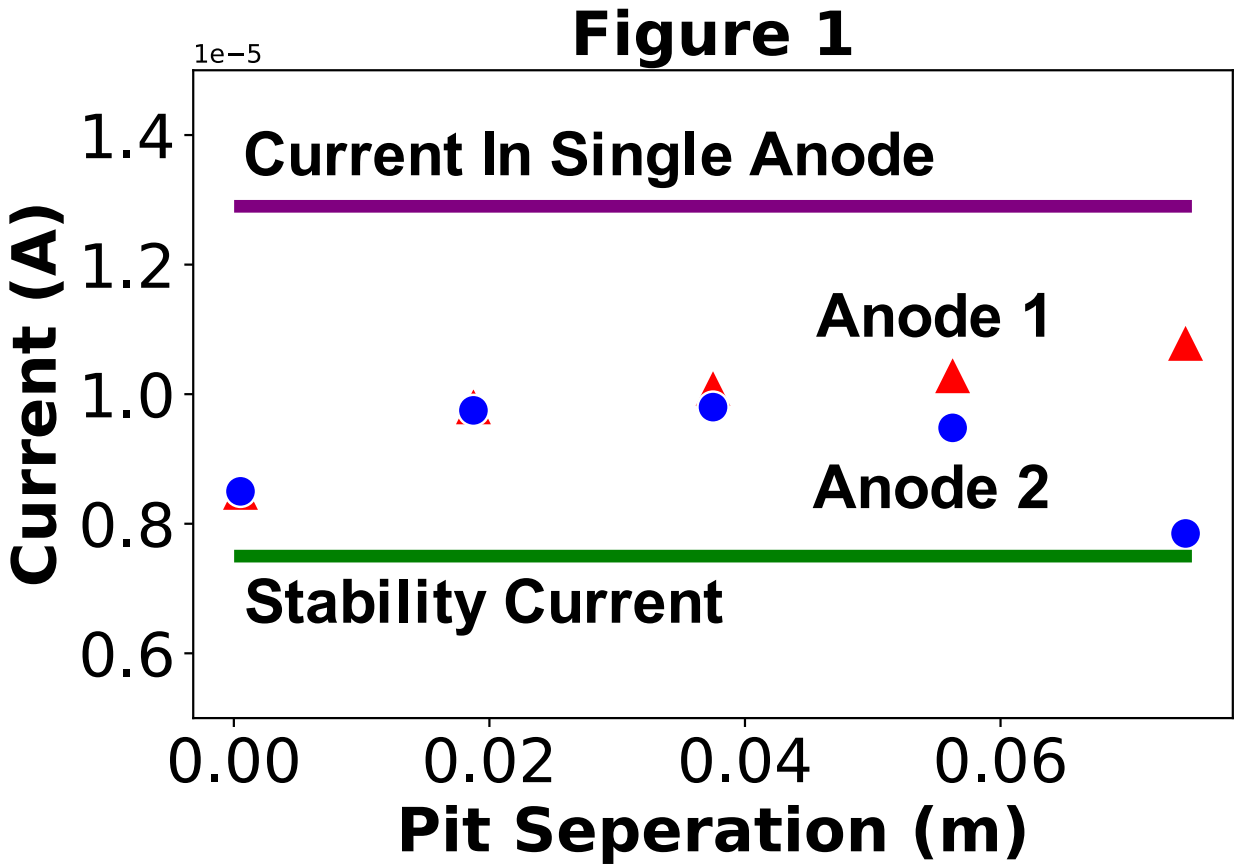
- Current at various points of interest
- Potential at certain points of interest

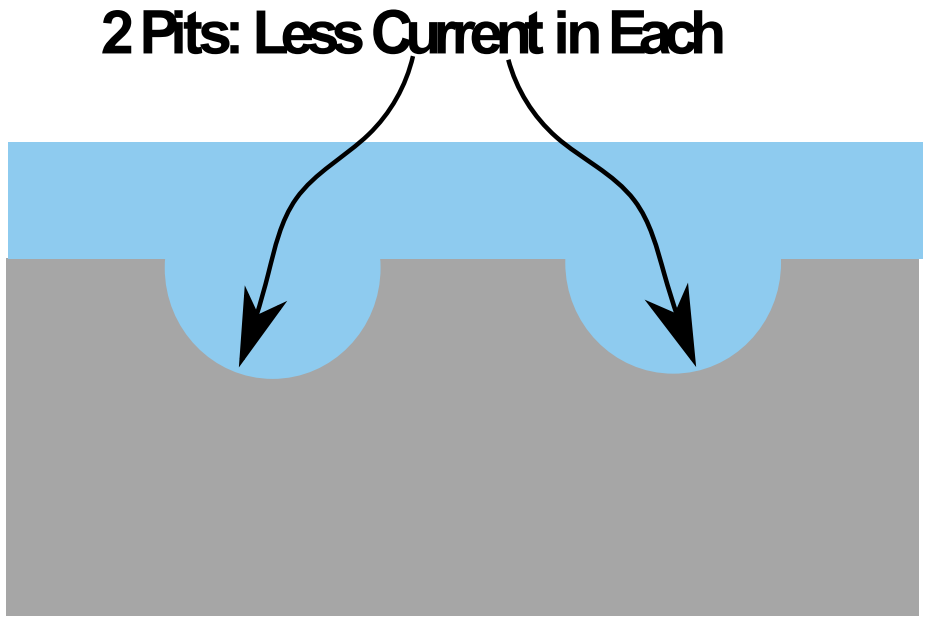


NOTE ON BOUNDARY CONDITIONS



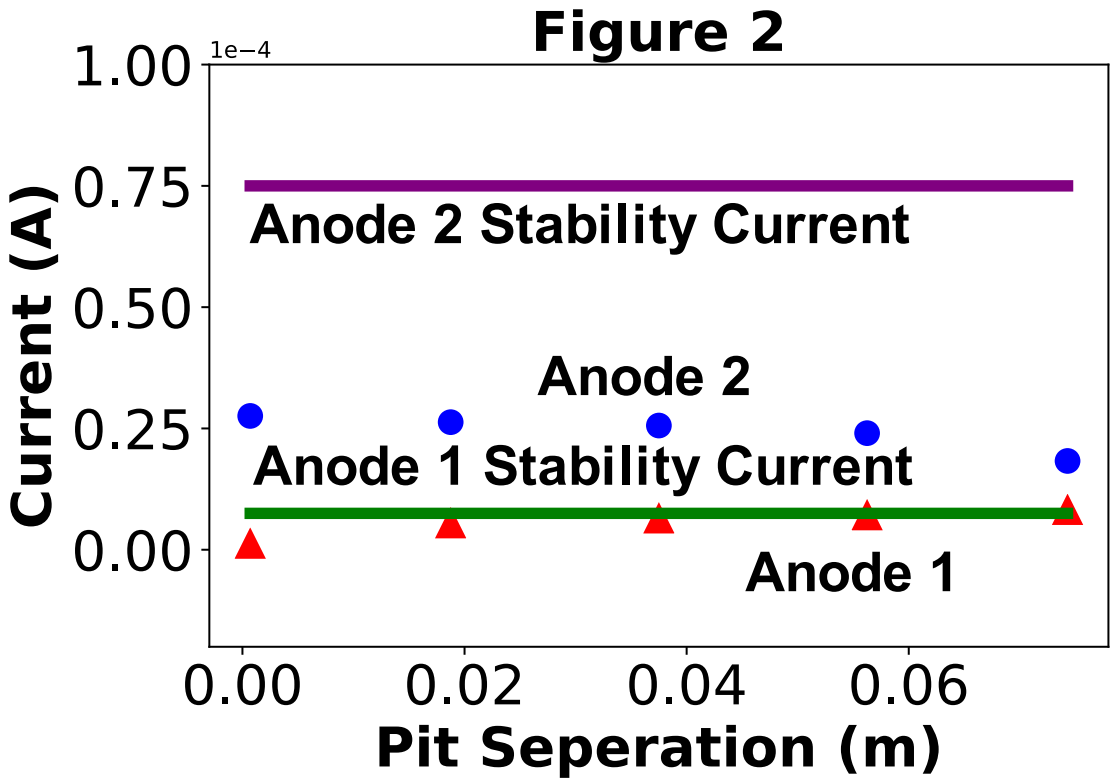
CURRENT FINDINGS

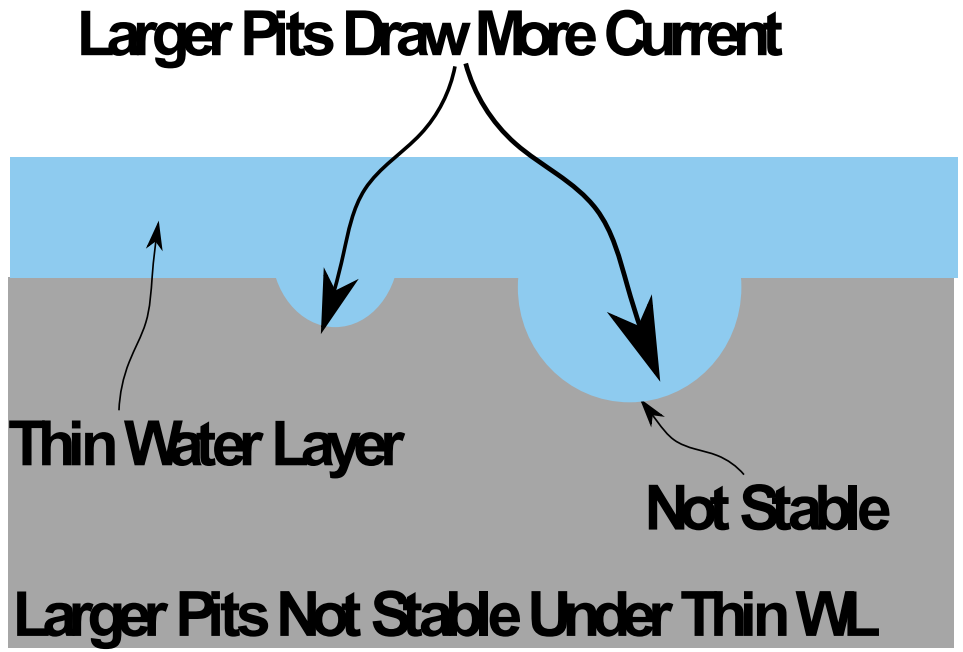




- Stability: current needed to maintain an aggressive environment & and avoid repassivation.
- When two pits are present the current in one is less than if it was alone(single pit)

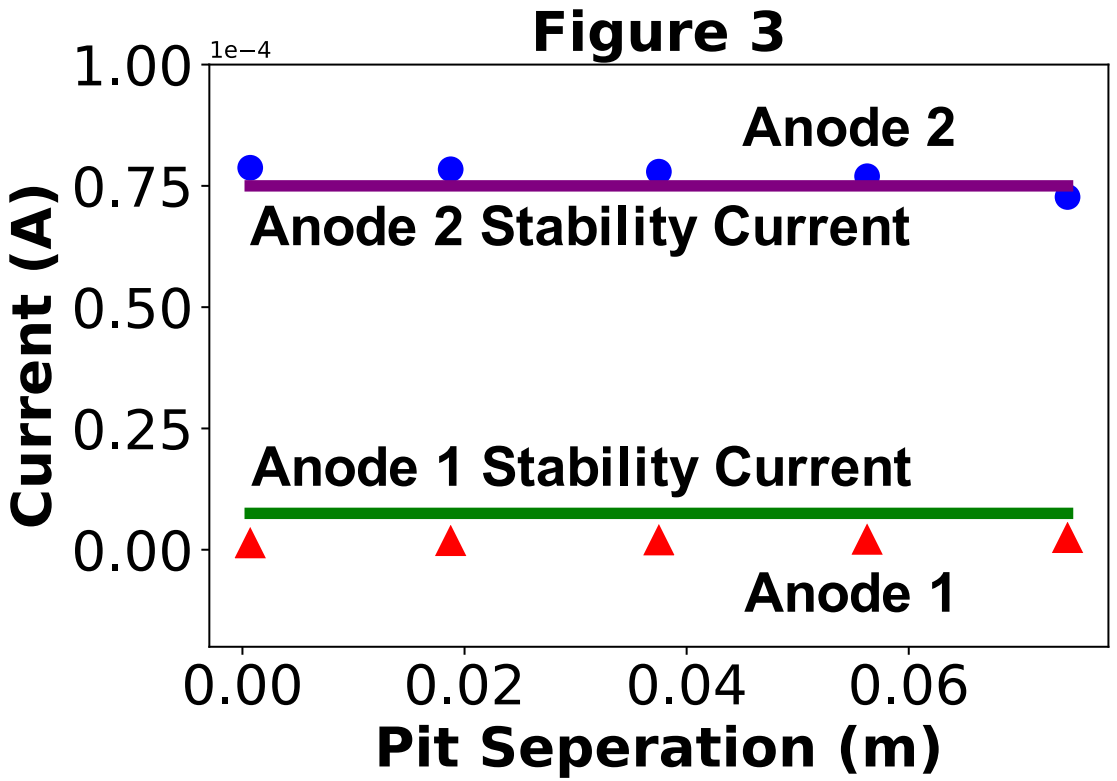
CURRENT FINDINGS

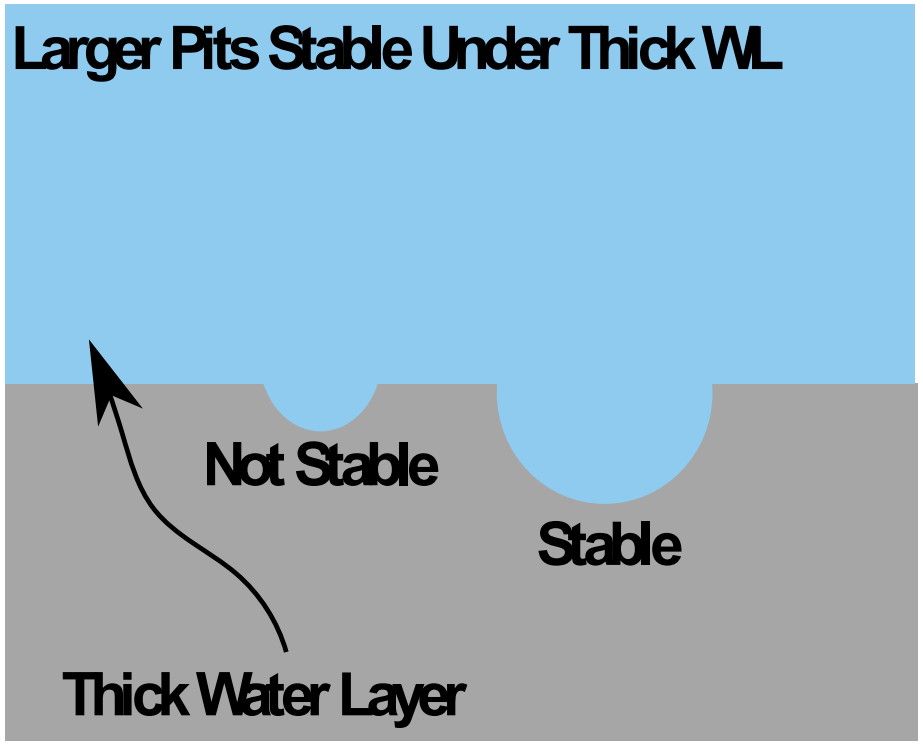




- Bigger pits tend to draw a higher proportions of current than smaller pits.
- Larger pit not stable under thin water layer thicknesses.

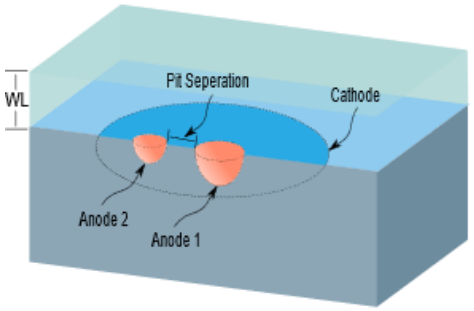
CURRENT FINDINGS



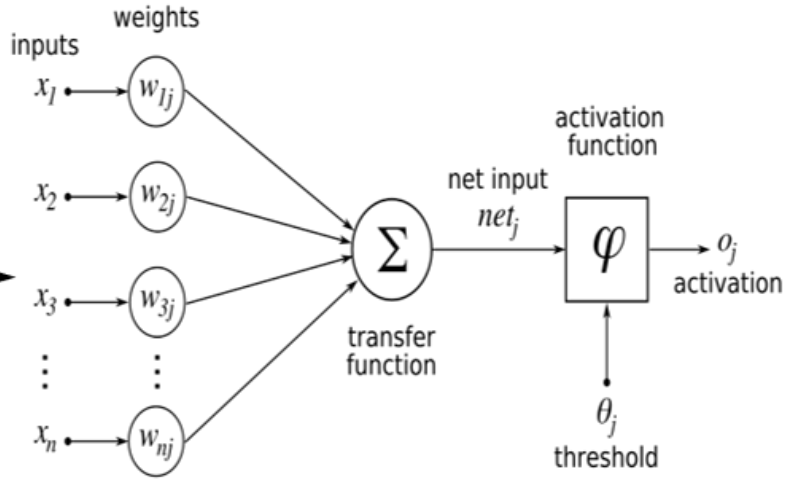


- Larger pits stable under thick water Layers

MACHINE LEARNING SURROGATE MODEL



Generate FEM Data

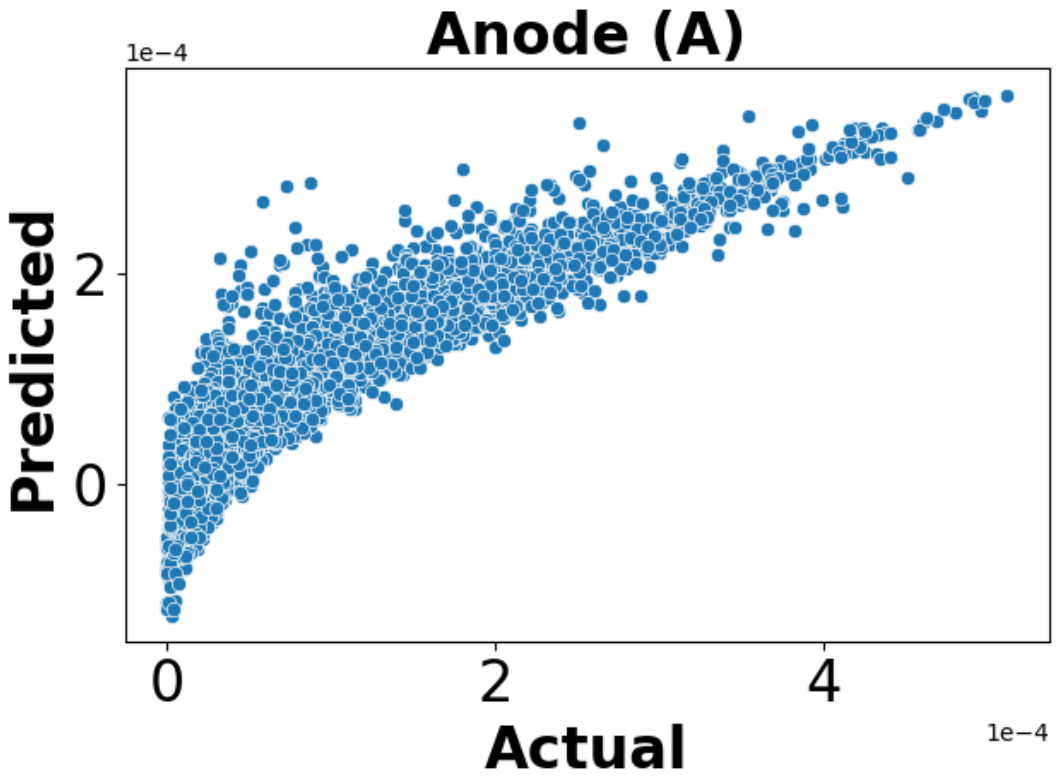


Make ML Surrogate Model

Quicker Predictions with Surrogate Model

Using ML, a surrogate model was created to increase computational efficiency in stability predictions.

INITIAL ML RESULTS



- Created with linear regression
- A basis for future models to compare too
- Agreement is good
- Further ML techniques are being explored

CONCLUSIONS & FUTURE WORK

Key Takeaways:

- **When 2 pits are present the current in one is less than if there was just one pit.**
- **Larger pits draw more current but aren't stable with a thin water layer.**
- **Larger pits are stable under a thick water layer.**

Future Work:

- **Improve current ML model.**
- **Make a active transport model.**

MY EXPERIENCE AT SANDIA

MY EXPERIENCE

- First Internship & involvement with research
  - Love Research
    - Looking into going in to research for computer science.
  - Mentor was amazing
    - Allowed me to explore my interests
    - Made sure that I was involved in research

- CHRES Intern
  - Allowed me to be here
  - Checked in to make sure that internship was going well
  - If I needed anything they help provide it

MY EXPERIENCE

- Conversion
  - Converted to year-round intern.
    - Excited to continue on the research
  - Seem to be flexible during school year, regarding scheduling.
    - Good for student

- The work in meaningful and it is motivating
  - You feel like you are actually achieving something at sandia.
  - The work naturally draws you in, it motivates you to work your best.
  - The work environment is really inspiring
    - Peers are amazing, high achievers.