Methodology for Numerical Modeling of TSA Coated Corrosion Sample Coupons

D. Cocco
LIC Energy UK, Bristol, UK

Introduction:
Thermally sprayed aluminium (TSA) has the potential to provide a corrosion management solution that is technically superior to a conventional paint + anodes approach.

While TSA has been used in offshore oil and gas for many years, some of the challenges and solutions that existed before this technology can be adopted by the offshore wind sector.

The CROWN project aims to address these barriers and provide industry with the data required to confidently specify TSA.

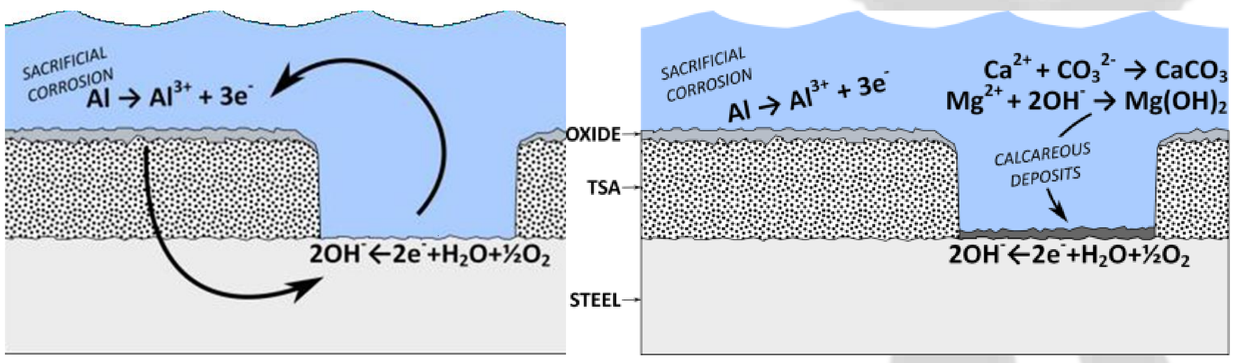

Figure 1. Calcareous deposit deposition would slow down the TSA corrosion rate . Courtesy TWI.

Modelling method:
With no reference modeling procedure available to take from, the current modelling method uses lab test data (current run at TWI, Ref.[2]) and evolves with the interpretation of their results.

Figure 2. Lab testing on TSA coated coupons with varying TSA/holiday (bare steel) areas ratio. Courtesy TWI.

The initial observations suggest that:
- The bare steel is polarized by TSA
- The current density (and maximum current flow, hence the TSA corrosion rate) is limited by the oxygen reduction current density at the steel-seawater interface

Modeling and key design parameters:
The key design parameters are
- Oxygen reduction current at steel interface
- Tafel parameters describing the TSA anodic reaction

$$i_{loc} = i_0 * 10^{\frac{\eta}{\beta_a}}$$

Figure 3. Tafel equation, Ref.[1]

Results:
The main focus is the current density on TSA and steel surface.
After calibration of the parameters, the results from the COMSOL® Corrosion Module show a higher current density at the center of the holiday, and less at the steel-TSA interface edge. This is important as it determines the rate of species deposition on the steel surface observed in the lab.

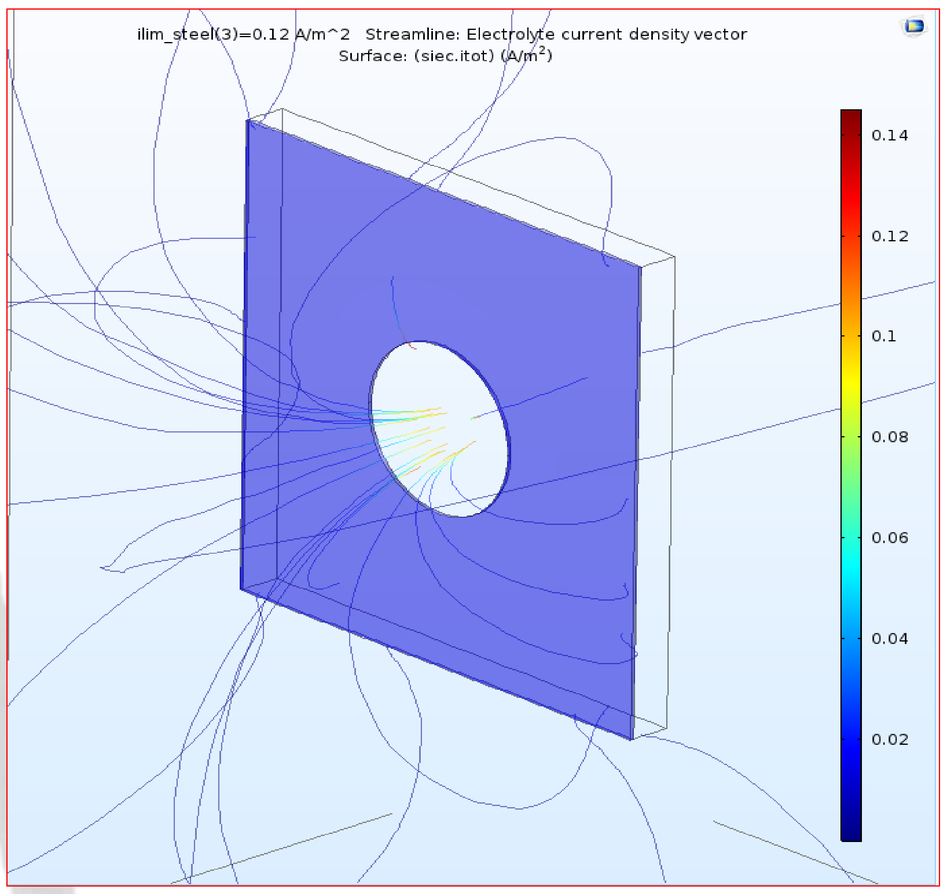

Figure 5. Numerical Model and Current Density

Coming up:
The lab testing continues and the numerical model may need further review to capture the electrochemical behavior of TSA. Tafel parameters and the oxygen limiting current density will be time-dependent and need to be taken into account the dynamic behavior of the TSA degradation and the deposition of species on the steel surface.

References:
1. COMSOL Help Documentation
2. TWI Ltd https://www.twi-global.com/