Methodology for Numerical Modeling of TSA Coated Corrosion Sample Coupons

D. Cocco[1]

[1]LIC Energy UK, Bristol, UK

Abstract

The CROWN project is a collaboration between 8 partners (LIC Energy, TWI, EDF Energy, DONG Energy, ORE Catapult, Wilton Engineering, Universal Coating, Metallisation) that is born from the offshore wind (OW) industry interest in the potential of Thermally Sprayed Aluminium (TSA) as corrosion protection system for offshore substructures - and leveraged by LIC experience on the design of OW substructures and corrosion protection systems.
The main goal of the CROWN project is to qualify the use of TSA for application in OW substructures by addressing the main technical barriers.
This paper refers to the methodology that is developed in COMSOL Multiphysics® to reproduce the result of the experimental testing that are run on the corrosion-test coupons. Also, it does refer to how this methodology can be scaled from the "lab testing" up to the "offshore substructure" scale. Two modeling approaches are initially considered: (1) based on "dissolving/depositing species" formulation and (2) based on the use of "polarization curve". The first one, although adequately detailed to finely reproduce the coupons behavior during the corrosion testing, is considered too detailed for the larger scope of the project of extending the modeling methodology up to the complete substructure scale. This leads to the methodology (2) as being the preferred one.
Besides, one single polarization curve would not fully describe the dynamic of the electrochemical behavior of the TSA, and the generation of more (time dependent) polarization curve are requested from the corrosion testing so to capture all likely operational scenarios that the TSA may encounter when applied on an offshore substructure: undamaged TSA coating, partially damaged coating, "clean" coating, partially/totally passivated TSA coating.
The numerical model should also be sufficiently accurate to guide the designer to which of the polarization curve would better suit their design scenario (with specific reference to the likelihood that under certain circumstances the TSA coating may passivate, which would result in a quick drop of its corrosion rate).
This paper concludes with the list of inputs that are required from the lab testing to create digital-twins of the testing coupons, and on how these inputs are used to build the model in COMSOL Multiphysics®, then run and validate it.

Figures used in the abstract

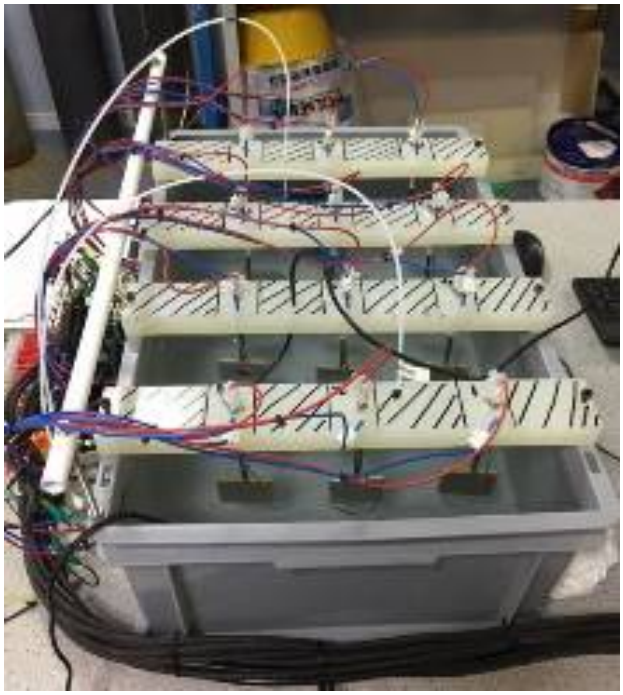

Figure 1: TSA coated corrosion sample coupons.