

Objective:

SICOM will develop numerical models at different scales. A microscale model will simulate localised corrosion of Al-Alloys with regard to precipitates and intermetallics in the matrix. The outcome of the microscale model provides local corrosion rates. They will be averaged and used for a mesoscale model. This mesoscale model is at the level of occluded cells and deals with all electrochemical and geometrical factors to simulate crevice corrosion in assembling. The above mentioned mass transport based models are combined with the probabilistic approach utilising the cellular automaton principle to provide a predictive model for intergranular corrosion. Finally a macroscale model will be developed for prediction of galvanic corrosion behaviour at the level of structural elements of an aircraft.

Component scale/ cm to m

Engineering model

It considers galvanic effects and global influence of coating, electrolyte and materials.

Macroscopic simulations based on charge conservation

PRINCIPLE

- Steady state electric charge conservation equations
- Laplace equation in 3D space
- Polarising boundary conditions
- Boundary Element Method

INPUTS

- Polarisation curves of electrode materials
- Structure geometry
- Electrolyte conductivity

OUTPUTS

- Corrosion rates
- Identification of anodic and cathodic regions
- Electrolyte potential
- IR voltage drop in the electrolyte

Crevice scale/ 0.1 to 10 mm

Engineering model

It considers effects in occluded geometries. Macroscopic simulations based on species balance equations and electro-neutrality using averaged polarisation data.

Zoom to occluded regions

Zoom to surface structure

Intermetallics scale / 10 to 100 μm

Research model at intermetallics level

It is looked at the role of intermetallics and pretreatment

Microscopic simulations based on species balance equations and electro-neutrality using microgalvanic polarisation data

PRINCIPLE

- Time dependent species balance equations and electro-neutrality
- Polarising boundary conditions
- Finite Element Method

INPUTS

- Polarisation data on intermetallics and substrate
- Surface structure geometry
- Ion transport data
- Homogeneous reaction kinetics

Microelectrochemical cell setup:

Grain boundary scale/ 0.1 to 10 μm

Research model at intergranular level

It is looked at the role of intermetallics, and pretreatment

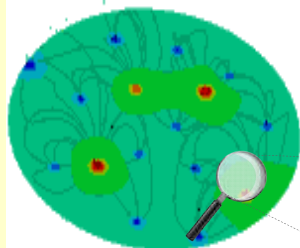
Microscopic simulations based on a statistical approach (cellular automaton models)

PRINCIPLE

- Evaluation of optimum probabilities based on CA rules and IGC input data

INPUTS

- 3-D Grain structure
- IGC depths with timekinetics

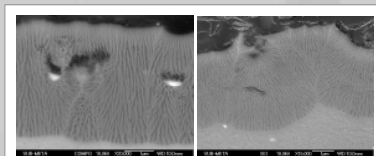
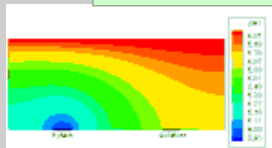


Zoom into the material

OUTPUTS

- Local corrosion rates
- Role of O₂, Cl⁻
- Role of alloy
- Role of pretreatments

Impact of surface treatment



Defects due to precipitates + different orientations observed in CAA porous film formed on AA 2024

OUTPUTS

- IGC path depths, and lengths with time