PHYSICS-INFORMED NEURAL NETWORKS FOR CORROSION ANALYSIS

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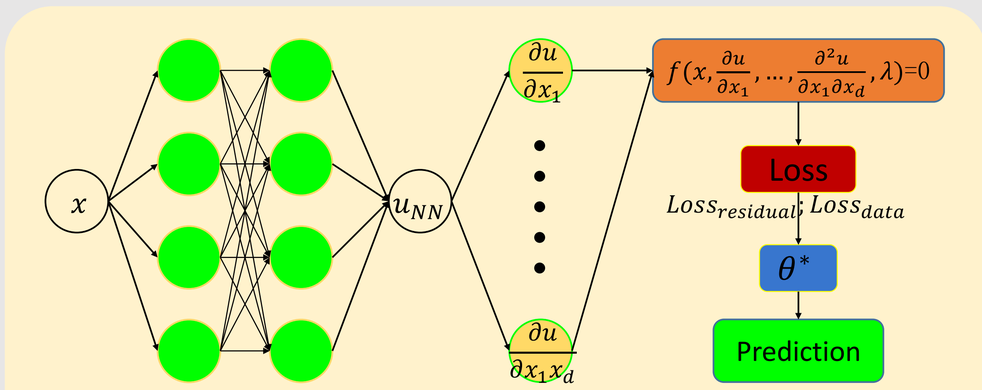
BACKGROUND

- Physics-informed neural networks (PINNs) are a type of artificial neural network that incorporates physical laws and constraints into their architecture, allowing for more accurate and robust predictions.
- PINNs have achieved a lot of progresses in various fields, including fluid mechanics, materials science, and biomedical engineering.
- Corrosion is a natural process that involves the deterioration of materials, usually metals, due to chemical reactions with the environment.
- The study of Corrosion evolution is the main focus in the community of corrosion modeling.

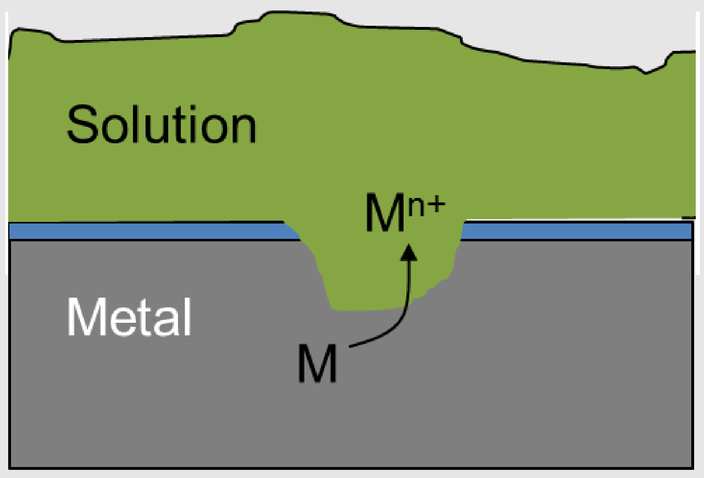
OBJECTIVE

A PINN framework to model the evolution of corrosion damage



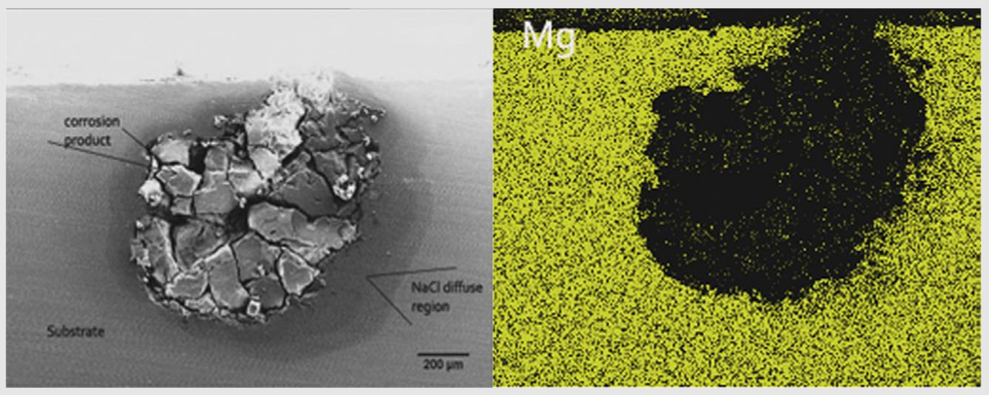
Typical architecture of a PINN

ELECTROCHEMICAL KINETICS



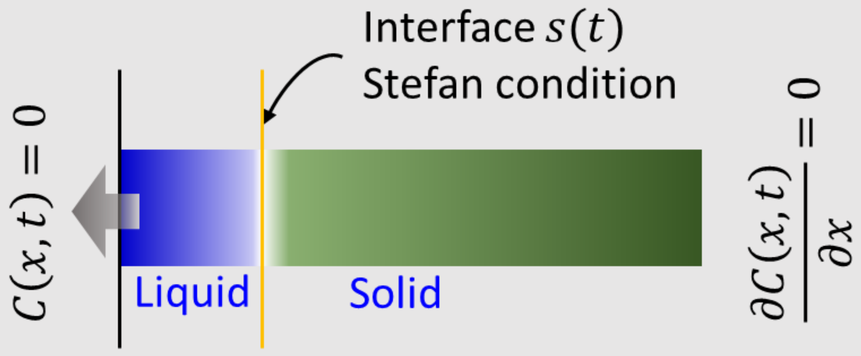
Anodic reaction

$$M(s) \rightarrow M(aq)^{n+} + ne^-$$



Typical sectional SEM image of a corrosion pit on a Mg-alloy

PROBLEM FORMULATION



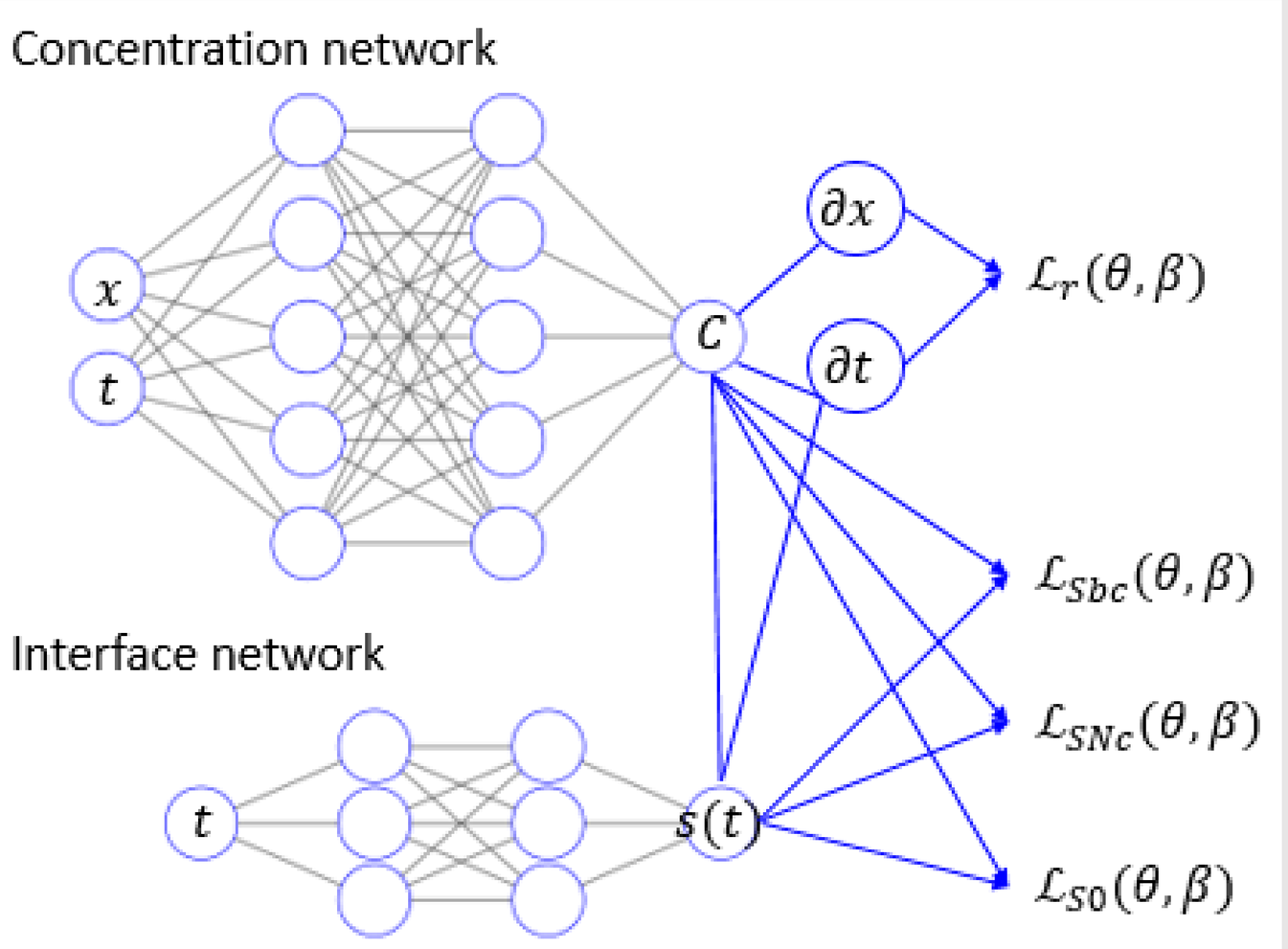
PDE $\frac{\partial C(x,t)}{\partial t} = D\nabla^2 C(x,t)$

I.C. $C(x,0) = C_{solid}, 0 < x \leq L$

B.C. $C(0,t) = 0, t \geq 0$
$C(L,t) = C_{solid}, t \geq 0$

S.C. $C(s(t),t) = C_{sat}$
$S(0) = 0$
$\frac{1}{D}(C_{solid} - C_{sat})\frac{\partial s(t)}{\partial t} = \frac{\partial C(s(t),t)}{\partial x}$

PINN FOR CORROSION ANALYSIS



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