VRIJE UNIVERSITEIT BRUSSEL

The faculty of Engineering of the Vrije Universiteit Brussel invites you to attend the public defense leading to the degree of

DOCTOR OF ENGINEERING SCIENCES

of **Zahra Jiryaeisharahi**

The public defense will take place on **Friday 26th June 2026 at 5pm** in room **D.2.01** (Building D, VUB Main Campus)

To join the digital defense, please register here
Meeting ID: 348 515 517 945 662
Passcode: SA2Ao7Kx

ON THE INVESTIGATION OF TRANSPORT AND INTERFACIAL PROPERTIES OF COATED METALS USING ORP-EIS AND A NOVEL SENSOR APPROACH

BOARD OF EXAMINERS

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Abstract of the PhD research

In a world that relies fundamentally on materials for infrastructure, transportation, energy, and technology, the degradation of these materials represents a major concern and a significant economic challenge. This issue is particularly critical for metallic systems, not only because metals are finite natural resources, but also because their long-term durability strongly influences maintenance demands, economic efficiency, and overall sustainability. Corrosion is the gradual deterioration of materials, most commonly metals, caused by chemical or electrochemical interactions with the surrounding environment.

Organic coatings are of primary interest for protecting metals from corrosive media in various applications. The protective performance of these coatings is significantly governed by their barrier properties against the diffusion of water and ions. Arrival of the electrolyte at the buried interface can induce adhesion failure and corrosion. Therefore, understanding the diffusion behaviour of water and ions is crucial in designing hybrid systems with high barrier properties.

The main objective of this PhD research is to improve our understanding of how water and ions travel across protective coatings, as these two processes strongly influence the durability of the system. Although water uptake in coatings has been extensively studied, much less attention has been given to monitoring the movement of ions independently. To address this gap, this work develops a new electrochemical measurement approach that makes it possible to distinguish between the transport of water and ions. An important outcome of this work is the ability to study how ions penetrate protective coatings under different conditions.

In addition, this research introduces a novel sensor-based methodology for investigating electrolyte transport through organic coatings, with particular emphasis on coated metal structures protected by thick insulation layers. The approach was designed to enable rapid and non-destructive detection of corrosion under insulation (CUI), one of the most critical and costly degradation mechanisms in industrial facilities. As CUI develops beneath insulation and typically remains undetected without intrusive inspection or insulation removal, reliable early-stage monitoring is highly desirable. The sensor system developed in this work allows the detection and quantification of moisture accumulation within insulation layers, enabling early identification of corrosion initiation beneath the insulation.

Overall, the methodologies proposed in this PhD contribute to a deeper understanding of how local transport phenomena influence the global protective performance of hybrid coating systems. These insights provide a foundation for faster and more effective optimization of corrosion protection strategies.