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 **Ehsan Jalilian**

The public defense will take place on **Tuesday 23rd April 2024 at 4:00 pm** in the **Green Room** (U-Residence, VUB Main Campus)

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CHEMICAL AND PHYSICAL PROPERTIES OF ORGANIC COATINGS AS BARRIERS AGAINST THE TRANSPORT OF MOISTURE AND IONS

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Abstract of the PhD research

Corrosion in organic-coated metals presents a complex and costly challenge to manage due to the intricate interplay of subsystems within a coated metal exposed to a corrosive environment. In response, organic coatings have evolved in such a way that they can provide protection for several decades. However, the performance gain is at the cost of increasing innovation times and challenging analytical characterisations since the time scales of failure dynamics have become very slow. To shorten the innovation cycles, mechanistic models to predict the failure of organic coatings are a necessity and in-line with increasing demands for sustainability and environmentally friendly approaches in the chemical industry.

As part of a large-scale project known as PredictCor, this thesis aimed to establish a knowledge platform for water and ion transport through model organic layers, the availability of which could lay the groundwork towards synthesising a predictive model. First, a series of methodologies were developed for in-house quantification of crucial transport properties of polymer films, which are solubility, diffusivity, and permeability, to differentiate a large number of model systems. Next, the impact of the formulation components of UV-cured model systems was studied with a large set of analytical characterisation tools to provide a holistic view of the performance of the polymer layer as a barrier in coating applications. The complexity of the formulations was increased towards the end of the thesis. Finally, the well-characterized model systems were benchmarked against standard anti-corrosion coatings systems prepared by the industry.

The results obtained in this thesis contributed to developing new methodologies for measuring transport properties, critical evaluation of water diffusivity calculations, and establishing UV-cured acrylates as potential model coatings for the creation and validation of an industrially relevant predictive model for the onset of corrosion. The outcome of the work also offers insights into some future research directions, including chemical analysis of nanoscale non-uniformities in UV-cured acrylates and engineering interstitial zones in these layers for improved barrier properties. The comprehensive approach of the work provides a broader understanding of transport phenomena in UV-cured layers, making it a contribution to other applications as well as corrosion in coated metals.

Keywords: Transport in polymer films, UV-initiated FRCC, Model coatings for corrosion studies, Structure-property relations