Advanced experimental and modelling approaches to understand and predict better corrosion of metals

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In the advanced materials industry, there is a clear trend towards more sustainable concepts, and this is certainly also the case for metals. They take a prominent position in the materials market thanks to their multifunctionality and structural and mechanical properties. However, metals are prone to corrosion, and therefore often organic coatings are applied to extend their lifetime. The search for organic coated metals with higher multifunctionality and extended lifetime goes together with the search for more sustainable material concepts in the context of the REACH regulation. Nowadays, materials are developed for providing components with a lifetime ranging from 10 to 25 years. The lifetime of a material highly depends on its exposure to the environment inducing ageing processes. In the current state of the art, lifetime and ageing assessment are performed by means of experiments, combining accelerated and field testing. The limitation of the first is that the conditions of the accelerated tests are not representative for the real environmental conditions and that there is no proven relationship between accelerated laboratory tests and field performance data. The limitation of the second is that it takes several years (5 to 10 years).
The only way to realise a substantial decrease in the development time of new materials is to introduce modelling in the design cycle. What is needed to realize a breakthrough in this field is a tool that can predict quantitatively and dynamically the corrosion behaviour of (organic coated) metals. The long term scientific motivation of our research is to build a knowledge and technology platform to enable the prediction of durability behaviour and the estimation of lifetime of (organic coated) metals under long-term environmental ageing and corrosion conditions. This requires advanced research because corrosion of a (organic coated) metal is the result of an intense interplay between several physical phenomena that need to be characterized in real conditions and modelled. Within VUB and TUDelft research we try to focus on both aspects bringing in new advanced combined electrochemical & in situ surface analysis, advanced finite element electrochemical modelling and more recently quantum chemical modelling. During the lecture an overview will be given on our state of the art in the different domains, emphasizing some success but also bringing bottlenecks when it really comes to predictions of corrosion.

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