Title: Non-destructive mechanistic study of buried interfaces between organic coatings and engineering metals

In a wide variety of applications, metals are covered with an organic coating in order to increase corrosion resistance or to add surface functional properties. The efficiency and durability of coated metals is largely determined by the phenomena occurring at the organic-inorganic interface. Especially the presence of environmental water at the interface has a major effect on the local interfacial molecular phenomena.

In this project, we aim to tackle three major bottlenecks in hybrid interfacial research. First, the molecular interface between a metal(oxide) and an organic coating is not accessible in a non-destructive way by surface analytical techniques. We will solve this issue by using organic model systems, which can be applied sufficiently thin to ‘see’ the buried interface. On the other hand, novel, state-of-the-art techniques will be deployed, such as lab scaled High Energy XPS, allowing to analyze deeper non-destructively in the structures.

The proposed methodology above leads to the second bottleneck to be resolved. Organic model systems are currently limited to the use of polymeric films with well-chosen functional groups. However, organic coatings are much more complex and contain additives, fillers, ... Hence, a second goal in this project is bringing the state-of-the-art from polymeric model systems to organic coating model systems.

A third issue that arises is that most surface analytical techniques operate under vacuum conditions. Vacuum is however far from technological relevant conditions. In order to understand the influence of water, electrolyte and gaseous species on the interfacial interactions, a spectro-electrochemical approach will be further developed. This approach consists of the combination of infrared spectroscopy in a Kretschmann geometry and impedance spectroscopy. The IR technique uses a PVD deposited metal layer on an internal reflective element, which allows to characterize interfacial interactions in a variety of atmospheric conditions. The electrochemical response of the system will be investigated using Odd Random Phase Electrochemical Impedance Spectroscopy (ORP EIS), an in-house variant on the single sine EIS, allowing an in-depth analysis of the data obtained, leading to the calculation of instantaneous impedances and trustworthy data treatment. To unravel nano-scaled surface contributions, nano-IR spectroscopy will be used.

The research group Electrochemical and Surface Engineering would be delighted to host interested researchers in this challenging buried hybrid interfaces domain!

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