OXYGEN REDUCTION KINETICS AT BURIED INTERFACES AND UNDER ULTRATHIN ELECTROLYTE LAYERS

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An important step towards unravelling the underlying mechanisms of corrosion driven paint delamination was the application of the Kelvin Probe technique, established by Stratmann et al. to corrosion research (see [1]-[3]). It was found that the electrochemical stability of the buried metal-organic coating interface of painted metal is crucially governed by how effectively the oxygen reduction reaction at the interface is inhibited. As this interface is not directly accessible for study by conventional electrochemical techniques, no detailed knowledge of the kinetics of oxygen reduction at the interface and how it is governed by structural parameters is available. Even the Kelvin Probe technique per se does not provide this information, as it in principle only allows studying the progress of an advancing delamination, but not the involved interfacial reaction kinetics.

To overcome this problem, a new non-destructive method has been developed wherein hydrogen permeation, defining the reaction current density I, is used to quantitatively measure the oxygen reduction kinetics underneath coatings at the resulting equilibrium potential U(I) [4]. By changing the permeation current density of hydrogen a full U(I) curve can be constructed. Furthermore, also the resulting degradation process at the interface can be studied in situ [5]. While the first works have been carried out with model samples based on Pd membranes as substrates, this approach has now also been applied for studies of technically more relevant cases and also for investigating corrosion under ultra-thin electrolyte layers well below 1 micron in thickness. The general applicability of this novel technique will be discussed for a number of different examples and an outlook for future developments will be provided.

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[5] D.Vijayshankar, A. Altin, C. Merola, A. Bashir, E. Heinen, M. Rohwerder, J. Electrochem. Soc. 163 (2016) C778.