

## Reactivation of Delamination Process on Polymer-Covered Iron Samples

Mariusz Wicinski, Stephan Bonk, Michael Rohwerder,  
Achim Walter Hassel, Martin Stratmann  
Max-Planck-Institut für Eisenforschung GmbH  
40237 Düsseldorf,  
Germany

An enhanced type of Kelvin Probe was developed (see Figure 1), which allows variations in humidity to be made by keeping a thermostated water reservoir inside the investigation chamber. Humidity changes are thus independent of the chamber temperature. This Kelvin Probe was used to investigate passive/active transitions in cyclic corrosion tests.

Normally the co-dependence of these two factors makes it difficult to change one of them without affecting the other. However, with the implemented improvements on the Kelvin Probe and the proper control software of the devices, manipulation of a single factor has been made possible when changes are introduced slowly.

The major difference between a constant exposure and cyclic climatic tests is the alternating wetting and drying of the surface under investigation. The metal surface will passivate during the drying cycle. During a subsequent wetting cycle, corrosion does not start immediately, rather an activation time is necessary.

This tendency is illustrated in Figures 2 and 3; a defect was induced in a polymer-coated iron sample and filled with salt solution. In Figure 2, the potential distribution variation over time is presented. The potential jump observed in the different potential curves represents the advancing delamination front.

The time dependence of the Volta potential after rewetting the sample is shown in Figure 3. The only changes are in the potential values of the delaminated zone. It is remarkable that this potential shift is anodic at times immediately following exposure to moisture. Over longer observation times, the potential returns to that observed before drying. Delamination restarts only after longer time.

This process can be explained by changes in the properties of the interfacial iron oxide layer. During drying the oxide becomes oxidised and delamination can only restart once the oxide has been reduced. The potential observed is a combination of static potentials produced by the redox state of the iron oxide and kinetic effects caused by on-going electrochemistry. Oxide reduction and oxidation takes place slowly due to the rate of transport of material through the solid phase.

The results are discussed in terms of the potential changes that are accompanied with wet/dry cycling is accompanied by potential changes, which reflect changes in the oxide composition as well as the electronic properties of the oxide covered substrate.

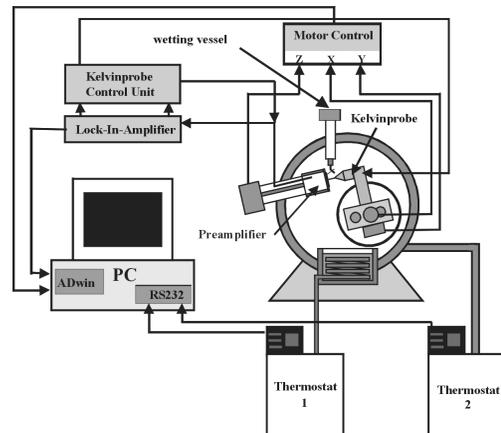


Figure 1 Schematic diagram of the Scanning Kelvin Probe set-up

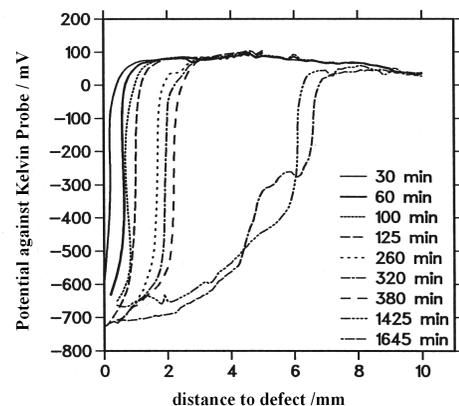


Figure 2 The potential distributions after various exposure times on an iron sample with a defect in the coating (20  $\mu\text{m}$  thick) after the first contact with a 0.1 M NaCl solution

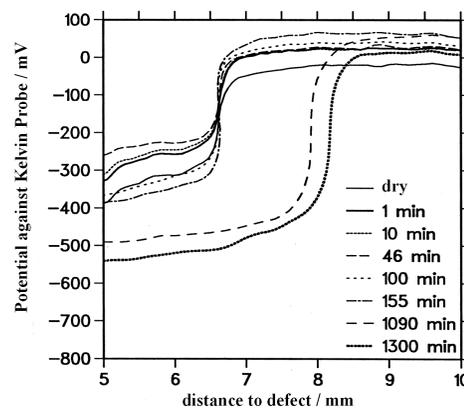


Figure 3 Potential distributions after rewetting of the same sample as in figure 2-1. Only potential changes take place in the first three hours. The delamination process starts not immediately but after an incubation time.