Scanning Kelvin Probe investigation of atmospheric corrosion and hydrogen insertion under mechanical load

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The method of Scanning Kelvin Probe (SKP) has proven its usefulness and versatility in numerous corrosion studies. Especially for investigation of atmospheric corrosion, the SKP is a promising method. The contact potential difference, measured with SKP in a non-contact and thus non-destructive mode of operation, is strongly influenced by the sample's surface composition, condition and its interaction with the environment. Integrating the SKP into a climate chamber enables in-situ visualization of corrosion processes occurring on the metal surface with a local resolution in the µm-range. Beside its ability to reveal changes of the metal surface due to corrosion, SKP was used repeatedly for studying hydrogen insertion and distribution in steel and other metals. The contact potential difference measured on a steel sample is sensitive to the composition of surface oxides. Hydrogen causes a change in the Fe^{2+}/Fe^{3+}-ratio of these oxides and, as a consequence thereof, an alteration in contact potential difference. As side reaction of atmospheric corrosion, hydrogen can be formed and part of it may enter the metal lattice. Particularly for high-strength steels this hydrogen insertion can induce severe damages and material failure under mechanical load due to hydrogen embrittlement.

The aim of this work is the investigation of atmospheric corrosion on different steel grades (ferritic, dual-phase and complex-phase steels) focusing on hydrogen insertion and distribution in the steel sample during application of mechanical load. Therefore, a SKP setup was equipped with a climate chamber and a four-point bending device. Corrosion was promoted by addition of salt and variation of relative humidity in the climate chamber. Influences of corrosion reactions, hydrogen insertion and the application of stress on the evolution of the contact potential difference measured on the sample surface with SKP are discussed.