In-situ Studies of Initial Atmospheric Corrosion of Iron. Influence of SO_2, NO_2 and NaCl.

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This work aims at a better molecular understanding of the iron/atmosphere interface through an experimental approach which allows simultaneous chemical and kinetic in-situ information to be obtained with sub-monolayer sensitivity. The techniques used are infrared reflection absorption spectroscopy (IRAS) and quartz crystal microbalance (QCM), which have been integrated into one unique experimental set-up (1). When iron is exposed to clean and humidified air, the introduction of sub-ppm concentrations of SO2 results in no detectable changes in corrosion kinetics. When NO2 is subsequently introduced in the same concentration range, a significant increase in corrosion kinetics can be monitored in-situ with IRAS as well as with QCM. Yet, the corrosion kinetics is surprisingly slow, approximately one order of magnitude lower than of copper under similar exposure conditions. The difference is mainly attributed to a localized atmospheric corrosion behavior of iron, as opposed to a more general atmospheric corrosion behavior of copper (2). The susceptibility to localized corrosion has been further explored through in-situ atomic force microscopy (AFM) studies of iron with or without predeposited NaCl particles. The sulfate- enriched areas detected on the iron surface are believed to act as precursors to so-called sulfate nests, a commonly found corrosion attack on iron and steel under natural outdoor exposure conditions (3).

References: 1. T. Aastrup and C. Leygraf, J. Electrochem. Soc., 144, 2986 (1997) 2. J. Weissenrieder and C. Leygraf, Outdoor and Indoor Atmospheric Corrosion, ASTM STP 1421, A.B. Smith and C.D. Jones, eds., American Society for Testing and Materials, West Conshohocken, PA (2001) 3. V. Kucera and E. Mattsson, Atmospheric Corrosion, Corrosion Mechanisms, F. Mansfeld, ed., Marcel Dekker, New York (1987)