INDUSTRIAL PILOT PROJECT

In-situ AP-XPS study of corrosion in AM steels

THE INDUSTRIAL CHALLENGE

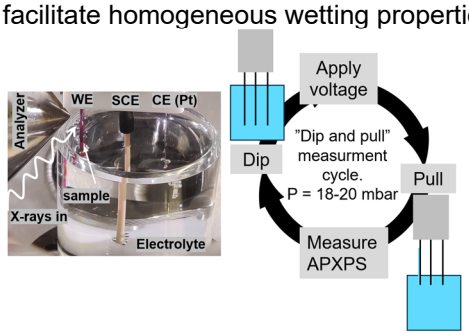
The replacement of conventional stainless steel (SS) elements with sophisticated geometry by additively manufactured (AM) components is of strategical importance for Alfa Laval, which specializes in production of heat exchangers. Quintus Technologies specializes in HIP processing of AM components. Both companies are looking for new methods able to provide a direct insight into the chemical processes accompanying corrosion in wet environments, to be able to use them for optimisation of post-processing and printing of AM materials.

WHY USING A LARGE SCALE FACILITY

The aim was to test if ambient pressure XPS (APXPS) combined with electrochemical cell can be used to complement the laboratory corrosion tests. The high brightness of the synchrotron allows to perform APXPS measurements for which the signal to the background ratio is very small. This would allow direct studies of the chemical composition of the surface in presence of thin liquid electrolyte layer.

HOW THE WORK WAS DONE

The experiment was performed at HIPPIE beamline of MAX IV in Lund. Samples were cut from AM 316L SS columns and polished to achieve surface roughness of 3 µm to facilitate homogeneous wetting properties.



The sample holder has slots for the sample, which also acts as working electrode, as well as for the SCE reference- and Pt counter electrodes. The sample holder was placed on the manipulator in the vacuum chamber which was kept at 18-20 mbar. To run the electrochemical reaction, the electrodes were dipped in the beaker with electrolyte (1M NaCl or 0.1M HCl) and the potential was applied. After a fixed time, the electrodes were pulled from the beaker and APXPS spectra were measured through the thin electrolyte film. The manipulator in the dipped position is shown in the figure together with the diagram illustrating "dip and pull" measurement cycle.

THE RESULTS AND EXPECTED IMPACT

The results revealed that APXPS can be used to follow changes in the oxide, even though the anodic potential was not applied exactly during the APXPS measurements and only thin layer of electrolyte was present on the sample surface.

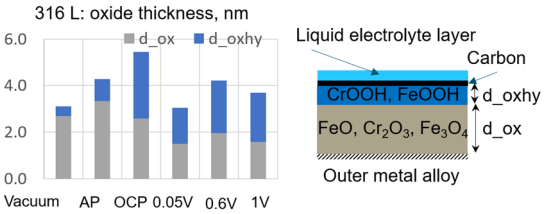


Figure above shows how the thickness of oxide changes for a sample kept at vacuum, at ambient pressure, and after contact with 0.1M HCl electrolyte at OCP followed by stepwise increase of anodic potential. The concentration of chemical species in the corresponding oxide layers was calculated. This information allows to directly relate the corrosion current to the changes in passive film composition, which is highly relevant for the industry and can be used for in-depth corrosion investigations.

"It has been a great opportunity to participate in exploring the APXPS technique, which can lead to improved understanding of oxide properties and corrosion behaviour." */D. Klint, Alfa Laval*

"Quintus Technologies looks forward to follow-up this work using HIPed material." */J. Shipley, Quintus Technologies*

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