INDUSTRIAL PILOT PROJECT

HAXPES study of oxide films on AM stainless steel materials

THE INDUSTRIAL CHALLENGE

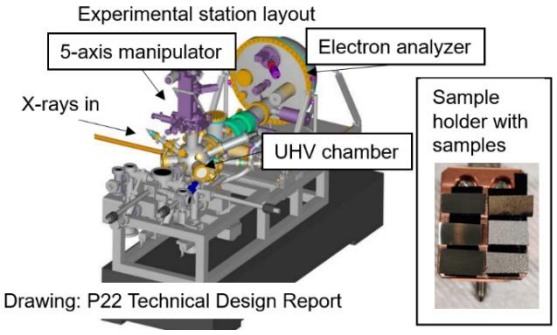
The replacement of conventional stainless steel (SS) with additive manufactured (AM) SS material has many strategical benefits. The printed components used by Alfa Laval often require further treatments to improve their corrosion and structural performance. In turn, Quintus Technologies is specializing on the post-processing of AM components and works together with Alfa Laval and Swerim on improving the corrosion performance of AM SS. For prediction of corrosion performance, it is important to understand how post-processing protocols affect thickness and chemical composition of the surface oxide films.

WHY USING A LARGE SCALE FACILITY

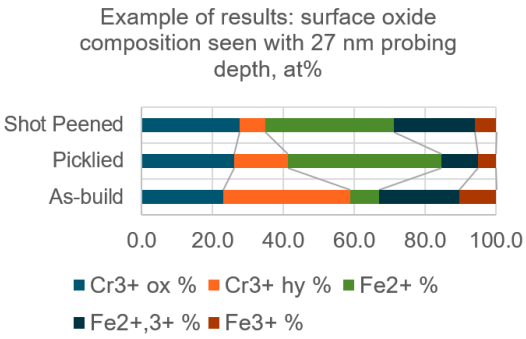
Unlike conventional X-ray Photoelectron Spectroscopy (XPS), the synchrotron-based hard X-ray version (HAXPES) allows to tune the probing depth by changing the incoming photon energy for performance of non-destructive chemical depth profiling of relatively thick oxide films (up to 30 nm). Thanks to the very high brightness, the rough surfaces of as-build AM SS can be studied, and good signal-to-noise ratios can be achieved in a short time.

HOW THE WORK WAS DONE

The experiment was performed at the P22 beamline of Petra III, Hamburg. Samples of AM 316L SS were cut from the printed columns and mounted on the sample holder. The HAXPES spectra were measured using 7.5 keV and 2.5 keV photon energies and at two different incidence angles. The 13 samples tested had been subjected to high pressure heat treatment, shot peening and pickling (in total about 400 spectra during 40h beamtime).



THE RESULTS AND EXPECTED IMPACT



The results revealed changes in chemical composition of the surface oxide introduced by post-processing. Illustration above shows results for as-build, shot-peened and pickled surfaces. The surface oxide of non-treated AM steel appeared to be thick (about 20 nm) and with non-uniform composition (the top 10 nm rich with Fe oxides and the bottom 10 nm rich with Cr_2O_3 in presence of metallic Fe and Cr). Shot peening and pickling surface treatments made surface oxide more uniform and homogeneous with a thickness of 5 nm. Effects of interaction with pickling solution and glass beads were obtained for pickled and shot peened surfaces, respectfully, which can potentially impact their corrosion properties. The results will contribute to the strategical efforts to develop guidelines for production of AM parts with predictable corrosion properties.

"Possibility to participate in a project and join on-site during the measurements, has provided a better understanding of how the HAXPES technique works and how to interpret data"/ D.Klint, Alfa Laval

"The project is extremely useful in understanding the effect of Hot Isostatic Pressing on surface alloy and oxide composition"
/J. Shipley, QuintusTechnologies

Contacts: D. Klint – Alfa Laval Lund, daniel.klint@alfalaval.com
J. Shipley – Quintus Technologies, james.shipley@quintusteam.com
K. Simonov – Swerim AB, konstantin.simonov@swerim.se

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