INDUSTRIAL PILOT PROJECT

Synchrotron X-ray photoemission electron microscopy for characterization of alkaline cleaned ZnAlMg coated steel

THE INDUSTRIAL CHALLENGE

Zinc coatings alloyed with aluminium and magnesium (ZnAlMg) are of great interest for the automotive industry since they provide better formability and corrosion properties, which allow a reduced coating thickness compared to conventional hot dipped galvanized zinc (HDG Zn) coatings on steel. The use of ZnAlMg coatings can therefore reduce scrap formation and provide a higher production flow. However, the multiphase composition of a ZnAlMg metal coating leads to challenges when cleaning the surfaces in industrial surface treatment lines. This could be related to variations of the ZnAlMg surface microstructure, which may lead to local variations in the composition and thickness of the surface oxide after cleaning. Since some of these conditions can lead to poor wetting and affect subsequent surface treatment steps, it is of great importance to able to relate a certain surface condition to the resulting performance.

WHY USING A LARGE SCALE FACILITY

As the coating's thickness is in the order of a few microns and less, it is a challenge to determine the local surface distribution and speciation of the elements therein. This requires surface-sensitive techniques with micrometer / submicron scale lateral resolution. For this purpose, synchrotron-based X-ray photoemission electron microscopy (XPEEM) is an excellent tool which can provide high resolution imaging of the outermost oxide layers as well as local X-ray photoelectron spectroscopy (μ-XPS) for speciation of the elements of relevance such as oxides, hydroxides, carbonates and carboxylates of Zn, Al and Mg.

HOW THE WORK WAS DONE

The XPEEM and μ-XPS experiments were carried out at the MAXPEEM beamline of MAX IV on ZnAlMg coating substrates cleaned with a conventional alkaline cleaning process with chemicals used in the industrial processes of Volvo. The imaging of the local distribution of elements on the surfaces was performed with XPEEM and local spectroscopic speciation of the elements in the surface oxide was determined with μ-XPS.

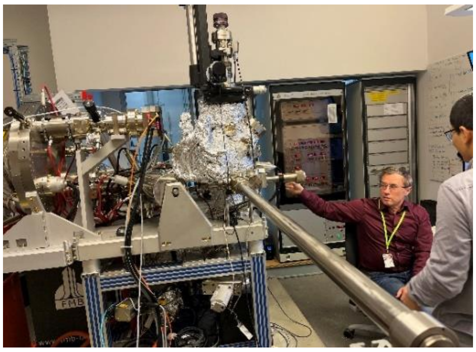

Figure 1. Experimental setup for XPEEM measurements at the MAXPEEM beamline. Beamline scientists Alexei Zakharov and Lin Zhu assisted.

THE RESULTS AND EXPECTED IMPACT

The XPEEM and μXPS measurements on the ZnAlMg-surfaces could confirm local variations in the elemental and chemical composition, and probably also the thickness of resulting oxides/ surface films after alkaline cleaning and how this in turn was related to process bath composition. These results were in contrast to the measurements performed on the conventional and more homogeneous HDG/ Zn reference surfaces. Thus, introduction of a more complex metal coating leads to additional challenges for surface analysis. In summary, the experiments show that XPEEM and μ-XPS can provide information about the surface composition at the microscopic level which can be a very valuable tool for development of cleaning and pre-treatment processes on multiphase zinc alloy coatings.

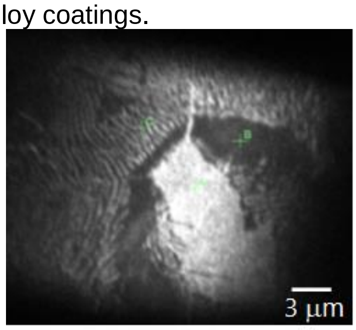

Figure 2. Core level chemical contrast of Zn for an alkaline cleaned ZnAlMg showing microscopic variation in Zn-content over the surface.

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