Surface chemistry and pretreatment effects on Zn-Al-Mg coatings: insights into oxide and zirconium conversion layer formation

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Abstract

Zn-Al-Mg hot-dip galvanized steel is one of the frequently used materials for an automotive industry. With high corrosion resistance and good mechanical properties, it serves as a base for consequent processes, such as painting or applying organic coatings. The influence of intermitting processes, such as chemical cleaning of the surface, surface activation and application of a conversion layer, on the Zn-Al-Mg coating surface chemistry plays an important role in later adhesion and susceptibility to corrosion. This thesis investigates the surface chemistry of Zn-Al-Mg coatings under varying chemical treatments. Thus, a comparative analysis of depth profiles by surface-sensitive techniques is conducted to interpret compositional changes in Zn-Al-Mg coatings subjected to alkaline and acidic pretreatments. The results showed in practice high applicability of XPS and LEIS to the industrially produced coatings, and the ability of SIMS to complement these results on complex matrix material. Further, combination of analytical and surface-sensitive approach characterized the surface chemistry modifications and dissolution mechanism of Zn-Al-Mg coatings induced by industrially applicable cleaners in mild and strong alkaline areas. The results highlight the critical role of choosing the right cleaning conditions, depending on the preferrable effects, essential for the next step in the coating process. The findings on effects of alkaline and acidic pretreatments on Zr-conversion layers indicate that alkaline pretreatments result in double-layered coatings, consisting of an oxidic and fluoridic layer. Acidic conditions deflect an insoluble fluoride layer formation. Therefore, strong alkaline pretreatment are preferrable for building an uniform complex Zr-conversion coating.