

Corrosion Performance of Zinc Magnesium
Aluminium Coated steel: discussion of fundamental
mechanisms

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The explanations for an improved corrosion protection of ZMA coatings in comparison to Zn coatings reported in the literature are manifold. Ogle et al. [1, 2] propose that for Mg-containing alloys the improved corrosion resistance is achieved by stabilization of protective simonkolleite and zinc hydroxysulfate. According to these authors Mg cations ions bind the excess of carbonate preventing the formation of soluble or less-protective products. Mori et al. [3] on the other hand, attribute the main effect on the formation of zinc aluminium carbonate hydroxide (a layered double hydroxide, LDH) or aluminium rich oxide layer in general [4]. Also possible effects on surface reactivity [5], on semiconducting properties of the formed oxides [6-8] or on the crystallinity of the formed corrosion product layer that might be indirectly affected by the presence of Mg cations during precipitation, even when no Mg is incorporated, are proposed[1].

This exemplifies how diverse the reports on the possible working mechanisms of Zn-Mg-Al coatings are. Also for the actual performance the reports differ significantly. Already in 2007 Hosking et al. pointed out that obviously the actual improvement of the corrosion performance of Zn-Mg alloy coatings in comparison to zinc coatings depends critically on the corrosion conditions. According to their literature analysis reports claiming no effect to claims of a factor of 24 can be found [9].

Concluding, it can be stated that depending on the actual testing conditions not only the corrosion performance but also the corresponding corrosion products which can be found on the surface may vary. Some of the proposed mechanisms, such as buffering the pH or consumption of CO₂ for stabilizing simonkolleite were usually developed on the basis of results obtained from high Mg-content alloys and certainly require certain minimum amounts of magnesium cations, while others, such as an effect on the precipitation of zinc corrosion products, i.e. indirectly affecting the crystallinity, might work already at lower concentrations.

In this paper, a detailed discussion of the possible

underlying mechanisms is presented, which – for a systematic approach- is divided in three different aspects of the overall corrosion process:

- (1) the performance at the cut edge or at the scribe down to steel, especially the inhibition of oxygen reduction on the exposed steel surface [10],
- (2) the delamination behaviour between paint and the metal coating and
- (3) the corrosion of the metal coating itself.

Each of these points will be discussed in detail and it will be shown that for each of them distinctly different mechanisms have to be considered.

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