In-situ vertically grown Zn-Al LDH conversion coatings prepared by a two-step electrochemical method

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Abstract *L*ayered double hydroxides (LDH) have many merits and have been widely used for corrosion protection of metals, including used as the conversion layers for a protective coating system. Vertically-grown morphology is favorable for a conversion layer, but LDH coating having such orientation can only be prepared by hydrothermal method, which is time consuming and requires high temperature. In this work, a novel two-step electrodeposition method was proposed to in-situ prepare vertically grown Zn-Al LDH coating on either galvanized steel, aluminum alloy or ZnAlMg-coated steel, from precursor solutions containing Al^{3+}-only, Zn^{2+}-only, and both Al^{3+}/Zn^{2+} ions-free, respectively.

To do so, anodic currents were applied to the metallic substrates in the first step, to in-situ produce Zn^{2+} and Al^{3+} in solution near the galvanized steel and aluminum alloy surface, respectively. Cathodic currents were then applied to ensure the cathodic deposition of Zn-Al LDH film when the anodically dissolved ion and another already existed ion in the precursor solution react with the in-situ cathodically produced OH^-. Similar approach was applied on ZnAlMg-coated steel, on which both the Zn^{2+} and Al^{3+} ions were produced in the first anodic dissolution step, and these ions react with the in-situ produced OH^- in the second cathodic deposition step to form LDH coating.

The resulting LDH coatings exhibit a unique vertically grown morphology that ensure them be suitably used as pretreatment layer of the subsequent epoxy coatings, and thereby improving the corrosion resistance of the entire coating system. Additionally, incorporated corrosion inhibitors into the LDH pretreatment layer can further enhance the anti-corrosion performance of the coating system.

This series of work developed a new approach to prepare vertically grown LDH coatings using a rapid and mild in-situ two-step electrochemical method, reducing or even eliminating the requirement for externally added metal ions during the preparation process.

Keywords Layered double hydroxide, pretreatment layer, vertically grown, two-step electrochemical method, anti-corrosion coating system