In situ formation of LDH-based nanocontainers on the surface of AZ91 magnesium alloy and detailed investigation of their crystal structure

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Magnesium alloys constitute one of the most important groups of engineering materials and are highly used for biomedical, transportation, and 3C industries. However, their application is limited due to high reactivity, which requires adequate corrosion protection. The present work explored the possibility of direct synthesis of LDH (layered double hydroxide) as corrosion protection coating on the surface of AZ91 magnesium alloy in the presence of a chelating agent (DTPA -diethylenetriaminepentaacetic acid). The conversion layer of LDH nanocontainers was formed under ambient pressure without the addition of carbonate in the electrolyte. The samples of AZ91 magnesium alloy were immersed in the prepared treatment baths (aqueous solutions containing DTPA pentasodium salt, $Al(NO_3)_3$ and $NaNO_3$) preheated to different temperatures under continuous stirring. As the optimal conditions of LDH formation, the following parameters were identified: DTPA concentration equal to 0.1 M, temperature of 95°C, and pH of the solution equal to 10. The optimal duration of LDH growth was defined as 6h. For further industrial application, the synthesis can be additionally optimized to obtain LDH under milder conditions (e.g., 0.01 M DTPA concentration, 80°C and 3h). The obtained LDH was characterized by the combination of experimental (SEM-EDS, XRD, TGA, XPS, Raman spectroscopy) and computational methods (thermodynamic calculation, modeling of possible LDH crystal structures). A comparison of three possible LDHs (LDH-OH, -NO_3 and -CO_3) was performed. Based on the experimental results and crystal simulation approach, it was confirmed that an LDH-based mixture with the general formula Mg-Al LDH-OH/CO_3 is grown on the surface under applied synthesis conditions in the presence of DTPA pentasodium salt.

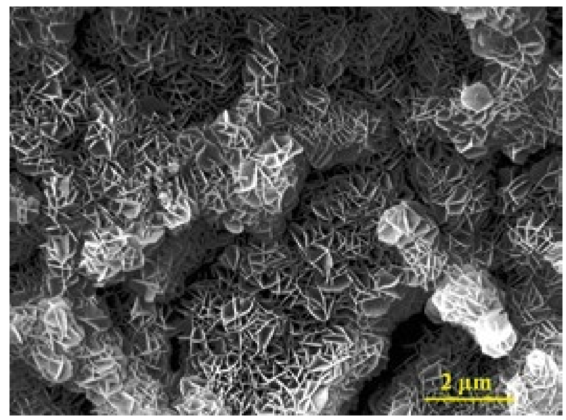

FIGURE 1
Surface morphology of AZ91 obtained as a result of the hydrothermal LDH synthesis in the presence of a DTPA chelating agent.

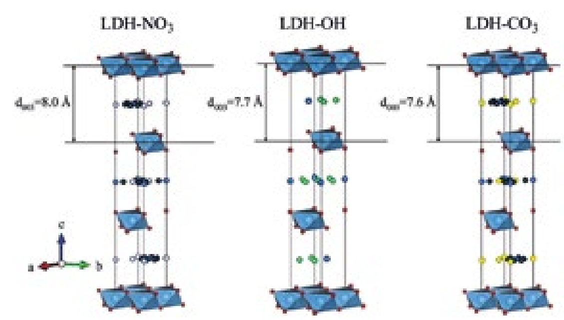

FIGURE 2
Schematic representation of the unit cells of LDH-NO_3, LDH-OH and LDH-CO_3.

Reference
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