

Treatment of LDH by phytic acid for enhancing the self-healing and binding strength of hydroxyapatite coating on AZ31 magnesium alloy

Peng Chuang¹, Qi Kai^{1,2,3,4}, Qiu Yu-bing^{1,2,3,4*}, Guo Xing-peng^{2,3,5}

¹*School of Chemistry and Chemical Engineering, Huazhong University of Science and Technology, Wuhan 430074, China*

²*Key Laboratory of Material Chemistry for Energy Conversion and Storage (Huazhong University of Science and Technology), Ministry of Education, Wuhan 430074, China*

³*Hubei Key Laboratory of Materials Chemistry and Service Failure, Wuhan 430074, PR China*

⁴*Hubei Engineering Research Center for Biomaterials and Medical Protective Materials, Wuhan 430074, PR China*

⁵*School of Chemistry and Chemical Engineering, Guangzhou University, Guangzhou, 510006, PR China*

pengchuang@hrbeu.edu.cn

Abstract Magnesium alloy biodegradable implant materials have attracted wide attention recently because of their suitable mechanical strength and harmless degradation products to the host body [1]. However, the application of magnesium alloys in clinical medicine has been limited by uncontrolled degradation in complex humoral environments [2]. Hydroxyapatite (HA) coating has become widely used for surface modification of magnesium alloys due to its excellent corrosion resistance and biocompatibility [3]. In this work, Mg-Al LDH coating was in situ grown on AZ31 magnesium alloy as an intermediate layer to prevent the nucleation of HA by Mg²⁺ owing to the magnesium alloy corrosion during the preparation process. Subsequently, the HA coating was prepared using hydrothermal treatment of LDH with a phytic acid solution (Fig. 1). Following the treatment with phytic acid for different times (0, 0.5, 1.0, and 2.0 h, denoted as LDH and LDH0.5-2), the crystallization properties of LDH remained unaltered (Fig. 2a). However, the corrosion resistance of the LDH layer was enhanced (Fig. 2c), which subsequently influenced the surface morphology and cross-section thickness of the HA coating prepared by hydrothermal preparation (Fig. 1). Concurrently, the introduction of phytic acid provided nucleation sites for HA nucleation and enhanced the binding force, among which HA/LDH2 exhibit best binding force was 8.48±0.24 MPa (Fig 2f). Artificial scratches were prepared on HA/LDH1, and

electrochemical monitoring was conducted in Hank's solution (Fig. 2e). It was demonstrated that HA/LDH1 exhibited self-healing properties.

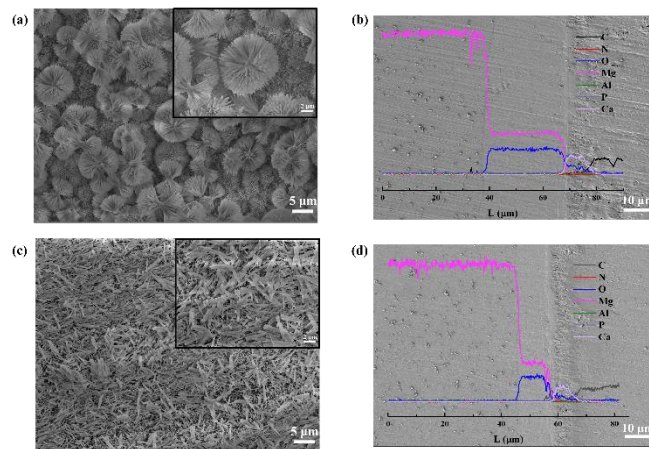


Fig. 1. Surface and cross-section SEM images of (a, b) HA/LDH and (c, d) HA/LDH1 samples.

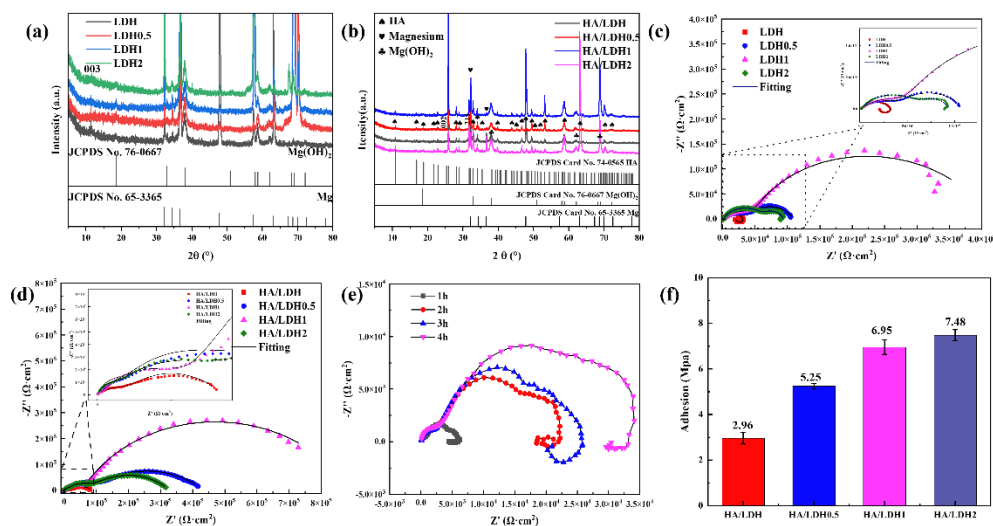


Fig. 2. XRD patterns of (a) LDH coatings and (b) HA coatings. Nyquist plots of (c) LDH coatings, (d) HA coatings, and (e) scratched HA/LDH1 coating in Hank's solution at different times. (f) Binding force of various HA coatings.

Keywords Magnesium alloy, Hydroxyapatite, Layered double hydroxide, Phytic acid treatment, Self-healing coating

Reference

[1] Z.-Z. Yin, W.-C. Qi, R.-C. Zeng, X.-B. Chen, C.-D. Gu, S.-K. Guan, Y.-F. Zheng, Advances in coatings on biodegradable magnesium alloys, Journal of Magnesium and Alloys, 8 (2020) 42-65.

[2] P. Jiang, R. Hou, S. Zhu, S. Guan, A robust calcium carbonate (CaCO₃) coating on biomedical MgZnCa alloy for promising corrosion protection, *Corrosion Science*, 198 (2022).

[3] A.-M. Zhang, P. Lenin, R.-C. Zeng, M.B. Kannan, Advances in hydroxyapatite coatings on biodegradable magnesium and its alloys, *Journal of Magnesium and Alloys*, 10 (2022) 1154-1170.