Designing of a high-strength and high corrosion-resistance magnesium alloy based on the dissolution-ionization-diffusion-deposition model

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Abstract A novel designing idea for the high-strength and high corrosion-resistance magnesium (HSCR Mg) alloy was proposed based on the dissolution-ionization-diffusion-deposition (DIDD) model. This approach considers both corrosion and mechanical properties simultaneously, introducing alloying element selection principles informed by electrochemical dissolution, deposition tendencies, and strengthening mechanisms. The multi-stage nucleation mechanism and the downward-magnifying effect on nucleation of low-alloying elements (LA), micro-alloying elements (MA), and Mg play a critical role in enhancing corrosion resistance. Furthermore, LA also forms strengthening phases with Mg, achieving an optimal balance between mechanical strength and corrosion resistance. The designed VW63-05In alloy, after extrusion and aging, exhibits an exceptional combination of mechanical properties and corrosion resistance, with a yield strength of 320.77 ± 1.70 MPa, a tensile strength of 377.34 ± 0.78 MPa, an elongation of 14.99 ± 0.08%, and a corrosion rate of 0.08 ± 0.01 mm/a. This design approach provides new insights into the development of high-performance Mg alloys and is expected to broaden the application potential of Mg alloys.

Keywords Magnesium alloy; Alloy designing; DIDD model; High strength; High corrosion resistance.