A novel strategy for constructing active anti-corrosive coatings by embedding three-dimensional fiber networks

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Abstract The corrosion protection effectiveness of micro/nanocontainers-based intelligent coatings is significantly affected by the dispersion of these micro/nanocontainers throughout the coating matrix. Inspiration by the bionics idea of a 'vascular network', a polylactic acid (PLA) three-dimensional fiber network incorporated with different concentrations (1 wt.%, 2 wt.%, and 3 wt.%) of pH-responsive titanium dioxide-8-hydroxyquinoline (TiO_2-8HQ) nanotubes are designed on the Mg alloy surface using the electrospinning technology. The electrospun TiO_2-8HQ@PLA network is crosslinked and evenly dispersed on the surface, which is also sensitive to the local pH variations. The encapsulated 8HQ inhibitors can transport through the three-dimensional fiber network and promise to realize the continuous and effective self-healing effects on the multi-defect areas on the coating surface. Afterward, an epoxy coating is performed on the surface, which permeates through the inner network and forms a kind of vascular network intelligent coating. The corrosion protection and self-healing performance of these coatings are assessed through the electrochemical test and surface analysis. Results reveal that the embedded TiO_2-8HQ@PLA three-dimensional network significantly improves the corrosion resistance and self-healing performance of the coatings. Especially, 2%TiO_2-8HQ@PLA-EP demonstrates the most enduring corrosion resistance over 50 days of immersion in a 3.5 wt.% NaCl solution, with the coating resistance and charge transfer resistance values of 2.33×10^6 $\Omega \cdot cm^2$ and 4.81×10^6 $\Omega \cdot cm^2$, respectively. Additionally, the crosslinked three-dimensional fiber network enhances the adhesion strength (38.01 MPa) and surface wettability (104.25° ± 0.15°), which greatly strengthens the physical barrier performance, which is capable of sustaining long-term serving life in an aggressive environment. The combination of the micro/nanocontainers technology and vascular network innovative design provides a unique insight into active corrosion control on diverse metals.

Keywords *Stimulus-responsive, 3D fiber network, Micro/nanocontainers, Active corrosion inhibition, Self-healing*

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