Study on the Corrosion Resistance and Mechanical Properties of CNF/ZIF-8@AMT Coating on Copper

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Abstract Metal, as an indispensable basic material for the daily production and life of human society, is widely used, especially in the face of corrosive environments (such as CL-containing environments), and the demand for protective technology is particularly urgent [1]. Among the many metals, copper is known for its long history and wide range of applications, from electrical lighting to machinery manufacturing, from building decoration to defense technology. However, although the traditional coating technology has made significant progress in corrosion resistance, it is still insufficient in terms of mechanical properties, especially in solving the problems of weak adhesion between the coating and the substrate and the coating spalling caused by external friction and collision [2]. To address these challenges, a novel CNF/ZIF-8 composite nanocontainer has been developed to effectively load the AMT corrosion inhibitor, enhancing both corrosion resistance and mechanical properties of the coating. XRD and FTIR analysis confirmed that AMT was successfully loaded onto CNF/ZIF-8, with thermogravimetric tests indicating an AMT loading of approximately 14.29% when comparing the weight changes of CNF/ZIF-8@AMT and CNF/ZIF-8 over the temperature range of 30°C to 800°C. Electrochemical testing, along with morphology observation and nanoindentation, revealed promising results; after 365 days of immersion in a 3.5 wt% NaCl solution, the impedance of the PVB/CNF/ZIF-8@AMT coating increased by 104.76% compared to the PVB/AMT coating, and by 175.84% relative to unmodified PVB. The nanoindentation tests demonstrated that the hardness of the PVB coating incorporating CNF/ZIF-8@AMT increased by 29.89%. These findings underscore the enhanced corrosion resistance and mechanical properties of the PVB/CNF/ZIF-8@AMT coating. Molecular dynamics simulations suggest that the porous ZIF-8 structure facilitates comprehensive loading of corrosion inhibitors, and the three-dimensional coordination between hydroxyl and carbonyl groups of the PVB resin and zinc ions in ZIF-8 significantly improves the compatibility of CNF/ZIF-8 nanocontainers with PVB coatings.

Keywords Nanocontainers, Corrosion inhibitors, coating, Corrosion resistance, Mechanical properties

Reference

[1] Y.P. Liu, Y.Y. Zhou, W.Z. Wang, L.M. Tian, J. Zhao, J.Y. Sun, Synergistic damage mechanisms of high-temperature metal corrosion in marine environments: A review, Prog. Org. Coat. 197 (2024) 20.http://dx.doi.org/10.1016/j.porgcoat.2024.108765.

[2] S. Anwar, X.G. Li, A review of high-quality epoxy resins for corrosion-resistant applications, J. Coat. Technol. Res. 21(2) (2024) 461-480.http://dx.doi.org/10.1007/s11998-023-00865-5.