Study of Simulated Corrosion Immersion Experiments and Corrosion Mechanisms of Ancient Bronze Artifacts

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Abstract: In order to reveal the corrosion mechanism of the bronze tripod during Warring States Period excavated in Tianshui City, we used Cu-Sn bronze pieces to simulate the tripod sample, and prepared soil simulation solution according to the composition of buried soil to characterize the corrosion behavior of the bronze sample systematically. The surface morphology and chemical composition of the samples before and after corrosion were characterized by metallography microscope, roughness tester, contact angle measurement, SEM, EDS, XRD, XPS methods, and the OCP, EIS and Tafel tests of Cu-Sn bronze samples under different corrosion periods was carried out by electrochemical workstation. The results show that the main components of the passivated film are CuO and $Cu_2(OH)_2CO_3$, and the harmful corrosion is $Cu_2(OH)_3Cl$. The contact angle of the bronze sample decreases gradually and the roughness increases gradually over time, which is mainly caused by the corrosion products generated on the sample surface. Moreover, the open-circuit voltage curve of the bronze sample is a change characteristic of first increasing, then slowly decreasing, and then increasing after fluctuations, which indicates that the corrosion rate of the bronze sample shows a trend of first increasing, then slowly decreasing, and then increasing. This trend may be that the corrosion products in the bronze reduce the contact area between the surface of the bronze and the corrosion medium, and form a passivation film with protective properties, thereby decreasing the corrosion rate, which also verified by the resuts of Tafel and EIS curves. However, the appearance of $Cu_2(OH)_3Cl$ will accelerate the corrosion rate at the final corroiosn stage. The experimental phenomena and conclusions of this study can provide a theoretical basis for the corrosion of ancient bronzes and provide support scientific basis for selecting appropriate protection strategies.

Keywords

Corrosion behaviors; Cu-Sn alloy; Bronze rust layer; Electrochemistry