

Selective corrosion mechanism of ancient bronzes and Re-deposition copper cause analysis

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Abstract Selective corrosion is a common phenomenon observed in ancient high-tin bronze artifacts. The bronze samples from Shandong Province were analyzed by metallurgical microscope, and scanning electron microscope energy spectrometer (SEM-EDX). This analysis revealed that α -phase preferential corrosion is more prevalent in bronze mirror samples, whereas δ -phase preferential corrosion is more common in other types of bronze samples. Notably, both types of corrosion coexist in a few samples. The surface of antique bronze mirrors is typically smooth and susceptible to oxygen absorption corrosion in soil, seawater, and the atmosphere. In contrast, the surface of other types of bronze is typically rough, and occlusion cell corrosion is prone to occurring at surface defects. The solution within the occluded cell will be markedly acidic due to the hydrolysis of metal ions, and the acidic conditions may potentially reverse the α and δ phases. The results of the simulated corrosion test proved that bronze corrosion starts from the α -phase in an environment with low acidity and alkalinity and from the δ -phase in a strong acid condition. The δ -phase in the occlusion cell is the anode, which undergoes an oxidation reaction to produce copper ions, and the α -phase is the cathode, which undergoes a reduction reaction to produce pure copper grains. Because of the slow diffusion of ions in the electrolyte solution, the current inside the corrosion cell is intermittent due to concentration polarization, and a twin-crystal structure sometimes appears in the generated copper grains.

Keywords High-tin bronze; Elector-chemical corrosion; Re-deposition copper; Crystal twinning