Photo-induced passivation: A new corrosion mitigation strategy for bronze artifacts

Jinxian Wu[1], Yuqing Wu[2], Julin Wang[2], Wugan Luo[1]

[1] *Department of Archaeology and Anthropology, University of Chinese Academy of Sciences, Beijing 100049, China*

[2]*Key Research Base of State Administration of Cultural Heritage for Evaluation of Science and Technology Research in Cultural Relics Protection Field, Beijing University of Chemical Technology, Beijing 100029, PR China*

wujinxian@ucas.ac.cn

Abstract To explore the potential protective effect of UV illumination on the tin bronzes, the corrosion behaviors of four ternary Cu-Sn-Pb alloys with varying tin contents in a chloride-containing borate buffer solution (pH 8.4) were investigated in both the dark and UV illuminated conditions. UV illumination was found to consistently inhibit bronze corrosion across varying tin contents by facilitating the formation of a compact SnO_2 layer on the surfaces. This process is referred to as photo-induced passivation. Concerning the effect of Sn content on the photo-induced corrosion process, a substantial Sn enrichment within the patina layer favors the formation of this compact oxide film more readily. Moreover, the oxide films on high-tin bronzes generally exhibit greater photostability and provide more long-lasting protection compared with low-tin bronzes.Two kinds of artificial patinated bronzes were prepared to further access the inhibitive effect of photo-induced passivation treatment on the bronzes covered with typical patina layers. The maximum inhibition efficiencies achieved were 93.1% for the patinated Cu5Sn bronze, which is covered with a Sn-rich single-layered patina mainly consisting of cuprite, and 82.4% for the patinated Cu10Sn bronze, which features a Cu_2O/CuCl inner layer and a $Cu_2(OH)_3Cl$ outer layer. These values are comparable to those achieved by organic substances used on various artificially patinated bronzes.Overall, photo-induced passivation treatment can effectively mitigate the corrosion of Cu-Sn-Pb alloys without introducing foreign substances that might interfere with the archaeological information of bronze artifacts during the preservation process. However, further research is still necessary before it can be applied to actual bronze artifacts.

Keywords bronze; photo-induced passivation; patina; oxide film

Reference

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