Casting a Healthier Future: Electrochemical and Microstructural Characterization of the Cu-Zn-Al-Sn Alloy System for Antimicrobial Use

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Microbial contamination in healthcare and marine environments compromises safety and incurs billions in costs. To address this, a parametric study was conducted on eight cast Cu-Zn-Al-Sn alloys in the copper-rich corner of a pseudo-ternary system. The goal was to engineer a tunable platform by correlating microstructure to electrochemical corrosion behavior and validating its antimicrobial efficacy. Alloy phases were characterized using SEM (BSE/SE/EDS), XRD, and XRF. Corrosion mechanics were analyzed via Open Circuit Potential (OCP) and Potentiostatic Electrochemical Impedance Spectroscopy (PEIS) in simulated human sweat. Antimicrobial utility was validated using modified ISO 22196:2011 bacterial assay technique. Results indicated that Zn and Al variations drove distinct intermetallic phase formations, directly dictating corrosion resistance. Validation of antimicrobial performance provided results indicating ~5-log reduction within two hours, surpassing the EPA's 3-log target among nearly half casted alloys. This study establishes a validated, microstructurally engineered platform for tunable antimicrobial applications in a variety of environments.

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