Surface Analysis of Biomedical Alloys and Industrial Metals: Evaluating Corrosion Resistance in Diverse Environments

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This research employs time-of-flight secondary ion mass spectrometry (ToF-SIMS) and X-ray photoelectron spectroscopy (XPS) to explore the corrosion resistance of biomedical alloys, specifically medical-grade stainless steel and titanium-aluminium-vanadium (TiAlV) alloy, alongside commonly used industrial metals such as steel, copper, zinc, and brass. These materials are pivotal in their respective fields, i.e. biomedical for clinical applications and industrial metals for construction, electronics, and marine environments. ToF-SIMS is used in the study to visualize surface species distributions in depth. This technique provides insights into surface treatments' elemental and molecular improvements. Complementarily, XPS offers quantitative data on the chemical states and compositions at the material surfaces, which is crucial for assessing the stability and integrity of passivation layers that mitigate corrosion. The findings highlight the necessity for distinct corrosion resistance strategies tailored to the operational demands of biomedical and industrial applications. This involves enhancing device design and functionality for biomedical alloys to improve safety and longevity in clinical settings.

Conversely, developing cost-effective and robust corrosion protection methods for industrial metals suited for harsh environmental exposures is essential. Integrating ToF-SIMS and XPS elucidates the interaction mechanisms at the material surfaces, guiding the development of more effective corrosion-resistant treatments. This study advances material performance across various industries by bridging the gap between theoretical surface science and real-world application.