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Electropolishing Valve Metals with a Sulfuric Acid-Methanol Electrolyte at Low Temperature

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Abstract

This study reports the electropolishing of Ti and Nb metals using a fluoride-free electrolyte of sulfuric acid and methanol at low temperature (-70°C) without prior treatment. A fluoride-free electrolyte provides a less hazardous and more environmentally friendly option for electropolishing procedure. Experimental studies are presented on electropolishing with sulfuric acid electrolyte, which provides high quality macro- and micro-smoothing of the metal surfaces. Optimal conditions yielded leveling and brightening of the surface of Ti and Nb metals beyond that by the currently utilized electropolishing procedures with fluoride-containing electrolytes. The root mean square roughness (R_q) from atomic force microscopy (AFM) analysis was 1.64 and 0.49 nm for Ti and Nb, respectively. Lower temperature experiments led to noticeable kinetic effects, indicated by a dramatic drop in current densities and the expansion of the steady-state current density plateau in anodic polarization curves. In addition, the voltage range of the current plateau expanded with increasing acid concentration. Surface characterization of Ti and