Particle Size Refinement of Zn Electrodeposits in Alkaline Zincate Solutions with Polyethylene Glycol and Tween 80

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The alkaline zinc electrowinning process can directly recover powdery Zn metal from oxidized zinc ores and industrial wastes. However, the industrial-scale practice shows that the Zn powders produced generally have a broad particle size distribution, and further milling is required prior to applications. In this study, the effects of two kinds of organic additives, polyethylene glycol (PEG) and tween 80, on the particle size refinement of Zn deposits in alkaline electrolytes were investigated for the first time. The results show that both of the additives dramatically reduced the particle size of Zn deposits and increased the weight percentage of undersized product (<150 μm) while the current efficiency remained > 98% and the Zn purity was > 99%. From results of scanning electron microscopy (SEM), energy-dispersive x-ray spectroscopy (EDS), X-ray diffraction (XRD) analysis, and cyclic voltammetry (CV) experiments, the possible explanation is that the addition of tween 80 and/or PEG increased cathodic overpotential and subsequently increased the Zn nucleation rate and restrained the Zn grain growth. Eventually, an increased amount of Zn deposits with fine 3-D structure were produced, and a higher Zn deposit refinement was achieved. Orthogonal experiments were designed to investigate the co-effects of the additives and the electrolysis parameters: electrolyte temperature, current density, and electrolysis time. The optimum particle size refinement was obtained when 5 mg/L tween 80 and 100 mg/L PEG were added to the alkaline electrolyte, and the electrolysis was conducted for 10 min at 0 °C with a current density of 800 A/m²; 99.82 wt.% of <150 μm particles and 52.94 wt.% of <45 μm particles were observed.

Keywords: Polyethylene glycol; Tween 80; Particle Size Refinement; Zn powder; Alkaline

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