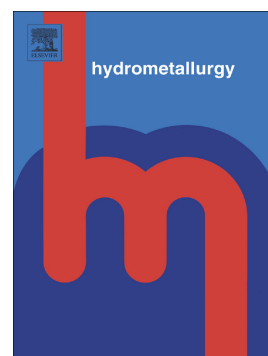


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Electrochemical Behaviour of Copper in Alkaline Glycine Solutions

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Copper, glycine, electrochemical dissolution, leaching, slag, electronic waste, passivation

1. Abstract

The fundamental electrochemical properties of the copper-glycine system were investigated in this study to understand the factors that affect the dissolution of metallic copper. Potentiodynamic polarisation measurements were carried out over the pH range 9.0 to 11.5, at temperatures of 22°C and 60°C and glycine concentrations 0.1 M and 0.3 M. A window for maximum corrosion current was determined to be between pH 10.0 and 10.5 with a maximum at 60°C and 0.3 M glycine. Passivation was only observed at pH values greater than 10.5, and then only at potentials above 0.4 V (vs SHE) for quiescent solutions. This passivation potential increased with the rotation speed of the copper electrode. The passive layer broke down after a short rest at the open circuit potential, which allowed reactivation of the surface and high initial currents to briefly flow until the layer re-formed. Potential-step and capacitance measurements are consistent with the formation of a duplex oxide layer of Cu₂O and CuO that thickens with increasing potential. The copper glycinate complex itself also acts as an oxidising agent, the effectiveness is increased with its concentration and the concentration of free glycine. Free glycine is oxidised irreversibly above 1.2 V (vs SHE).

2. Introduction

The application of glycine as a complexing agent in the alkaline leaching of copper minerals is currently being investigated at Curtin University and elsewhere with an emphasis on copper-gold ores (Eksteen et al., 2017; Nicol, 2017a; Oraby and Eksteen, 2015; Perea and Restrepo, 2018; Tanda et al., 2017). Glycine has not yet been used in an industrial leaching operation, and little research has been carried out on fundamental electrochemical properties in a metallurgical context. The simplest system for the initial study presented here is metallic (native) copper and will be used as a foundation study for more complex mineral-glycine systems.

Although native copper is relatively rare as an ore mineral, its electrochemical properties are still of interest in extractive metallurgy for the recovery of copper from converter slag, electronic waste and from its occurrence in supergene sulfide and oxide deposits. These leaching operations are typically carried out at acidic pH, due to the low solubility of copper at neutral and alkaline pH in the absence of a complexing agent (Altundoğan and Tümen, 1997; Cui and Zhang, 2008; Schlesinger et al., 2011). The dissolution of native copper is also well known in alkaline environments, where it forms complexes with cyanide in gold operations with consequent financial and environmental penalties.

Ammonia is another well-known example of a complexing agent for copper leaching at alkaline pH (Arbiter and McNulty, 1999; Reilly and Scott, 1977; Stanczyk and Rampacek, 1966; Warren and Wadsworth, 1984). It is yet to be proven financially viable for copper leaching, particularly for open-

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