Magnetic Field Effects on the Corrosion Behavior of Pure Copper in Mild Aqueous Media

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Copper is widely used in industry due to its excellent electrical and thermal conductivity. It is a key material in various devices subjected to intense magnetic fields, such as superconducting coils, electromagnets, and components in electric generators or motors [1]. However, in aqueous or humid environments, copper is vulnerable to corrosion, which can significantly degrade its long-term performance. The influence of magnetic fields on corrosion mechanisms remains underexplored and raises both scientific and industrial questions. In this context, the aim of this study is to evaluate the influence of a high static magnetic field on the corrosion behavior of pure copper, in order to determine whether this parameter can enhance the passivation of the metal in low acidic medium. The study was conducted in a slightly acidic environment (0.1 M KNO_3 solution at pH 4) using high-purity copper bars (99.99% copper). The samples were mechanically polished and partially coated with an insulating varnish (Blocjelt) to define an exposed surface area of 0.71 cm^2. Electrochemical tests, controlled by a PGZ100 potentiostat, were carried out at ambient temperature using a three-electrodes electrochemical cell consisting of a copper working electrode, a platinum counter electrode, and an Ag/AgCl (in KNO_3) reference electrode. Cyclic voltammetry showed no significant variation in corrosion kinetics under low magnetic field intensities (0.05 T to 1 T). However, at 11 T, electrochemical impedance spectroscopy (EIS) revealed a marked increase in polarization resistance, indicating the formation of a more protective passive layer. X-ray diffraction (XRD) analysis confirmed the presence of cuprite (Cu_2O) as the main corrosion product of pure copper surface at pH 4. These findings suggest that strong magnetic fields can enhance the stability and the protective quality of oxide films on pure copper, offering a promising approach to corrosion control in technological applications [2].

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