

Selective Electrooxidation of Ammonia to Nitrogen Gas on the Crystalline Cu₂O/Ni Foam Electrode

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Abstract : Electrochemical oxidation of ammonia (AEO) is one of the highly efficient and environmentally friendly methods for NH₃ removal from wastewater. Recently, researchers have focused on non-Pt-based electrodes (n-PtE) for AEO, aiming to evaluate the feasibility of these low-cost electrodes for future practical applications. However, for most n-PtE, NH₃ is oxidized mainly to nitrate ion NO₃⁻ instead of the desired nitrogen gas N₂, which requires further treatment to remove excess NO₃⁻. Therefore, developing a high N₂ conversion electrode for AEO is highly urgent. In this study, we fabricated various Cu₂O/Ni foam (NF) electrodes by electrodeposition of Cu on NF. The Cu plating bath contained different additives, including cetyltrimethylammonium chloride (CTAC), sodium dodecyl sulfate (SDS), polyamide acid (PAA), and sodium alginate (SA). All the prepared electrodes were physically and electrochemically investigated. Batch AEO experiments were conducted for 3 h to clarify the relation between electrode structures and N₂ selectivity. The SEM and XRD results showed that crystalline platelets-like Cu₂O, particles-like Cu₂O, cracks-like Cu₂O, and sheets-like Cu₂O were formed in the Cu plating bath by adding CTAC, SDS, PAA, and SA, respectively. For electrochemical analysis, all Cu₂O/NF electrodes revealed a higher current density (2.5-3.2 mA/cm²) compared to that without additives modification (1.6 mA/cm²). At a constant applied potential of 0.95 V (vs Hg/HgO), the Cu₂O sheet (51%) showed the highest N₂ selectivity, followed by Cu₂O cracks (38%), Cu₂O particles (30%), and Cu₂O platelet (18%) after 3 h reaction. Our result demonstrated that the selectivity of N₂ during AEO was surface structural dependent.

Keywords : ammonia, electrooxidation, selectivity, cuprous oxide, Ni foam

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