Selective Electrooxidation of Ammonia to Nitrogen Gas on the Crystalline Cu_2O/Ni Foam Electrode

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Abstract : Electrochemical oxidation of ammonia (AEO) is one of the highly efficient and environmentally friendly methods for NH_3 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, NH_3 is oxidized mainly to nitrate ion NO_3^- instead of the desired nitrogen gas N_2, which requires further treatment to remove excess NO_3^-. Therefore, developing a high N_2 conversion electrode for AEO is highly urgent. In this study, we fabricated various Cu_2O/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 N_2 selectivity. The SEM and XRD results showed that crystalline platelets-like Cu_2O, particles-like Cu_2O, cracks-like Cu_2O, and sheets-like Cu_2O were formed in the Cu plating bath by adding CTAC, SDS, PAA, and SA, respectively. For electrochemical analysis, all Cu_2O/NF electrodes revealed a higher current density (2.5-3.2 mA/cm^2) compared to that without additives modification (1.6 mA/cm^2). At a constant applied potential of 0.95 V (vs Hg/HgO), the Cu_2O sheet (51%) showed the highest N_2 selectivity, followed by Cu_2O cracks (38%), Cu_2O particles (30%), and Cu_2O platelet (18%) after 3 h reaction. Our result demonstrated that the selectivity of N_2 during AEO was surface structural dependent.

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