Supplementary Information

Three-dimensional Cu Nanobelt Cathode for Highly Efficient Electrocatalytic Nitrate Reduction

Xiaodan Wang, Mengqi Zhu, Guoshen Zeng, Xun Liu, Chihhsiang Fang, Chuanhao Li*

School of Environmental Science and Engineering and Guangdong Provincial Key Laboratory of Environmental Pollution Control and Remediation Technology, Sun Yat-sen University, Guangzhou 510006, China

E-mail: lichuanh3@mail.sysu.edu.cn

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Calculation of energy utilization efficiency

The energy utilization efficiency was calculated using the following equations:

\[
\eta = \frac{Q \left( \text{NO}_2^- - \text{N} \right)_t + Q \left( \text{N}_2 - \text{N} \right)_t + Q \left( \text{NH}_4^+ - \text{N} \right)_t}{Q_t} \times 100\%
\]  (1)

\[
Q_t = \frac{\int I \, dt}{1000}
\]  (2)

\[
Q \left( \text{NO}_2^- - \text{N} \right)_t = 2 \times \left[ \frac{C \left( \text{NO}_2^- - \text{N} \right) \times V}{M_N} \right] \times F
\]  (3)

\[
Q \left( \text{N}_2 - \text{N} \right)_t = 5 \times \left[ \frac{C \left( \text{NO}_3^- - \text{N} \right)_t - C \left( \text{NO}_2^- - \text{N} \right) - C \left( \text{NO}_2^- - \text{N} \right)_t - C \left( \text{NH}_4^+ - \text{N} \right)_t}{M_N} \times V \right] \times F
\]  (4)

\[
Q \left( \text{NH}_4^+ - \text{N} \right)_t = 8 \times \left[ \frac{C \left( \text{NH}_4^+ - \text{N} \right)_t \times V}{M_N} \right] \times F
\]  (5)

where \( \eta \) (\%) is the electro energy utilization efficiency, \( Q_t \) (C) is the total electric quantity that provide at time \( t \) (s); \( I \) (mA) is the current; \( Q(\text{NO}_2^- - \text{N})_t \), \( Q(\text{N}_2 - \text{N})_t \), and \( Q(\text{NH}_4^+ - \text{N})_t \) (C) are the electric quantities that cost during \( \text{NO}_3^- - \text{N} \) reduction to \( \text{NO}_2^- - \text{N} \), \( \text{N}_2 - \text{N} \) and \( \text{NH}_4^+ - \text{N} \) at time \( t \); \( V \) is the volume of solution (0.05 L), \( M_N \) is the molar mass of N (14000 mg mol\(^{-1}\)) and \( F \) is the Faraday’s constant (96487 C mol\(^{-1}\)).
Figure S1 Photographs of the Cu foam electrode, Cu(OH)$_2$ nanobelt electrode and 3D Cu nanobelt electrode.
Figure S2 (a) SEM images of the surface of Cu(OH)$_2$ nanobelts. SEM images of the surface of 3D Cu nanobelts obtained at different temperature (b) 300 °C, (c) 400 °C and (d) 500 °C.
Figure S3 (a) XRD patterns of the Cu foam, Cu(OH)$_2$ nanobelt and 3D Cu nanobelt electrodes. (b) XPS spectra of the 3D Cu nanobelts.
Figure S4 (a) Effect of calcination temperature on NO$_3^-$-N removal efficiency. (3D Cu nanobelts cathode, 50 mL solution with 30 mg L$^{-1}$ NO$_3^-$-N, 0.5 h treatment). (b) The effect of applied potential on energy utilization efficiency.
Figure S5 (a) Effect of initial pH on nitrate reduction and (b) TN removal. (30 mg/L NO$_3^-$-N, -1.4 V vs Ag/AgCl, 0.07 M NaCl, 0.05 M Na$_2$SO$_4$).
**Figure S6** Effect of Cl⁻ adding time on (a) nitrate removal, (b) nitrite generation, (c) ammonia generation and (d) TN removal.
Figure S7 The H$_2$O$_2$ generated by Cu foam and 3D Cu nanobelts in the absence and presence of nitrate (30 mg/L NO$_3$-N, -1.4 V vs Ag/AgCl, 0.05 M Na$_2$SO$_4$).
**Figure S8** Effect of dissolved oxygen on nitrate removal

(a) regular condition, (b) Ar-saturated condition, (c) O₂-saturated condition and (d) the corresponding current-time curve.