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Publication date:
2016

Document Version
Publisher's PDF, also known as Version of record

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Citation (APA):
High Catalysis Activity of Cu$_2$O Microcrystals to the Electrochemiluminescence of Luminol and H$_2$O$_2$

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Cuprous oxide (Cu$_2$O) is a classical p-type semiconductor with a direct band gap of 2.17 eV, which is wildly used for solar energy conversion, CO oxidation, and photo catalytic water splitting for the low cost and environmental friendliness.\(^1\) For the energy band positions are favorable to the hydrogen evolution and oxygen evolution potentials, Cu$_2$O materials also catalyze the reduction of hydrogen peroxide (H$_2$O$_2$), which is an critical molecule in the bodies’ metabolism processes or the industrial catalysis reactions.\(^2\) To improve detection sensitivity of H$_2$O$_2$, people have composed Cu$_2$O materials with Ag nanoparticles or graphene nanosheets, which are sophisticated and cost.\(^3\) Herein, we use the electrochemiluminescence (ECL) method to improve the sensitivity of the reaction catalyzed by Cu$_2$O microcrystals. As shown by Figure 1A, the ECL reaction of H$_2$O$_2$ and luminol catalyzed by Cu$_2$O octahedra (Figure 1B) is strong at the potential of –0.2 V (vs. Ag/AgCl). And the corresponding current of the reaction is not obvious (Figure 1A, inset). We also check the effect of copper ions (Cu$^{2+}$) to the ECL reaction, and there is much lower catalytic activity to the ECL reaction by Cu$^{2+}$ ions. It indicates that Cu$_2$O semiconductor microcrystal possess the good catalytic performance to this ECL reaction, which is important to develop the high-efficient and low-cost biosensors.

**Figure 1.** (A) ECL-potential curves of (a) 100 μM luminol and 100 μM H$_2$O$_2$ solution on the Cu$_2$O modified glassy carbon electrode (GCE), (b) 100 μM luminol, 100 μM H$_2$O$_2$, and 100 μM Cu$^{2+}$ solution on GCE, and (c) 100 μM luminol and 100 μM H$_2$O$_2$ solution on GCE. Phosphate buffer, 50 mM, pH 7.4. Inset, corresponding cyclic voltammograms, scan rate: 50 mV·s$^{-1}$. (B) Scanning electronic microscopy image of octahedral Cu$_2$O microcrystals.

References