Electrocatalytic reduction of carbon dioxide on gold–copper bimetallic nanoparticles: Effects of surface composition on selectivity

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Abstract

In this work, the bimetallic nanoparticles (NPs) of Au and Cu are synthesized for the electrochemical reduction reaction of CO_2 (CO_2RR). It is known that the binding strength between the reduction intermediates and the electrocatalyst affects the selectivity of products, but how to correlate the performance with the surface composition, structure, and properties of a bimetallic electrocatalyst, instead of stoichiometric or bulk composition remains less discussed. AuCu and $AuCu_3$ NPs with the size around ~8 nm were prepared. By excluding the size effect, the work studies the effects of surface composition and heteroatomic interaction on the selectivity and faradaic efficiency of the reduction products. Based on X-ray absorption spectroscopy (XAS), one can quantify the alloying extent and surface compositions of electrocatalysts, which are supposed to have the pivotal effects on the reaction pathways and the corresponding reduction products. It is found that high activity and notably improved CO selectivity of Au-Cu bimetallic NPs can be attributed to the heterometallic coordination and their electronic interactions. The reduction products were analyzed by gas chromatography and nuclear magnetic resonance (NMR) spectroscopy. Nearly 60 mA cm^{-2} of current density was recorded at -0.91 V vs. RHE, and selectivity of 78±4.3% CO was obtained using AuCu.

Keywords – Bimetallic, Carbon dioxide, Nanoparticle, Selectivity, Synergistic effect.