

Nitrate Reduction Catalyzed by Surface Bimetallic Composite on Au(111)

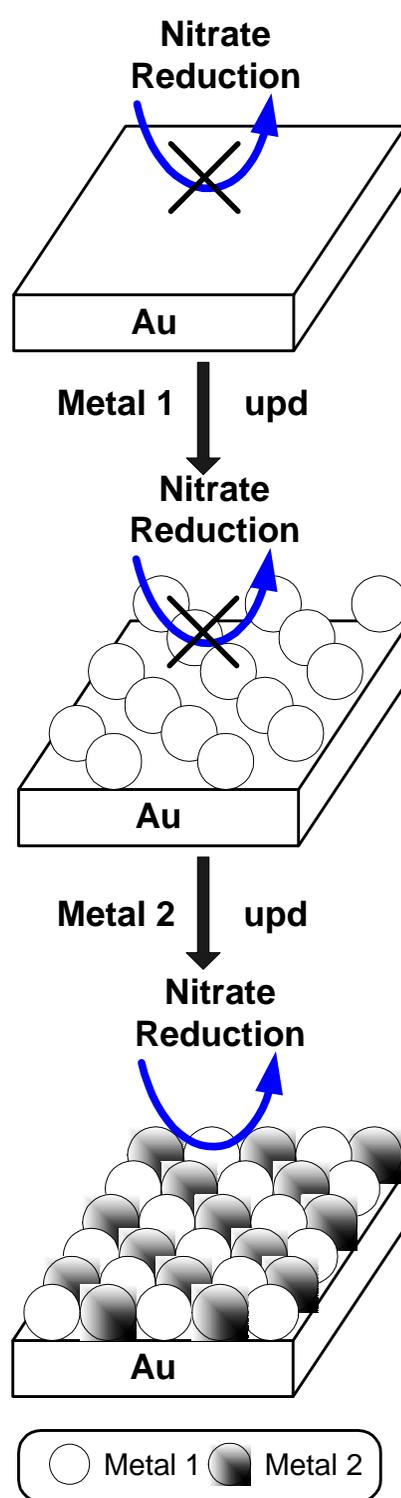
Seongpil Hwang, Joochan Lee, and Juhyoun Kwak

Department of Chemistry, Korea Advanced Institute of Science and Technology (KAIST)
373-1 Guseong-dong Yuseong-gu, Daejeon 305-701, Republic of Korea

Nanocomposite metallic and semiconducting surfaces have gained increasing importance as functional coatings due to their unique and unconventional mechanical, electromagnetic and catalytic properties. [1] In chemistry, the efficiency and selectivity of catalyst have been improved by bimetallic catalysts such as PtRu. Not only bulk alloy but also the influence of metallic coadsorbates on catalytic property of metal surface is an area receiving substantial attention as catalyst. Until now, bimetallic system in which only one adspecies is deposited on a substrate has been studied. But submonolayer to monolayer of more than one adspecies on a substrate surface can potentially modify the properties over the bulk alloys of two or more metals. However, more efficient catalyst materials by composite surface has not been reported yet.

Underpotential deposition (upd) of metal has been studied as catalyst, but only a limited number of the surface composition using upd have been reported. Recently, Laibinis et al. demonstrated composite monolayer of Ag and Cu on Au(111) by sequential underpotential deposition. [2] Ag (the more noble metal) was underpotentially deposited and the modified electrode was removed from the silver electrolyte and replaced with copper solution. Then, Cu (the less noble metal) was deposited underpotentially. They suggested that the less noble metal must not underpotentially deposit onto the more noble adlayer to prepare a laterally mixed single monolayer.

We present a study of one or two monolayer thick composite surface layer of various combination of two kinds of metal on Au(111) by sequential underpotential deposition. Upd process on modified Au(111) was characterized by cyclic voltammetry (CV), XPS and mass spectrum with and without nitrate. The composite surface catalyzes nitrate reduction which is important in the areas of detection and waste remediation and in the production of useful nitrate compounds. [3] This is the first example of more efficient catalyst by nanocomposite surface and shows new possible method to find a catalyst.



Scheme 1. Schematic diagram of composite layer on Au(111). Metal 1 is deposited underpotentially. After electrolyte is replaced with metal 2 solution, metal 2 is deposited. The composite layer system shows the catalytic effect for nitrate reduction.

Reference :

- [1] F. Besenbacher, I. Chorkendorff, B. D. Clausen, B. Hammer, A. M. Molenbroek, J. K. Nørskov, I. Stensgaard, *Science*, 279, 1913 (1998).
- [2] S. Takami, G. K. Jennings, P. E. Laibinis, *Langmuir*, 17, 441 (2001)
- [3] W.F. Plieth, *In Encyclopedia of Electrochemistry of the Elements*; Bard, A.J., Ed.; Marcel Dekker: New York, 1978; Vol. 8, p 321.