Formation of Bimetallic Au-Ag Nanoclusters via the Ethyl Glycol Method

Bing-Joe Hwang (黃炳照)[1], Feng-Ju Lai (賴鋒儒)[1], Ishii Hirofumi[2], Jeyaraman, Jeyakanthan[2], Jyh-Fu Lee (李志甫)[2], and Din-Goa Liu (劉定國)[2]

[1]Department of Chemical Engineering, National Taiwan University of Science and Technology, Taipei, Taiwan
[2]National Synchrotron Radiation Research Center, Hsinchu, Taiwan

The interest in gold nanoparticle science is growing owing its capability in catalyzing various oxygen transfer reactions and CO oxidation at ambient temperature. In general, Au catalytic activity is sensitive to the particle size. Recently, Iizuka et al. have found that addition of silver to the gold nanoparticle can enhance the CO oxidation. As the degree of activity enhancement is largely depends on the silver content, controlling the alloying extent is an important factor needs investigation. Hence, the formation mechanism of bimetallic Ag-Au nanocluster is important.

Figure 1 show the Au L_{III}-edge FT-EXAFS spectra during the formation of bimetallic Ag-Au nanoparticles. As can be seen, the bond length of Au-Cl at initial condition is 1.9 Å. However, when the pH is adjusted to 4.95 by adding the saturated NaOH, the magnitude of Au-Cl is decreased and Au-Au and Au-Ag bond is increased. Although, the Au-Ag bonding is not clear in the figure, the best fitting parameter show the presence of hetero-metallic bonding. When the reaction time is approached to 2 h, the Au-Cl is completely transferred to the Au-Au corresponding to a bond length of 2.5 Å. FT-EXAFS spectra at the Ag K-edge (Fig. 2), the peak of AgCl is clear in the spectra, as the precursor of $HAuCl_4$ and $AgNO_3$ is used. During the Au nanoparticle formation from $AuCl_4^-$ ions, the chloride is released to the solvent and may interact with the Ag ion to form silver chloride. Both AgCl and Ag-Au nanoparticles are stable in the solvent as can be seen the matching of Ag-Ag bond position on the Ag foil. From the best fitting parameters, the coordination number of the hetero-metallic interfaces is smaller when compared with the coordination of the homo-metallic interfaces.This understanding of formation mechanism of bimetallic nanocluster allows more easy control over alloying extent

.

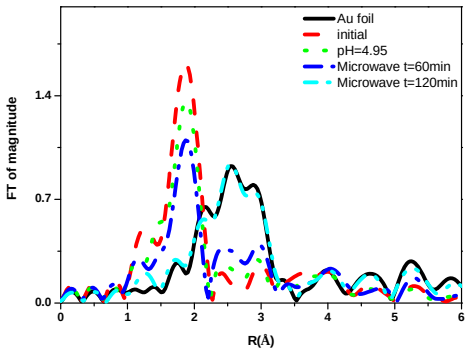

Figure 1. FT EXAFS spectra at the Au L_{III}-edge

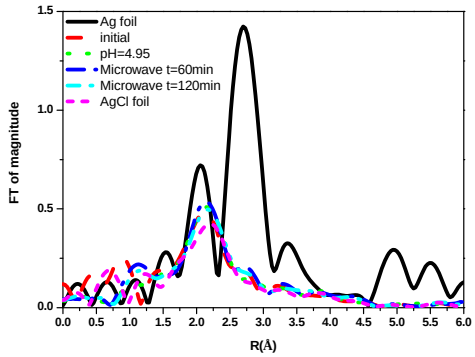

Figure 2. FT EXAFS spectra at the Ag K-edge