

CO Oxidation on Au-Ag Alloy Nano-Catalysts and the Kinetic Study under H₂-Rich Atmosphere

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We present a novel efficient catalyst, Au-Ag alloy nanoparticles supported on mesoporous aluminosilicate. The catalysts were applied to the low-temperature CO oxidation reaction. Au-Ag alloy catalysts showed high activity toward CO conversion under H₂-free atmosphere. In PROX reaction, these catalysts owned near 100% CO conversion at 80°C and, about 70% of selectivity at 40-80°C.

In order to confirm the Au-Ag alloy formation on the mesoporous support, we used the EXAFS technique to determine the atom type and number of atoms nearest to Au and Ag. The coordination number (CN) of Au-Au and Ag-Ag reflects the particle size and the degree of alloy formation.

From the Au L_{III}-edge EXAFS spectra ($\chi(k^3)$) of calcined and reduced samples with various Au/Ag ratios, we knew that Au and Ag form an alloy structure after H₂ reduced. Table 9 shows the Au L_{III}-edge EXAFS fitting results of H₂-reduced catalysts with varying Au/Ag ratios. The coordination number (CN) of Au-Au and Au-Ag reflects the particle size and the degree of alloy formation.³⁶ The bond distance for Au-Au and Au-Ag is almost the same, about 2.85 Å, and the ratios of coordination number for the catalysts are very close to the nominal Au/Ag ratios.

Kept Au/Ag ratio at 3/1 and changed the Si/Al ratio of the catalysts from 25 to 40. Both from the Au L_{III}-edge and Ag K-edge EXAFS $\chi(k^3)$ oscillation spectra could observed a extremely change at about 6 Å⁻¹ for H₂-reduced samples, which means the formation of gold and silver alloy. The fitting results of reduced catalysts were shown in Table 10, and their coordination numbers were similar with respected to the same metal ratio.

Table 1.

Au L_{III}-edge XAFS analysis of the AuAg@Al-SBA-15(TF) catalyst with different Au/ Ag ratios after reduction.

Sample	Bond	CN	R (Å)	σ^2	r-Factor
r5-30-560	Au-Au	7.7±0.5	2.85±0.04	0.008±0.0003	0.0025
	Au-Ag	1.5±0.4	2.85±0.03	0.009±0.0017	
r3-30-560	Au-Au	7.5±0.7	2.84±0.05	0.009±0.0012	0.0020
	Au-Ag	2.1±0.4	2.85±0.03	0.010±0.0017	
r1-30-560	Au-Au	5.2±0.7	2.85±0.04	0.007±0.0014	0.0028
	Au-Ag	4.2±0.5	2.85±0.03	0.010±0.0011	

Table 2.

Au L_{III}-edge XAFS analysis of the AuAg@Al-SBA-15(TF) catalyst with different Si/ Al ratios after reduction.

Sample	Bond	CN	R (Å)	σ^2	r-Factor
r3-40-560	Au-Au	6.6±0.8	2.85±0.03	0.008±0.0009	0.0084
	Au-Ag	2.5±0.6	2.87±0.01	0.009±0.0018	
r3-35-560	Au-Au	7.2±1.0	2.85±0.03	0.008±0.0014	0.0013
	Au-Ag	2.1±0.4	2.85±0.03	0.009±0.0016	
r3-30-560	Au-Au	7.5±0.7	2.84±0.05	0.009±0.0012	0.0020
	Au-Ag	2.1±0.4	2.85±0.03	0.010±0.0017	
r3-25-560	Au-Au	7.8±1.4	2.86±0.02	0.011±0.0022	0.0012
	Au-Ag	2.5±0.5	2.86±0.02	0.008±0.0013	