Effect of titania surface modification of mesoporous silica SBA-15 supported Au catalysts: Activity and stability in the CO oxidation reaction

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Abstract
As part of an ongoing effort to understand the deactivation and possibly improve the stability of metal oxide-supported Au catalysts in the low-temperature CO oxidation reaction, we have investigated the activity and stability of a set of Au catalysts consisting of Au nanoparticles supported on titania surface-modified mesoporous silica SBA-15. The extent of the surface modification was systematically increased, while the Au loading and the Au particle sizes were largely kept constant. Employing kinetic measurements at three different temperatures (30°C, 80°C, 180°C) and a number of ex situ methods for catalyst characterization as well as in situ diffuse reflectance infrared Fourier transform spectroscopy (DRIFTS), we found that the activity of these catalysts increases significantly with the Ti concentration, most pronounced at 180°C, and with temperature. The tendency for deactivation remains essentially unchanged. Detailed in situ DRIFTS measurements reveal that the Au nanoparticles are largely formed on the TiOₓ surface-modified areas of the SBA-15 support. At lower temperatures (30°C, 80°C) the deactivation is due to accumulation of molecularly adsorbed H₂O, which is formed from surface hydroxyl groups affecting the reaction either by blocking of active sites or blocking the access of reactants to these sites. For reaction at 180°C, where accumulation of adsorbed species is negligible, the observed deactivation must be due to other effects such as changes in the titania layer. The mechanistic ideas are supported by reactivation tests subsequent to calcination at 400°C, which cause the adsorbed water to desorb and fully restore the initial activity.

Keywords: Gold catalysis, CO oxidation, activity, deactivation, surface modification, Au nanoparticles

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