Gold nanoparticles (<5 nm) supported on oxide are active in CO oxidation at room temperature; however, the catalyst deactivates due to nanoparticle sintering and/or formation of carbonates. A way to overcome deactivation is to prepare bimetallic catalysts. Bimetallic combinations such as Au-Ag are known to exhibit significantly improved stability and improved activity in CO oxidation.

The goal of this work was to prepare Au-Ag catalysts supported on TiO$_2$ by a method different from commonly used impregnation or colloidal methods, to characterize them and test them in CO oxidation [1]. Ag was first deposited by deposition-precipitation with NaOH followed by Au deposited by deposition-precipitation with urea. The samples were prepared with 4 wt.% gold and different Au:Ag atomic ratios from 1:0.15 to 1:1. Monometallic Au and Ag catalysts were also prepared. Their catalytic activity were tested in CO oxidation reaction (1% vol. CO and 1% vol. O$_2$ in N$_2$, light-off experiment with a heating rate of 2 °C/min) after in-situ activation in H$_2$; stability tests were performed under the same conditions at 20 °C during 24 h.

Au/TiO$_2$ catalyst is already active at -5°C while Ag/TiO$_2$ is inactive at T < 60 °C. Bimetallic Au-Ag catalysts show higher conversion than Au/TiO$_2$ (Fig. 1a), which is a clear evidence of a synergic effect between gold and silver. Conversion increases as activation temperature increases, and reaches a maximum for the activation temperature of 550 °C (Fig. 1b). The Au-Ag/TiO$_2$ catalysts present a much better temporal stability at 20 °C than monometallic gold catalysts.

XANES and H$_2$-TPR results showed that gold in Au-Ag/TiO$_2$ was more easily reduced than in Au/TiO$_2$, indicating interaction between Au and Ag. The bimetallic character of the metal particles was confirmed by EDS analysis of a series of individual particles. EDS also showed that particle composition becomes more homogeneous as activation temperature increases. At the optimal temperature of activation of 550 °C (Fig. 1b), 90% of the particles contain both metals and the average size is 3.9 nm. So, small bimetallic Au-Ag particles can be obtained by this new method.

Comparison of the catalytic results with other works of the literature on Au-Ag on silica and alumina confirms the better stability of Au-Ag and the synergetic effect between gold and silver, and reveal no support effect, in contrast with monometallic gold catalysts.

References