Gold nano-particles stabilized in mesoporous MCM-48 as active CO-oxidation catalyst

M. Bandyopadhyay a, O. Korsak a, M.W.E. van den Berg b, W. Grünert b, A. Birkner c, W. Li d, F. Schüth d, H. Gies a,*

a Institut für Geologie, Mineralogie und Geophysik, Lehrstuhl Kristallographie, Fakultät für Chemie, Ruhr-Universität Bochum, Universitätsstr., D-44780 Bochum, Germany
b Lehrstuhl für Technische Chemie, Ruhr-Universität Bochum, Universitätstr., D-44780 Bochum, Germany
c Lehrstuhl für Physikalische Chemie 1, Ruhr-Universität Bochum, Universitätstr., D-44780 Bochum, Germany
d MPI für Kohlenforschung, Kaiser-Wilhelmplatz 1, D-45470 Mülheim, Germany

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Abstract

Gold in nano-crystal size is known as highly active CO-oxidation catalyst. Using simple deposition techniques gold has been deposited as ~3 nm particles inside the channels of mesoporous silica–TiO2–MCM-48. In the presence of gold nano-particles the catalyst converts CO to CO2 at 50% level at ~20 °C. The composite is stable against sintering up to at least 200 °C. XANES and EXAFS confirm the coexistence of elementary and ionic gold during the catalytic activity.

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1. Introduction

Gold is thought to be the noblest of all metals [1]. Ground breaking work by Haruta et al. [2–4], showed that gold as catalyst exhibits considerable activity when it is highly dispersed on metal oxides supports [5–7]. Two different classes of oxides could be used for the support [8]. Active supports, such as TiO2 and Fe2O3, which can be easily reduced, or inert supports, like Mg(OH)2, Al2O3, and silica. These supports can also give active catalysts, typically when some reducible elements are also introduced [9], although in some cases even for Au on the unmodified support material, low-temperature CO-oxidation activity has been reported. For all catalytic applications it is important that the small gold particles are highly dispersed on the oxide support [7]. Au/oxides catalysts have been widely applied to many important chemical reactions such as CO oxidation [2], hydrogenation of unsaturated hydrocarbons [10], reduction of NOx [11], epoxidation of C3H6 [12], selective CO oxidation in a hydrogen-rich steam [13], combustion of methane [14], etc. Recently, Hua et al. [15] have used Au/iron oxide catalysts for the water gas shift reaction.

The catalytic performances of different systems with gold on oxide supports is strongly influenced by the preparation method, the specific synthesis parameters such as light protection, the Au particle size, and more [5,9,16]. The deposition–precipitation (DP) process is considered to be the best method to synthesize highly active gold catalysts [17] because of the good control of the particle size by adjustment of pH during particle formation. In addition, some other methods like chemical vapor deposition [18] (CVD) or co-sputtering [19] are widely used for catalyst formation. An extensive study on Au/Al2O3 catalyst prepared by both DP and CVD methods reveals that finely dispersed Au/Al2O3 with Au particle size <5 nm can be

* Corresponding author.
E-mail address: hermann.gies@rub.de (H. Gies).

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