OUTLINE

• Backgrounds and History
• Preparation Methods
• Origins of Activities
  • Active Sites
  • Effects of Supporting Materials
• Deactivation Phenomenon

Haruta, M. Gold Bulletin 2004 • 37/1–2 27-36
Gold Catalysts Prepared by Coprecipitation for Low-Temperature Oxidation of Hydrogen and of Carbon Monoxide

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Novel gold catalysts were prepared by coprecipitation from an aqueous solution of HAuCl₄ and the nitrates of various transition metals. Calcination of the coprecipitates in air at 400°C produced ultrafine gold particles smaller than 10 nm which were uniformly dispersed on the transition metal oxides. Among them, Au/α-Fe₂O₃, Au/CoO, and Au/NiO were highly active for H₂ and CO oxidation, showing markedly enhanced catalytic activities due to the combined effect of gold and the transition metal oxides. For the oxidation of CO they were active even at a temperature as low as −70°C.

Graham J. Hutchings Gold Bulletin 2004 • 37/1–2 3-11

Figure 8
Publications on gold catalysis, red academic publications, blue patents
PREPARATION

Haruta, M. CATTECH (2002), 6(3), 102-115
• Particle Size

The Thickness

ORIGINS-Supporting Materials

- **Anchoring Sites for Gold Particles**
- **Effecting the Dispersion and Shape**
- **Oxygen Vacancies**

Figure 7. STM images (200 nm x 200 nm) of gold particles supported on a SiO₂ thin film annealed at (A) 1200 K (less defective) and (B) 1100 K (more defective). In the film A, gold particles nucleate and grow preferentially at step edges and line defects, while more random distributions of gold particles on terrace regions were observed in the film (B). Reprinted with permission from refs 52 and 53. Copyright 2004 American Chemical Society.

Min, B. K.; Wallace, W. T.; Goodman, D. W.
(53) Min, B. K.; Wallace, W. T.; Santra, A. K.; Goodman, D. W.
**ORIGINS-Supporting Materials**

- **Anchoring Sites for Gold Particles**
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- **Oxygen Vacancies**

Figure 6. Densities of vacancies and Au clusters before and after deposition of ~0.04 ML Au at different temperatures. 1 ML = 1 vacancy or cluster/TiO$_2$ (110) unit cell = 5.13 $\times$ 10$^{14}$ cm$^{-2}$. The data were obtained from corresponding high-resolution STM images. Reprinted with permission from ref 50 (http://link.aps.org/abstract/PRL/v90/p026101). Copyright 2003 by the American Physical Society.

DEACTIVATION

2.6nm(Diameter)/0.7nm(Height)

10 torr CO:O$_2$ for 120 min at 300 K

3.6nm(Diameter)/1.4nm(Height)

X.F. Lai and D.W. Goodman,

Figure 4. Topographic STM images of 0.25 ML Au clusters on a TiO$_2$(110) surface (a) before and (b) after 10 torr CO/O$_2$ exposure for 120 min at room temperature [33].
DEACTIVATION

(i) migration of surface clusters and coalescence subsequent to their collision

(ii) Ostwald ripening

A. Kolmakov and D.W. Goodman, B.
Thank you for your attention!