Supporting Information for:

From CO oxidation to CO₂ activation: An unexpected catalytic activity of polymer supported nano-gold

Feng Shi, Qinghua Zhang, Yubo Ma, Yude He and Youquan Deng*

Experimental procedure:

Preparation of Au/poly: polymer immobilized Au catalysts, Au/poly, was prepared as follows: 2g of dried polymers (*ca.* ϕ 0.5 mm, Amberlite IRA-400 (poly1), Shandong Dongda Chemical Industry Company, Zibo, 255200, China) was pretreated with 2M NaOH solution for 6 hours, and then filtrated and washed by distilled waster for 3 times (10ml $\times$ 3). After drying at 80 $^{\circ}$ C for 3 hours, the ionexchanger was dipped in 0.001~0.006M solution of H₂AuCl₄·4H₂O and dried at 150 $^{\circ}$ C for 6 hours, and polymer supported nano-gold catalysts named 0.01wt% Au/Poly1, 0.05wt% Au/Poly1, 0.1wt% Au/Poly1 and 0.5wt% Au/Poly1 were obtained. The gold contents were 0.01wt%, 0.05wt%, 0.1wt% and 0.5wt% respectively. Using Amberlite IR-120 (poly 2) to instead of poly1, another catalyst named 0.05wt% Au/Poly2 was prepared. It was worth to note that the procedure for preparation of the catalysts had great effect on the catalytic activity and some unclear factors usually affected the catalytic activity severely.

Reaction procedure

Synthesis of cyclic carbonate: 0.2 g Au/Resin catalyst, 4ml or 4g epoxy and 30atm CO₂ were successively introduced into a 90ml autoclave with a glass tube inside and then the autoclave was sealed and reacted at 150 $^{\circ}$ C for 5~15 hours. After the reaction, the autoclave was cooled to room temperature for analysis.

Synthesis of disubstituted ureas: 0.2 g Au/Resin catalyst, 4ml amines, 1ml water and 50atm CO₂ were successively introduced into a 90ml autoclave with a glass tube inside and then the autoclave was sealed and reacted at 180 $^{\circ}$ C for 20 hours. After the reaction, the autoclave was cooled to room temperature and 20ml water was added to dissolve the carbamate and the isolated yield could be obtained after filtration and drying.

Quantitative analysis was conducted with an Agilent 6820 GC (FID detector) using an out-standard method. Qualitative analyses were conducted with a HP 6890/5973 GC-MS with a 30m $\times$ 0.25mm $\times$ 0.33 μ m capillary column with chemstation containing a NIST Mass Spectral Database.

Characterization of the catalyst:

Gold loading analysis. The gold loading of Au/Resin catalyst were analyzed by a 3520 ICP atomic emission spectrometer.

TEM. Transmission Electron Microscopic investigations (TEM) were carried out using a JEOL JEM-1200EX Electron Microscope. The resin immobilized gold catalysts were suspended in ethanol and stirred for 12 hours before being deposited on the carbon support.

XRD. X-ray diffraction of the immobilized gold particles was performed on a Philips D/max-RB powder X-ray Diffractometer. Diffraction patterns were recorded with Cu K α radiation (40mA, 40kV) over a 2 θ -range of 15 $^{\circ}$ to 80 $^{\circ}$.

Complete Ref. 2b. Boyen, H.-G.; Kästle, G.; Weigl, F.; Koslowski, B.; Dietrich, G.; Ziemann, P.; Spatz, J. P.; Rietmüller, S.; Hartmann, T.; Nöller, M.; Smid, G.; Garnier M.; Oelhafen, P. *Science*, **2002**, 297, 1533.

Table S1. The basic properties of polymer immobilized nano-gold catalysts^a

Catalyst	Au (wt%, bulk)	Au (wt%, surface)	Au4f _{7/2} (ev)	Terminal group of polymers	Properties of polymers
0.01wt% Au/Poly1	0.01	1.7	84.2	quaternary ammonium	strong base
0.05wt% Au/Poly1	0.05	6.5	84.3	quaternary ammonium	strong base
0.1wt% Au/Poly1	0.1	8.7	84.1	quaternary ammonium	strong base
0.5wt% Au/Poly1	0.5	4.3/4.8	83.6/86.7	quaternary ammonium	strong base
0.05wt% Au/Poly1 ^b	0.03	3.4	84.3	quaternary ammonium	strong base
0.05wt% Au/Poly2	0.05	6.7	84.1	sulfonic acid	strong acid

a: poly1=Amberlite IRA-400, poly2 =Amberlite IR-120; b: catalyst 0.05wt% Au/Poly1 was reused for 5 times.

Figure S1. XPS spectra of (a) 0.05% wtAu/Poly1, (b) 0.05% wtAu/Poly1 reused 3 times and (c) 0.05% wt Au/Poly1 reused 5 times

Figure S2. XPS spectra of (a) 0.5%wtAu/Poly1, (b) 0.5% w Au/Poly1 used 3 times and (c) 0.5% w Au/Poly1 used 5 times

Figure S3 TEM image of 0.01Au%Au/Poly1

Figure S4 TEM image of 0.1Au%Au/Poly1

Figure S5 TEM image of 0.1Au%Au/Poly1

Figure S6. XRD patterns of catalysts 0.01wt%Au/Poly1, 0.05wt%Au/Poly1, 0.1wt%Au/Poly1 and 0.5wt%Au/Poly1