

# **Non-mercury catalytic acetylene hydrochlorination over bimetallic Au-Co(III)/SAC catalysts for vinyl chloride monomer production**

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## **Supplementary Information**

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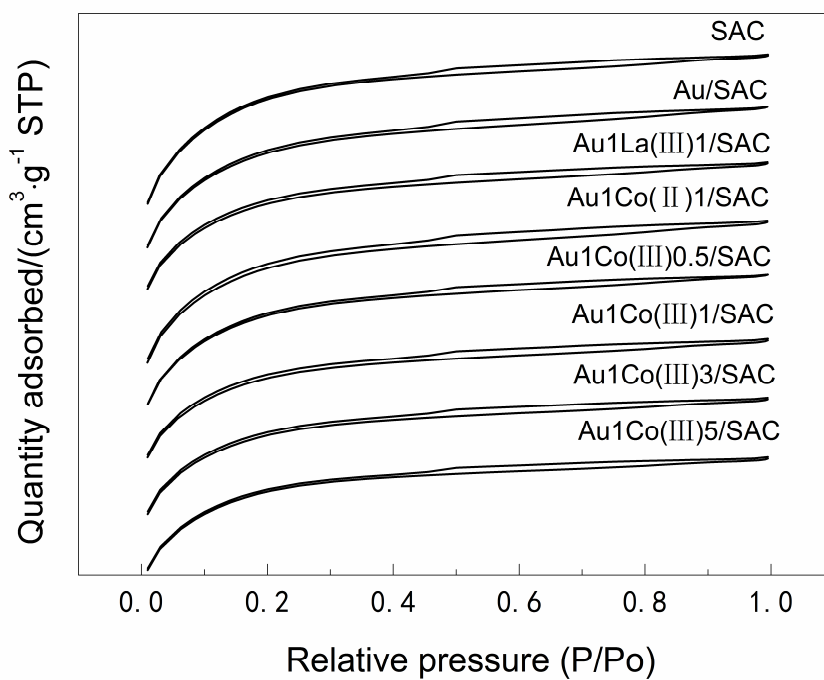
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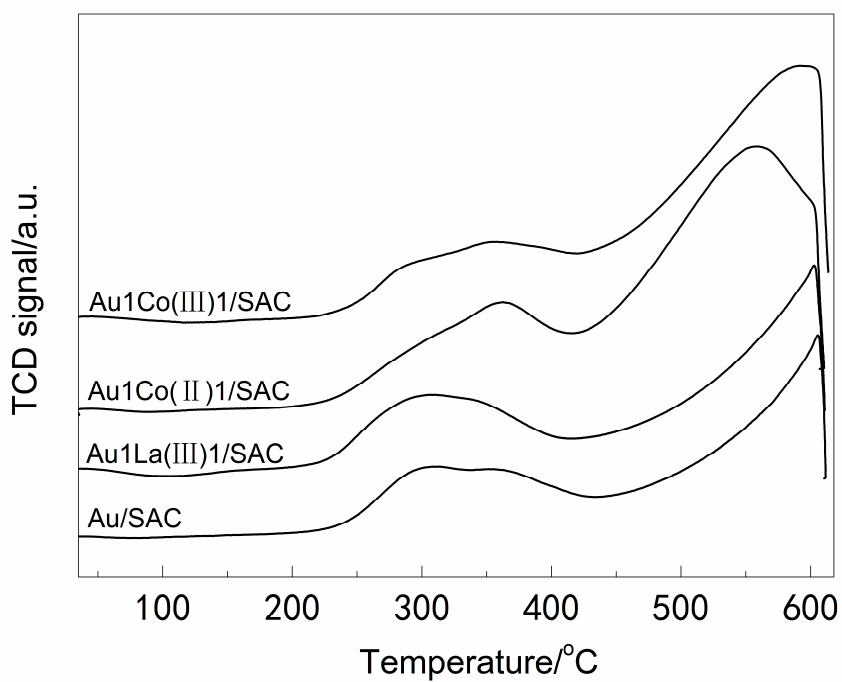
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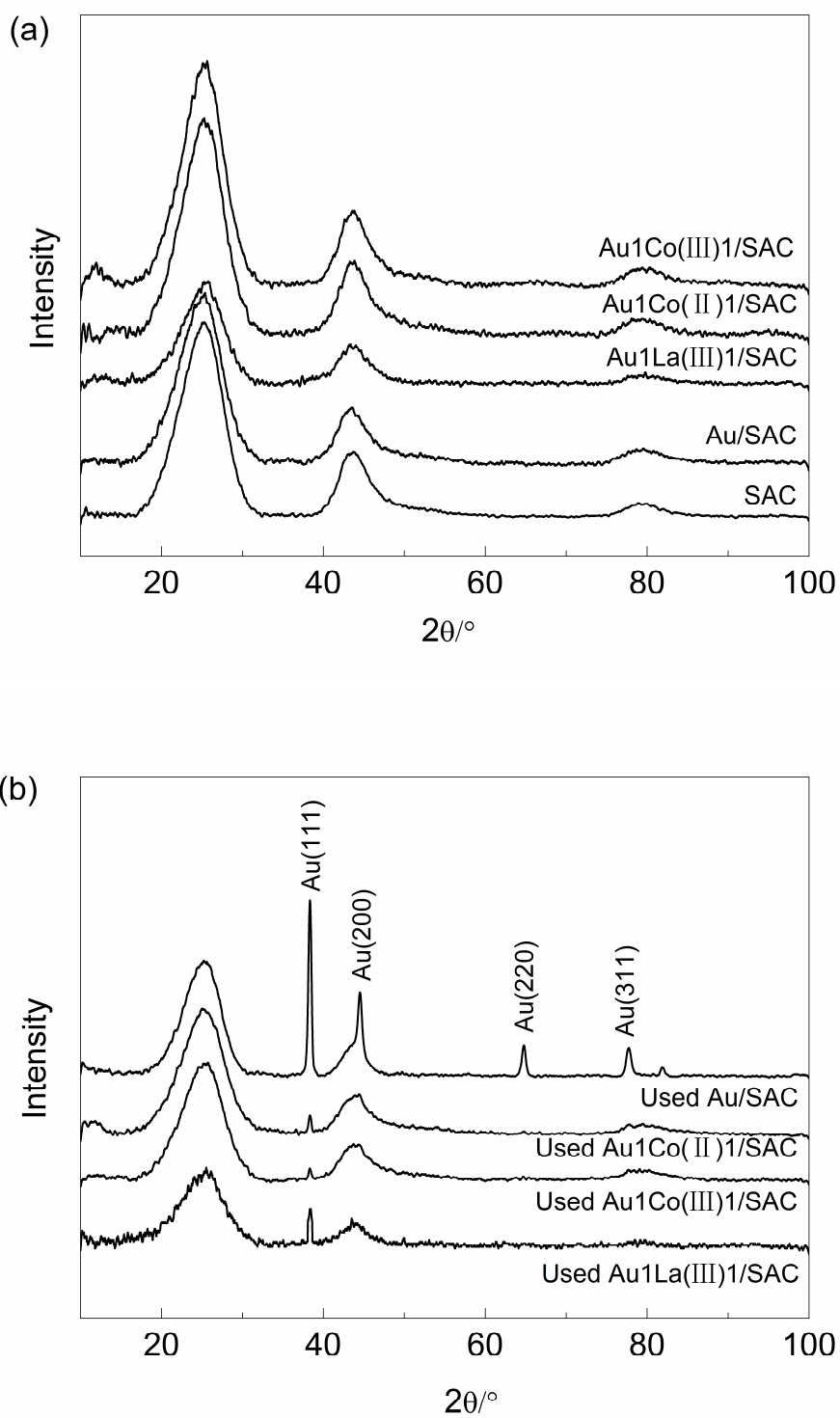
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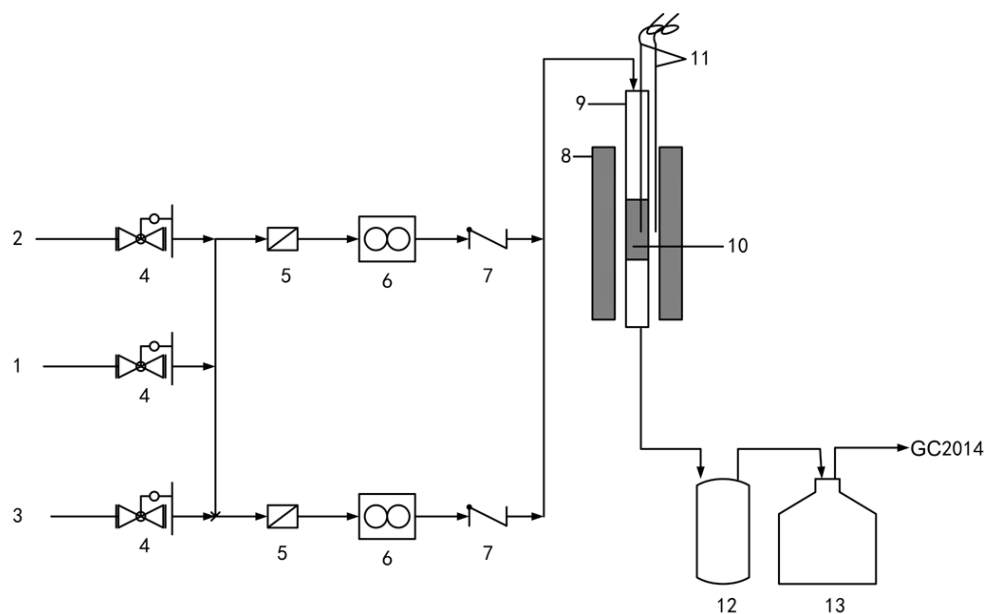
**Fig. S1** Isothermal adsorption-desorption curves of fresh samples.



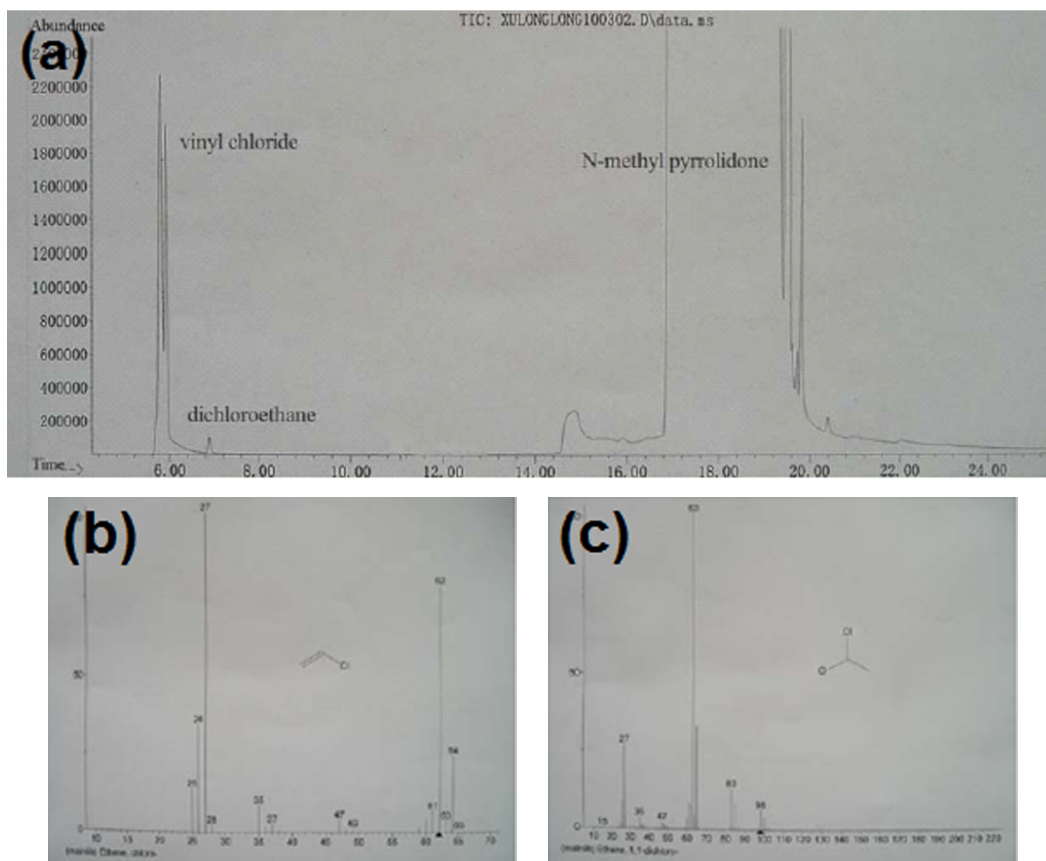
**Fig. S2** H<sub>2</sub>-TPR profiles of the fresh monometallic and bimetallic Au-based catalysts.



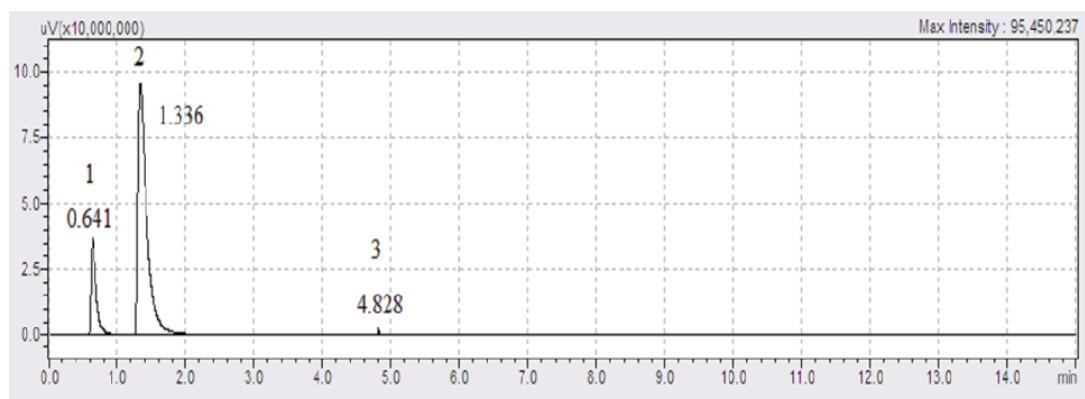
**Fig. S3** XRD patterns of carrier SAC, the fresh (a) and used (b) Au and bimetallic Au-based catalysts.



**Fig. S4** Catalyst experimental setup. 1. Nitrogen, 2. Hydrogen chloride, 3. Acetylene, 4. Pressure relief valve, 5. Filter, 6. Mass flowmeter, 7. One-way check valve, 8. Furnace, 9. Reactor, 10. Catalyst, 11. Thermocouple, 12. Buffer tank, 13. Absorption bottle.



**Fig. S5** GC-MS spectrum of the products. Analysis conditions are as follows: Agilent 7890A/5975C GC-MS; capillary column HP-5: 60 m × 0.25 mm × 0.25 μm; inlet temperature, 250 °C; split ratio, 50:1; ion source, EI source; ion source temperature, 230 °C; quadrupole temperature, 150 °C; electron energy, 70 eV; interface temperature, 280 °C.



1: C<sub>2</sub>H<sub>2</sub>    2: C<sub>2</sub>H<sub>3</sub>Cl    3: C<sub>2</sub>H<sub>4</sub>Cl<sub>2</sub>

**Fig. S6** Gas chromatogram spectrum of the products. Analysis conditions were as follows:  
chromatographic column type, 2 m × Φ 4 mm; packed column, GDX-301; column temperature,  
120 °C; detector type, flame ionization detector (FID); detector and vaporizer temperature, 150 °C;  
and injection volume, 60 μL.

**Table S1** Wight loss of fresh and used Au/SAC catalysts under different temperature ranges

Temperature/°C	<150	150-275	275-448	150-448
Wight loss of fresh sample, (%)	1.2	1.6	4.6	6.2
Wight loss of used sample, (%)	0.6	1.8	11.5	13.3

**Table S2** Wight loss of fresh and used Au1Co(III)3/SAC catalysts under different temperature ranges

Temperature/°C	<150	150-229	229-422	150-422
Wight loss of fresh sample, (%)	7.3	1.1	6.8	7.9
Wight loss of used sample, (%)	3.6	1.9	7.0	8.9

**Table S3** The Au species amount of the total Au loading determined by TPR

Catalyst	Au species (%)		Reduction Temperature center/°C	
	Au <sup>3+</sup>	Au <sup>+</sup>	Au <sup>3+</sup>	Au <sup>+</sup>
Au/SAC	18.4	15.8	310	354
Au1La(III)1/SAC	18.7	15.2	298	334
Au1Co(II)1/SAC	18.2	16.7	305	363
Au1Co(III)0.5/SAC	26.4	17.8	291	342
Au1Co(III)1/SAC	19.6	23.8	287	360
Au1Co(III)3/SAC	20.3	27.9	282	372
Au1Co(III)5/SAC	9.6	32.5	247	390



**Table S4** Size of Au particles in Au-based catalysts, determined by XRD<sup>a</sup>

Catalyst	Au particles Size/nm	
	Fresh	Used
Au/SAC	<4 <sup>b</sup>	20 ± 3
Au1La(III)1/SAC	<4 <sup>b</sup>	23 ± 3
Au1Co(II)1/SAC	<4 <sup>b</sup>	22 ± 3
Au1Co(III)0.5/SAC	<4 <sup>b</sup>	18 ± 3
Au1Co(III)1/SAC	<4 <sup>b</sup>	20 ± 3
Au1Co(III)3/SAC	<4 <sup>b</sup>	14 ± 3
Au1Co(III)5/SAC	<4 <sup>b</sup>	21 ± 3

<sup>a</sup> Error estimated from XRD peak broadening of 0.06° at the Au (111) reflection at 38.36° (2θ).

<sup>b</sup> It was not possible to assign any error band below 4 nm, as this size is below the XRD method.

**Table S5** Relative content of Au species in the catalysts before and after reaction, determined by XPS

Catalyst	Au species (%)				Binding energies/eV			
	Au <sup>3+</sup>	Au <sup>+</sup>	Au <sup>0</sup>	Au <sup>0-s</sup>	Au <sup>3+</sup>	Au <sup>+</sup>	Au <sup>0</sup>	Au <sup>0-s</sup>
Fresh Au/SAC	12.6	0	87.4	0	86.4	-	84.1	-
Used Au/SAC	0	0	95.6	4.4	-	-	84.0	85.5
Fresh Au1Co(III)3/SAC	16.6	18.4	65.0	0	86.4	85.0	84.0	-
Used Au1Co(III)3/SAC	12.5	27.3	60.2	0	86.9	84.8	83.7	-

**Table S6** The loss ratio of Au in those catalysts

Catalyst	Au loading, wt%		Loss ratio of Au (%)
	Fresh	used	
Au/SAC	0.9120	0.9030	0.99
Au1La(III)1/SAC	0.9152	0.9062	0.98
Au1Co(II)1/SAC	0.9088	0.9003	0.94
Au1Co(III)0.5/SAC	0.9093	0.9004	0.98
Au1Co(III)1/SAC	0.9091	0.9006	0.93
Au1Co(III)3/SAC	0.9119	0.9038	0.89
Au1Co(III)5/SAC	0.9054	0.8971	0.92