Supplementary material

Gold-based catalysts for complete formaldehyde oxidation: insights into the role of support composition

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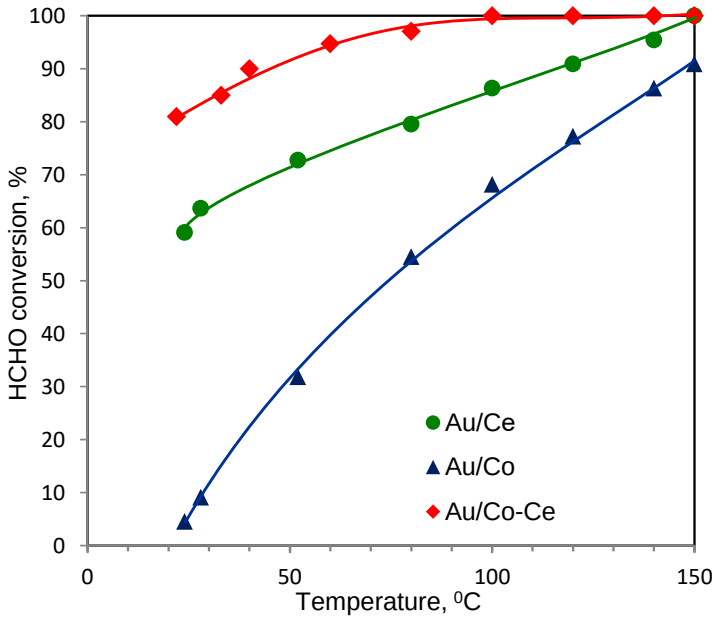

Figure S1. Comparison of HCHO conversion over Au/Ce, Au/Co, and Au/Co-Ce samples.

Table S1. HCHO conversion over the most active sample developed in this study compared with HCHO conversion over Co_3O_4-CeO_2-supported Au-based catalysts reported in the literature.

Catalyst	Au[1] amount (wt.%)	Preparation method[2]	WHSV (mL h^{-1} g^{-1})	$[HCHO]_{inlet}$ concentration	T (°C)	HCHO conversion (%)	Ref.[3]
Au/35%Co_3O_4-5%CeO_2/50%Al_2O_3-b	3	mechanochemical mixing	20,000	120 ppm	25 40	95 100	This study
Au/2DCo_3O_4-CeO_2 (Co/Ce=7:3)	1	nanocasting using 2D SBA-15 as hard template	24,000	200 ppm	25	50	[5]
Au/3DCeO_2-Co_3O_4 (Co/Ce=1:2.5)	1	precursor thermal decomposition-assisted colloidal crystal templating method	15,000	8 ppm	25 100	<10 100	[25]
Au/3DCeO_2-Co_3O_4 (Co/Ce=1:2.5)	2	precursor thermal decomposition-assisted colloidal crystal templating method	15,000	8 ppm	25 70	35 100	[25]
Au/3DCeO_2-Co_3O_4 (Co/Ce=1:2.5)	3	precursor thermal decomposition-assisted colloidal crystal templating method	15,000	8 ppm	25 39	61 100	[25]
Au/3DCeO_2-Co_3O_4 (Co/Ce=1:2.5)	4	precursor thermal decomposition-assisted colloidal crystal templating method	15,000	8 ppm	25 60	50 100	[25]
Au-Ce_3Co/GA (Co/Ce=1:3) GA - graphene aerogel	1	one-step method using SBA-15-OH as a hard template, mixing with GO	20,000	50 ppm	30 135	15 100	[27]
Au-Ce_3Co/GA (Co/Ce=1:3)	2	one-step method using SBA-15-OH as a hard template, mixing with GO	20,000	50 ppm	30 105	30 100	[27]
Au-Ce_3Co/GA (Co/Ce=1:3)	3	one-step method using SBA-15-OH as a hard template, mixing with GO	20,000	50 ppm	30 60	55 100	[27]
Au-Ce_3Co/GA (Co/Ce=1:3)	4	one-step method using SBA-15-OH as a hard template, mixing with GO	20,000	50 ppm	30 75	50 100	[27]
Au/$CeCo_9$ (Co mol.%=9)	1.5	hydrothermal method	30,000	100 ppmv	30 100	80 100	[28]
Au/$CeCo_9$ (Co mol.%=9)	3	hydrothermal method	30,000	100 ppmv	30 100	>90 100	[28]

[1] Gold content presented as nominal wt.%

[2] Method of preparation of Co_3O_4-CeO_2

[3] Reference numbers refer to citations in the paper.

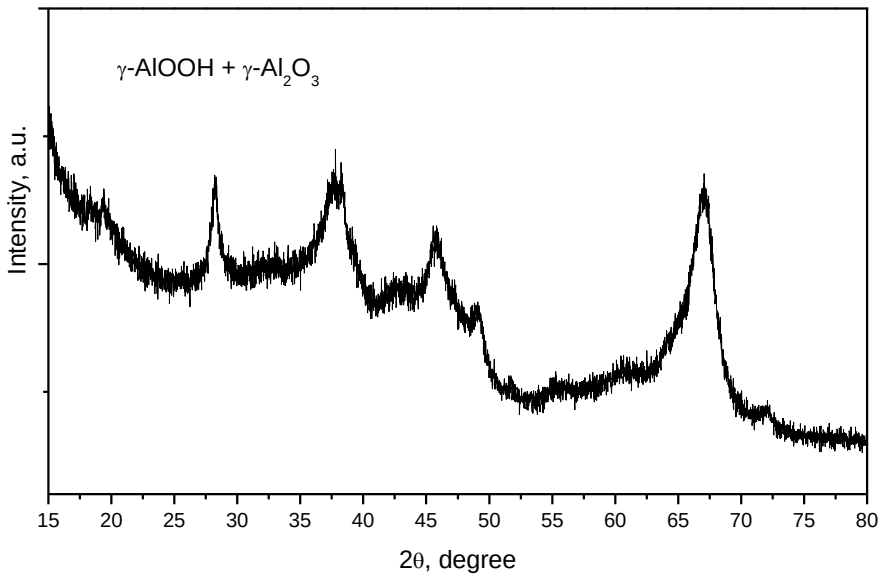

Figure S2. XRD pattern of γ-Al_2O_3 used for preparation of Co_3O_4-CeO_2/Al_2O_3 support.

XRD analysis showed a mixed phase of γ-Al_2O_3 (ICSD-PDF 01-079-1558) and boehmite γ-AlOOH (ICSD-PDF 01-073-6509). For correct determination of γ-AlOOH amount a combined DTA/TG analysis was performed. The amount of absorbed water and associated OH groups in the structure of boehmite was evaluated. The first step, ambient temperature to endothermic peak at 122 °C, was due to dehydration of γ-AlOOH and finished at about 260 °C. The next endothermic effect was observed at about 270 °C. It was ascribed to decomposition of by-products of the synthesis reaction [B. Sathyaseelan, I. Baskaran, K. Sivakumar, Phase Transition Behavior of Nanocrystalline Al_2O_3 Powders, Soft Nanoscience Letters, 2013, 3, 69-74]. Total weight loss at about 400 °C was nearly 13 %. The final step above 400–450 °C ended after 925 °C. It was related to the formation of γ-Al_2O_3 with a weight loss of about 5 %. According to Földvári calculated amount of γ-AlOOH was 33.33 % [M. Földvári, Handbook of thermogravimetric system of minerals and its use in geological practice, Budapest, vol. 213, 2011, Published by the Geological Institute of Hungary].

$2AlOOH \rightarrow Al_2O_3 + H_2O$

119.98 $\rightarrow$ 101.96 + 18 f = 119.98 /18 = 6.65 (stoichiometric factor)

6.65 x 5 (%) = 33.33 %

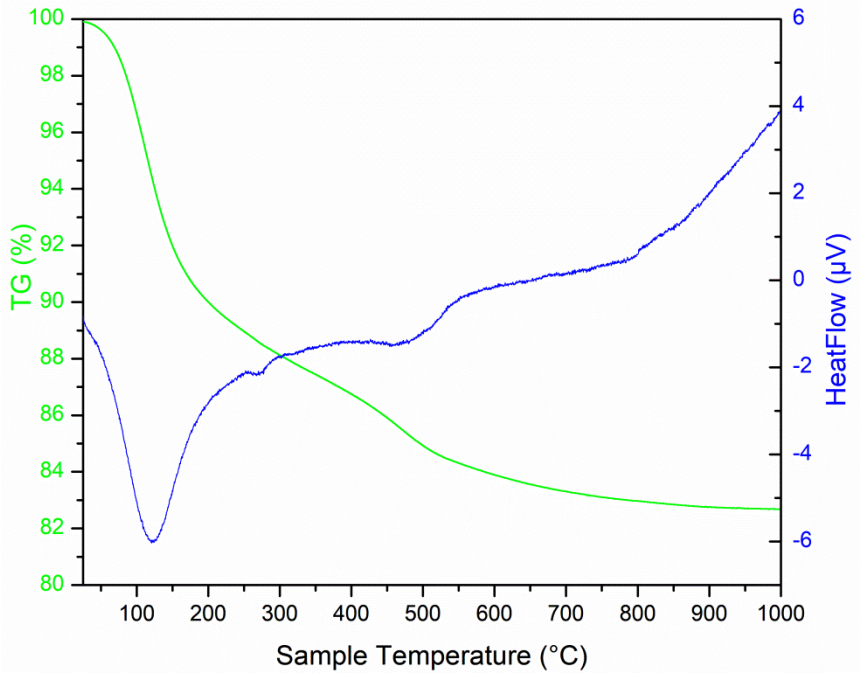

Figure S3. DTA/TG analysis of γ-Al_2O_3.