

SUPPLEMENTARY DATA

Bulk Co₃O₄ for Methane Oxidation: Effect of the Synthesis Route on Physico-Chemical Properties and Catalytic Performance

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Table S1. Criteria for accurate analysis of intrinsic reaction rates of the foam catalysts (as estimated for the CC catalyst at 375 °C).

Figure S1. N₂ physisorption isotherms of the bulk Co₃O₄ catalysts.

Figure S2. XRD patterns of the bulk Co₃O₄ catalysts.

Figure S3. Raman spectra of the bulk Co₃O₄ catalysts.

Figure S4. CH₄-TPRe profiles of the bulk Co₃O₄ catalysts.

Figure S5. Close-up view of the CH₄-TPRe profiles in the 300-500 °C range of the CC catalyst before and after the stability test.

Table S1: Criteria for accurate analysis of intrinsic reaction rates of the foam catalysts (as estimated for the CC catalyst at 375 °C)

Criteria	Recommendation	At 375 °C	Least favourable conditions
Minimum bed length	Bodenstein parameter < $L_{bed}/d_{particle}$	4.5 < 79.5	55.6 < 79.5 ^b
Minimum reactor diameter	$d_{tube}/d_{particle} > 10$	31.2 ^a	31.2 ^a
Extraparticle mass transfer	Carberry number < 0.05/n	0.0042	0.046 ^b
Extraparticle heat transfer	$\gamma\beta_e Ca < 0.05$	0.0017	0.028 ^c
Intraparticle mass transport	Wheeler-Weisz modulus < 0.15	$4.3 \cdot 10^{-4}$	$8.0 \cdot 10^{-4d}$
Intraparticle heat transport	Mears parameter < 0.1	$2.0 \cdot 10^{-6}$	$4.2 \cdot 10^{-6d}$
Radial temperature gradient	Radial gradient < 0.05	0.004	0.0057 ^d
Intraparticle temperature gradient	Temperature gradient < 0.3	0.15	0.175 ^c
Bed dilution	Bed dilution parameter < 0.05	0.047	0.047

^aThe value of this ratio is 25.4 if the thermocouple is taken into consideration for calculation of reactor diameter.

^bDetermined at 500 °C.

^cDetermined at 600 °C.

^dDetermined at 450 °C.

For the definition of each parameter the readers should refer to Eurokin - <http://eurokin.org/>; J. Perez-Ramirez, R.J. Berger, G. Mul, F. Kapteijn, J.A. Moulijn, *Catalysis Today* 60 (2000) 93–109 or A. Aranzabal, J.A. González-Marcos, J.L. Ayastuy, J.R. González-Velasco, *Chem. Eng. Sci.* 61 (2006) 3564–3576.

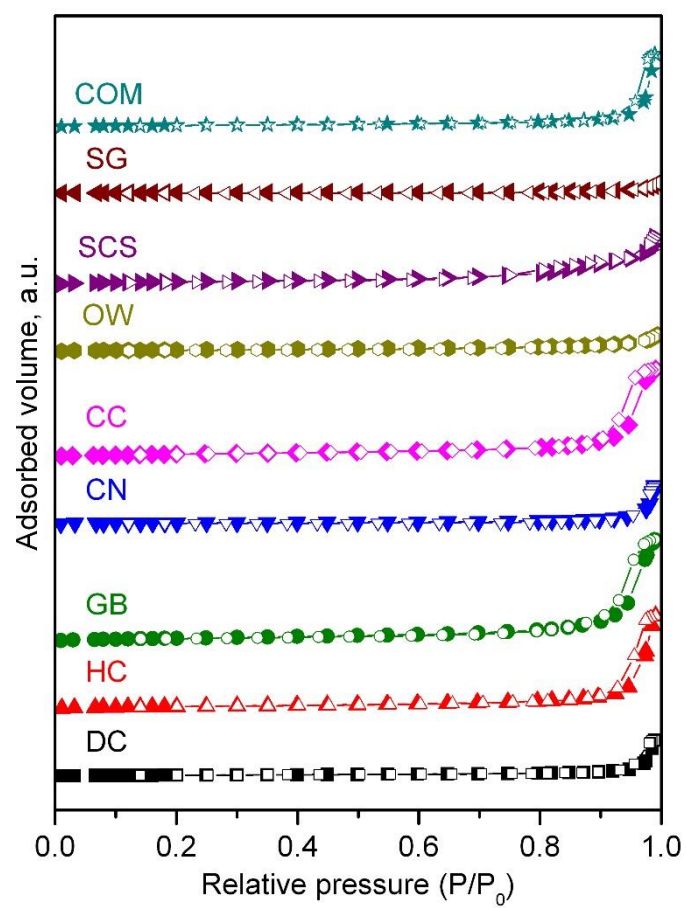


Figure S1: N₂ physisorption isotherms of the bulk Co₃O₄ catalysts.

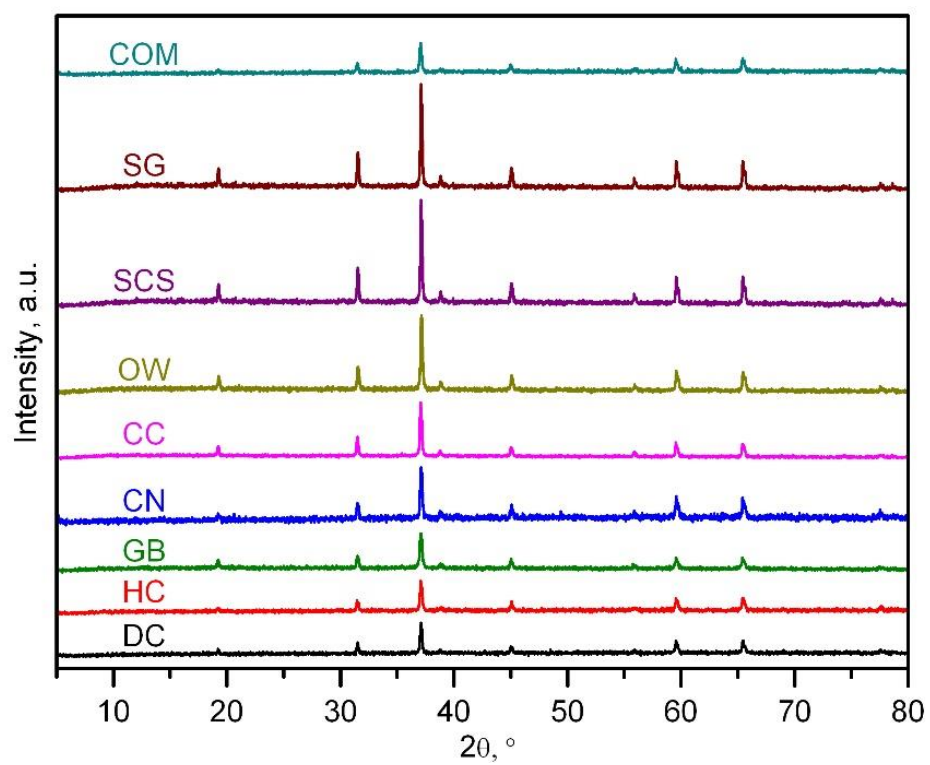


Figure S2: XRD patterns of the bulk Co_3O_4 catalysts.

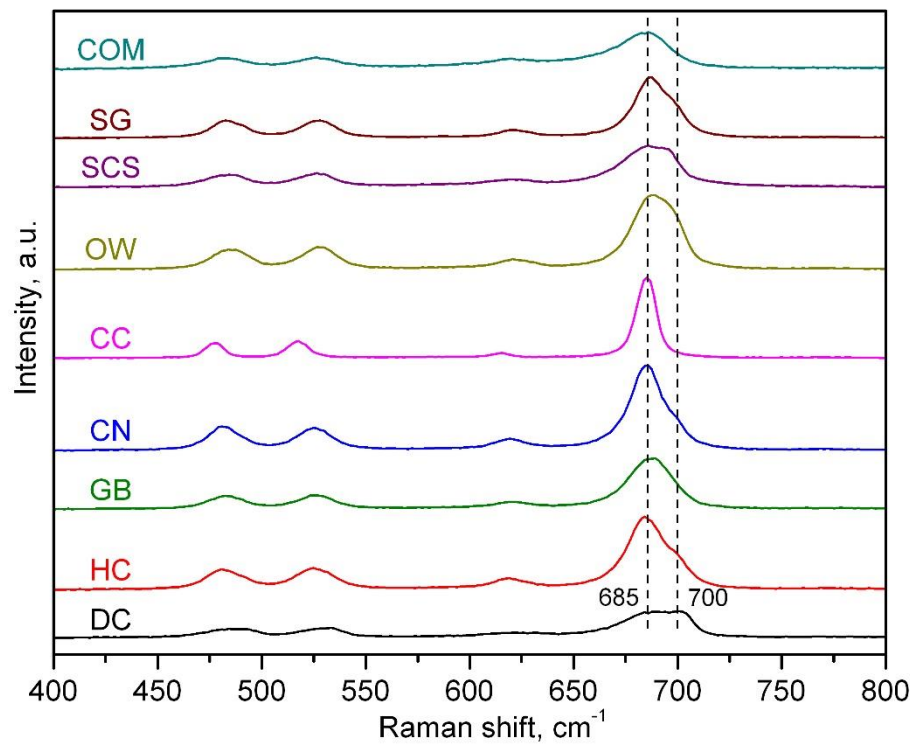


Figure S3: Raman spectra of the bulk Co_3O_4 catalysts.

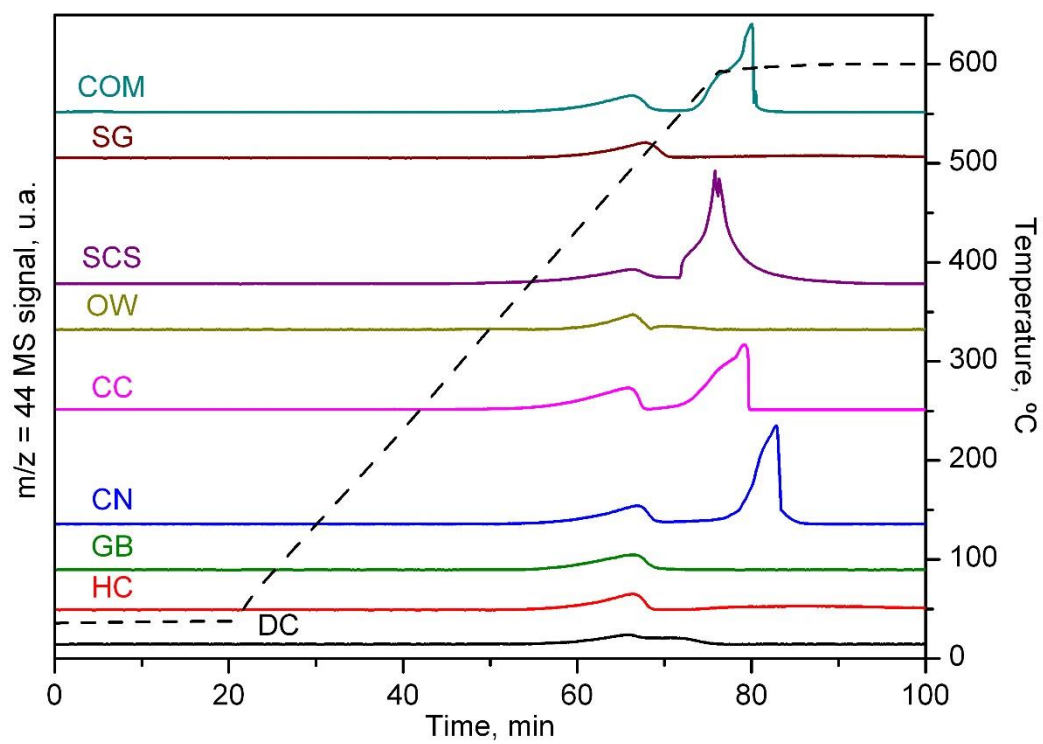


Figure S4: CH₄-TPRe profiles of the bulk Co₃O₄ catalysts.

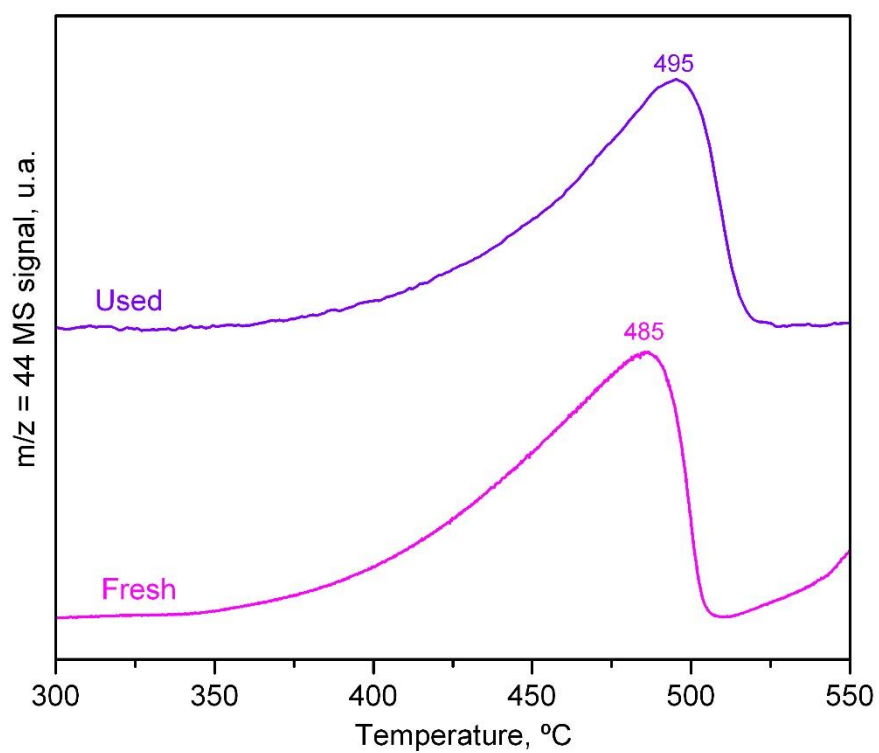


Figure S5: Close-up view of the CH₄-TPRe profiles in the 300-500 °C range of the CC catalyst before and after the stability test.