SUPPLEMENTARY MATERIAL

Comparative study of strategies for enhancing the performance of Co_3O_4/Al_2O_3 catalysts for lean methane combustion

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CAPTIONS FOR TABLES AND FIGURES

Table S1. Series of recommendations and criteria for accurate analysis of intrinsic reaction rates (as evaluated for the Co/Ce-Al catalyst at 400 °C).

Figure S1. CH_4-TPRe profiles of the supported cobalt catalysts.

Figure S2. Additional HAADF-STEM images of the Co-Ni/Al (left) and Co/Ce-Al (right) catalysts coupled to EELS (Co (red) and Ni (blue)) and EDX (Co (red) and Ce (green)) elemental distribution.

Figure S3. Pseudo-first order fit for the experimental data over the supported cobalt catalysts.

Criteria	Recommendation	At 400 ºC	Least favourable conditions
Minimum bed length	Bodenstein parameter < $L_{bed}/d_{particle}$	7.9 < 79.5	55.6 at 500 °C
Minimum reactor diameter	$d_{tube}/d_{particle}$ > 10	31.2[a]	31.2[a]
Extraparticle mass transfer	Carberry number < 0.05/n	0.007	0.046 at 500 °C
Extraparticle heat transfer	$_{e}Ca$ < 0.05	0.003	0.028 at 600 °C
Intraparticle mass transport	Wheeler-Weisz modulus < 0.15	$7.5 \cdot 10^{-4}$	$1.7 \cdot 10^{-3}$ at 500 °C
Intraparticle heat transport	Mears parameter < 0.1	$2.9 \cdot 10^{-6}$	$4.2 \cdot 10^{-6}$ at 450 °C
Radial temperature gradient	Radial gradient < 0.05	0.005	0.01 at 475 °C
Intraparticle temperature gradient	Temperature gradient < 0.3	0.15	0.18 at 600 °C
Bed dilution	Bed dilution parameter < 0.05	0.047	0.047

[a]The value of this ratio is 25.4 if the thermocouple is taken into consideration for calculation of reactor diameter.

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 and A. Aranzabal, J.A. González-Marcos, J.L. Ayastuy, J.R. González-Velasco, Chem. Eng. Sci. 61 (2006) 3564-3576.

Table S1

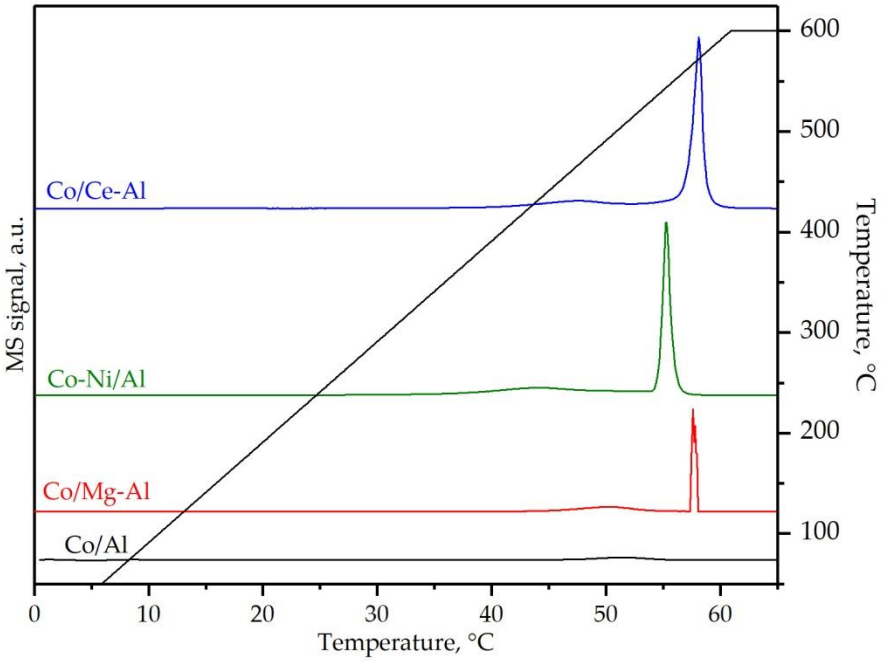

Figure S1

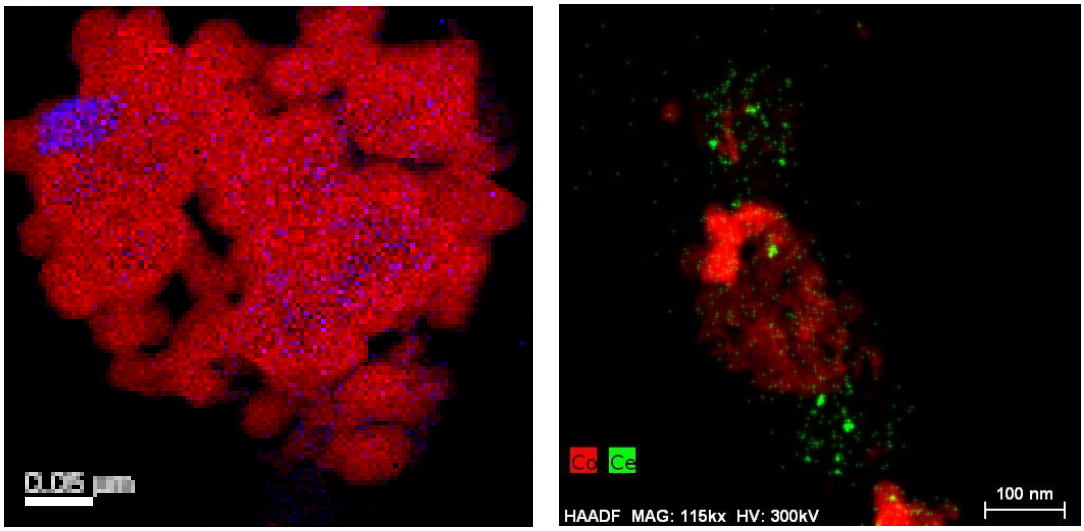

FIGURE S2

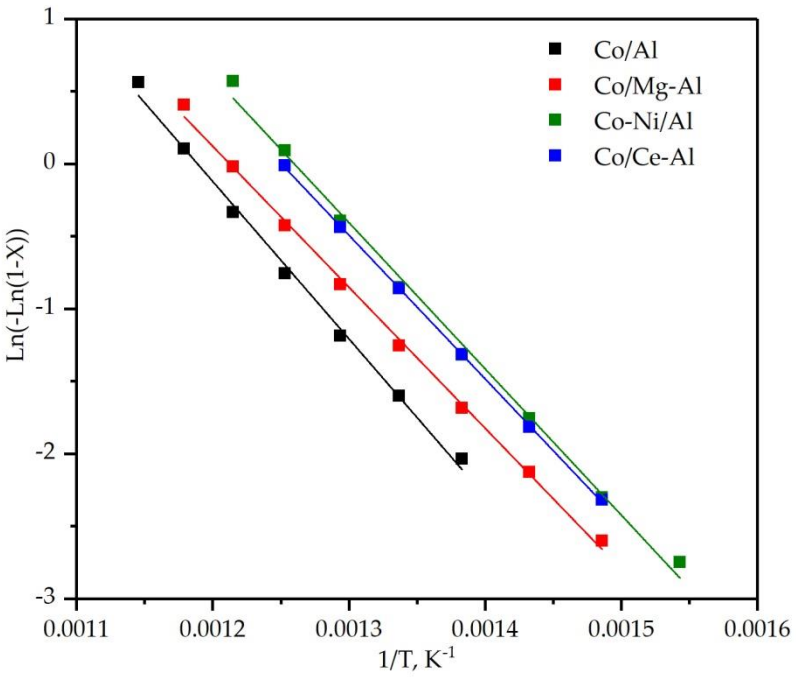
Co/Al
Co/Mg-Al
Co-Ni/Al
Co/Ce-Al
Ln(-Ln(1-X))
1/T, K-1
1
0
-1
-2
-3
0.0011
0.0012
0.0013
0.0014
0.0015
0.0016

Figure S3