Supplementary information

Title: Synergistic effects of plasma-catalyst interactions for CH_4 activation

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Table S1 Kinetic parameters obtained during plasma-assisted catalysis after correction and thermal catalysis.

plasma-assisted catalysis ($-r_{CH4,f,corr} = \frac{k_{plasma-cat} \times P_{CH4}}{(1 + K_{CH4,plasma-cat} \times P_{CH4})^2}$) [a]

temperature (K)	total flow rate (mL min^{-1})	DBD power (power$_{DBD}$, W)	$k_{plasma-cat}$ (s^{-1} kPa^{-1})	$K_{CH4,plasma-cat}$ (kPa^{-1})	ln ($k_{plasma-cat}$) VS. 1/power$_{DBD}$ slope	ln ($k_{plasma-cat}$) VS. 1/power$_{DBD}$ y-intercept	R^2
790	120	1	1.35 (± 0.05)	0.019	-0.85 (± 0.19)	1.15 (± 0.10)	0.91
		3	2.48 (± 0.10)	0.022			
		5	2.31 (± 0.05)	0.018			
		7	3.11 (± 0.14)	0.026			
790	130	1	0.64 (± 0.02)	0.004	-0.72 (± 0.18)	0.26 (± 0.10)	0.89
		3	0.89 (≤ ± 0.01)	0.011			
		5	1.26 (± 0.01)	0.015			
		7	1.72 (≤ ±0.01)	0.007			
790	140	1	0.45 (± 0.02)	0.037	-0.83 (± 0.09)	0.05 (± 0.05)	0.98
		3	0.82 (± 0.01)	0.058			
		5	0.94 (≤ ± 0.01)	0.017			
		7	0.87 (± 0.01)	0.012			
790 [b]	120 [b]	1 [b]	1.51 (± 0.02)	0.024	-0.70 (± 0.17)	1.12 (± 0.10)	0.89
		2 [b]	2.10 (± 0.08)	0.035			
		3 [b]	2.71 (± 0.09)	0.033			
		4 [b]	2.36 (± 0.11)	0.037			
810	120	1	0.95 (± 0.02)	0.017	-0.82 (± 0.07)	0.75 (± 0.04)	0.99
		3	1.59 (± 0.03)	0.018			
		5	1.73 (± 0.01)	0.013			
		7	1.99 (± 0.01)	0.008			
840	120	1	0.66 (± 0.04)	0.001	-1.54 (± 0.37)	1.07 (± 0.20)	0.90
		3	1.39 (± 0.13)	0.011			
		5	1.98 (± 0.11)	0.018			
		7	3.03 (± 0.12)	0.028			
850	120	5	2.00 (± 0.01)	0.005	-	-	-
865	120	1	1.26 (± 0.03)	0.017	-0.49 (± 0.15)	0.71 (± 0.08)	0.84
		3	1.61 (± 0.01)	0.007			
		5	1.73 (± 0.02)	0.010			
		7	2.11 (± 0.03)	0.009			
880	120	3	1.41 (± 0.01)	0.006	-	-	-
		5	2.73 (± 0.03)	0.006			
890	120	1	0.98 (± 0.03)	0.013	-1.33 (± 0.14)	1.31 (± 0.07)	0.98
		3	2.24 (± 0.04)	0.018			
		5	3.15 (± 0.16)	0.028			
		7	2.88 (± 0.08)	0.024			
890	140	1	0.38 (≤ ± 0.01)	0.019	-1.43 (± 0.43)	0.40 (±0.23)	0.85
		3	0.69 (± 0.01)	0.023			
		5	1.06 (± 0.01)	0.016			
		7	1.60 (≤ ± 0.01)	0.015			

thermal catalysis ($-r_{OBS} = k_{therm-cat} \times P_{CH4}$) [a]

temperature (K)	total flow rate (mL min^{-1})	$k_{therm-cat}$ (s^{-1} kPa^{-1})	ln ($k_{therm-cat}$) VS. 1/T slope	ln ($k_{therm-cat}$) VS. 1/T y-intercept	R^2
790	120	0.84 (± 0.04)			
840	120	1.94 (± 0.07)	-8.9 (± 1.5)	11.1 (± 1.7)	0.97
890	120	2.92 (± 0.07)			

[a] 1Ni of 5 mg; SiO_2 diluent of 100 mg; P_{CH4} of ≤ 25.3 kPa and P_{CO2} of 25.3 kPa (balanced by He); 1 atm. [b] 1Ni of 5 mg; $BaTiO_3$ diluent of 100 mg; P_{CH4} of ≤ 25.3 kPa and P_{CO2} of 25.3 kPa (balanced by He); 1 atm.

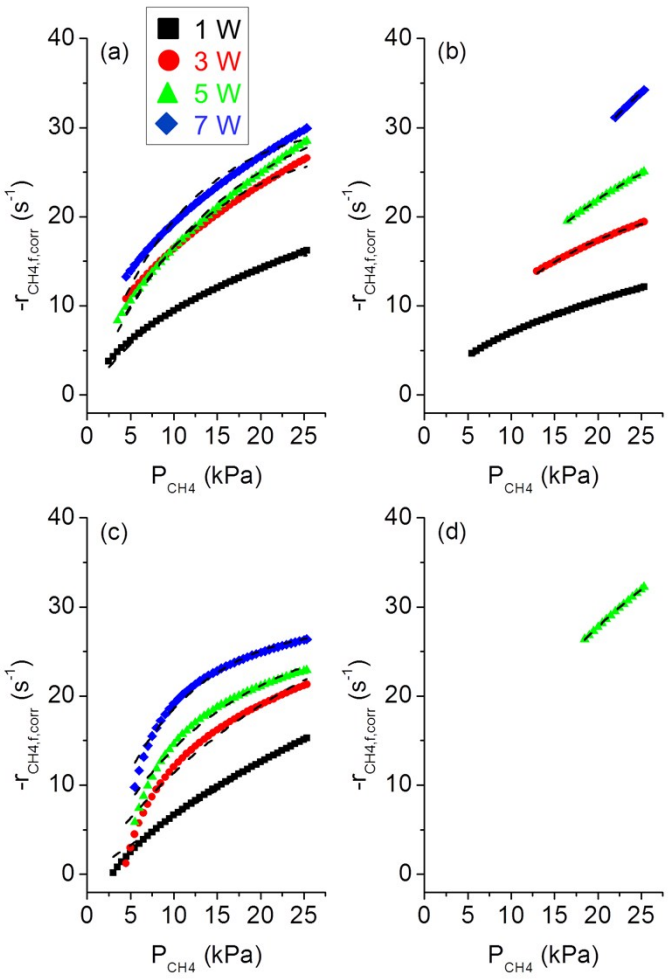

Fig. S1 Change in corrected forward CH_4 consumption rate ($-r_{CH4,f,corr}$) in a response to a change in partial pressure of CH_4 (P_{CH4}) at constant partial pressure of CO_2 (P_{CO2}) of 25.3 kPa (balanced by He) for plasma-assisted catalysis at different DBD plasma powers with a total flow rate of 120 mL min^{-1}: (a) at 790 K, (b) at 810 K, (c) at 840 K, and (d) at 850 K. All curve fits using Eqn. 21 show regression factors of ≥ 0.96 (dashed lines). Kinetic parameters are shown in Table S1.

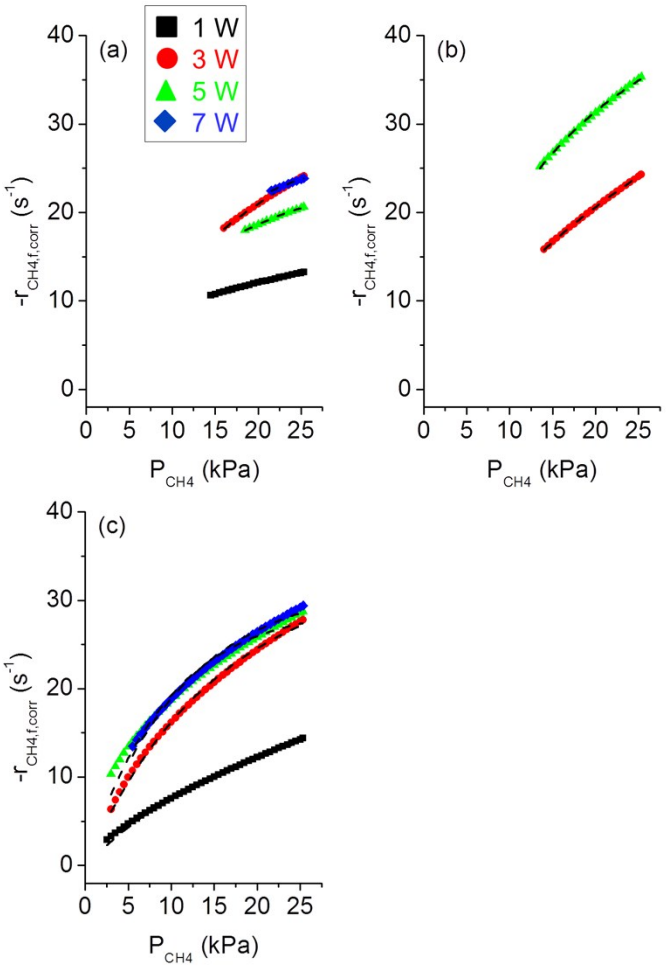

Fig. S2 Change in corrected forward CH_4 consumption rate ($-r_{CH4,f,corr}$) in a response to a change in partial pressure of CH_4 (P_{CH4}) at constant partial pressure of of CO_2 (P_{CO2}) of 25.3 kPa (balanced by He) for plasma-assisted catalysis at different DBD plasma powers with a total flow rate of 120 mL min^{-1}: (a) at 865 K, (b) at 880 K, and (c) at 890 K. All curve fits using Eqn. 21 show regression factors of ≥ 0.97 (dashed lines). Kinetic parameters are shown in Table S1.

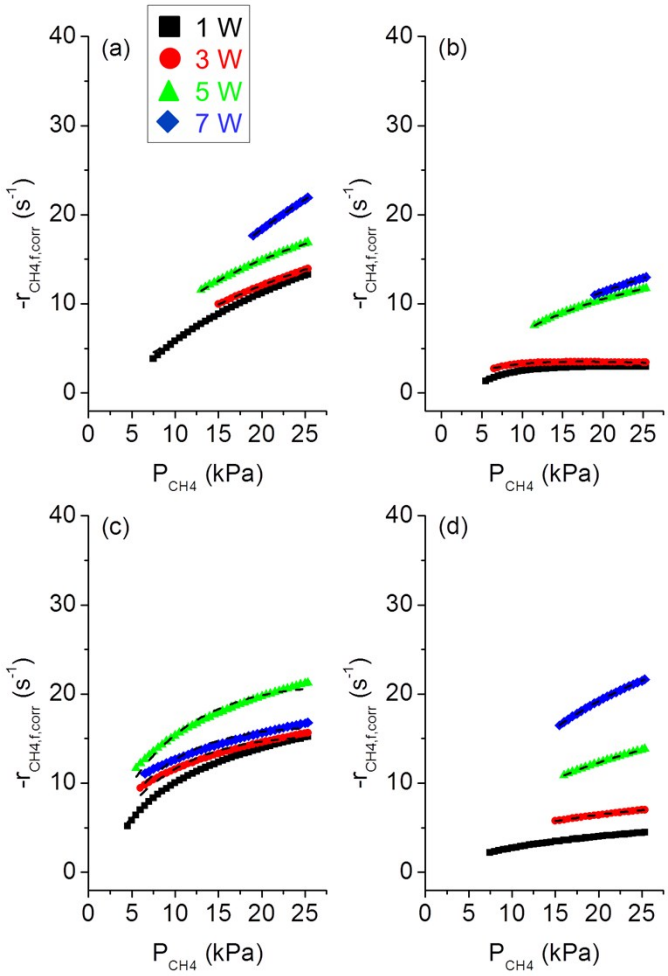

Fig. S3 Change in corrected forward CH_4 consumption rate ($-r_{CH4,f,corr}$) in a response to a change in partial pressure of CH_4 (P_{CH4}) at constant partial pressure of CO_2 (P_{CO2}) of 25.3 kPa (balanced by He) for plasma-assisted catalysis at different DBD plasma powers: (a) at 790 K and 130 mL min^{-1}, (b) at 790 K and 140 mL min^{-1}, (c) at 790 K and 120 mL min^{-1} with the use of $BaTiO_3$ diluent, and (d) at 890 K and 140 mL min^{-1}. All curve fits using Eqn. 21 show regression factors of ≥ 0.94 (dashed lines). Kinetic parameters are shown in Table S1.