Electronic Supplementary Material (ESI) for RSC Advances.

Supporting Information

Cs Promoted Fe_5C_2/Charcoal Nanocatalysts for Sustainable Liquid Fuel Production

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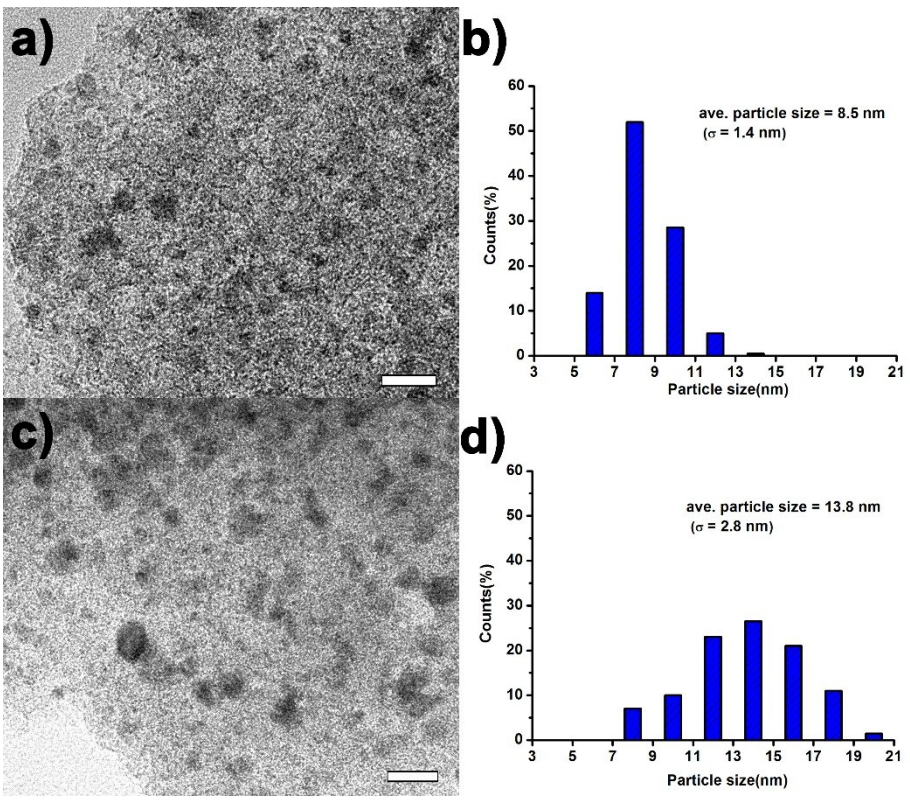

Fig. S1 TEM images and particle size distribution histograms of Cs promoted Fe_5C_2/charcoal. (a,b) Cs/Fe = 0.025, (c,d) Cs/Fe = 0.050. More than 200 particles were counted for each sample. The bars (a,c) represent 20 nm.

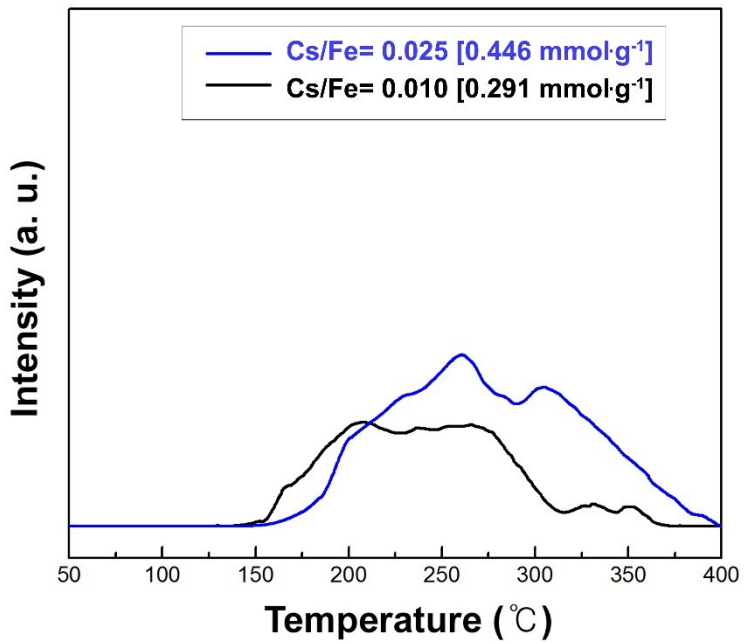

Fig. S2 CO_2-TPD profiles of Cs promoted catalysts and amount of CO_2 desorption measured by area under the peak.

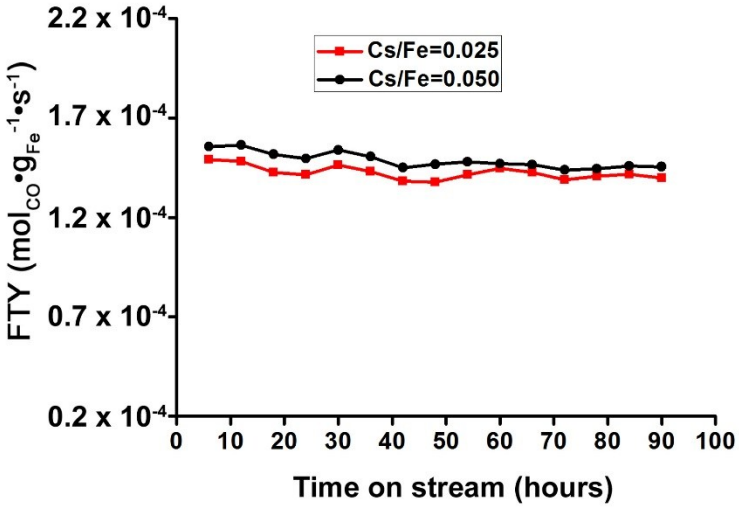

Fig. S3 Catalytic performance of Cs promoted Fe_5C_2/charcoal catalysts for high-temperature FT synthesis.

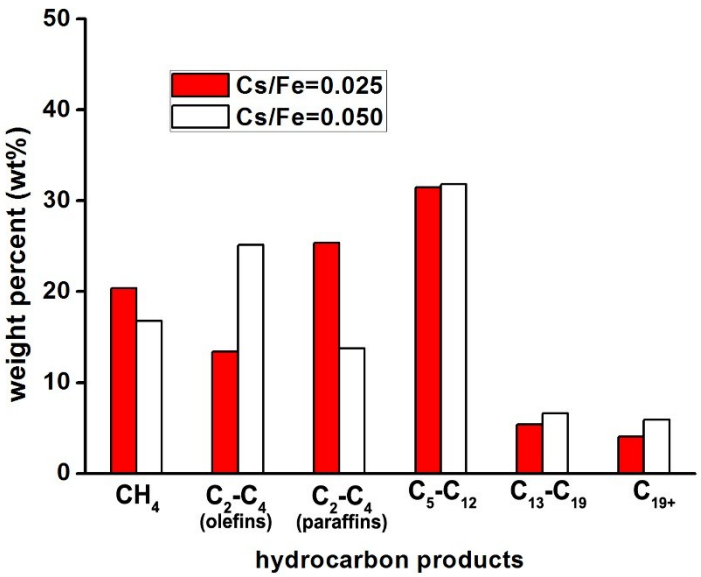

Fig. S4 Hydrocarbon product distributions. The hydrocarbon distributions (wt%) for each sample were calculated from GC analysis of gas products (C_1-C_4) and SIMDIS analysis of isolated liquid and solid products.

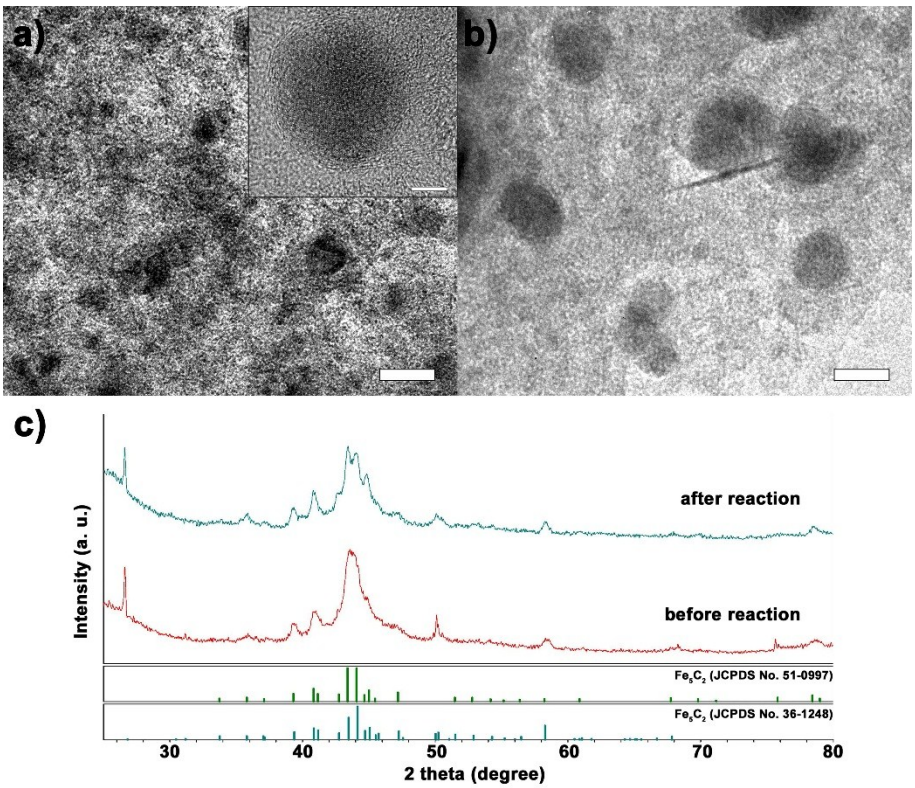

Fig. S5 (a) TEM and HRTEM images (inset) of the recovered Cs promoted Fe_5C_2/charcoal catalyst (Cs/Fe=0.025) after the FT reaction, (b) TEM image and (c) XRD spectrum of the recovered Cs promoted Fe_5C_2/charcoal catalyst (Cs/Fe=0.050) after the FT reaction. The bars represent (a,b) 20 nm and (inset) 5 nm.

Table S1 A comparison of the CO conversion and FT activity of Cs promoted Fe_5C_2 catalysts with some literature Fe supported catalysts in high temperature FT reactions.

Catalyst	Total CO conv. (%)	FTY ($mol_{CO} \bullet g_{Fe}^{-1} \bullet s^{-1}$)	Ref.
Cs/Fe_5C_2/charcoal (Cs/Fe=0.025, Fe 20wt%)	97	1.40×10^{-4}	This work[a]
Cs/Fe_5C_2/charcoal (Cs/Fe=0.050, Fe 20wt%)	96	1.45×10^{-4}	This work[a]
Cs/Fe_5C_2/charcoal (Cs/Fe=0.100, Fe 20wt%)	63	9.0×10^{-5}	This work[a]
Fe/CNF (Fe 12wt%)	88	2.98×10^{-5}	1)[b]
Fe-Cu-K-SiO_2 (Fe 32wt%)	79	1.12×10^{-5}	
Fe/α-Al_2O_3 (6wt% Fe)	77	8.48×10^{-5}	
Fe-Ru-K/CNT (9.8wt% Fe)	25	1.1×10^{-4}	2)[c]

Catalytic tests were carried out at [a]T = 320°C, P = 15 bar, H_2/CO ratio=1, [b]T = 340°C, P = 20 bar, H_2/CO ratio = 1, and [c]T = 275°C, P = 8 bar, H_2/CO ratio= 2, respectively.

Table S2 Liquid and solid hydrocarbon productivity of Cs promoted Fe_5C_2 on charcoal catalysts.

Data \ Catalyst	Cs/Fe=0.025	Cs/Fe=0.050
liquid oil productivity ($g_{liq} \bullet g_{cat}^{-1} \bullet h^{-1}$)	0.401	0.296
solid wax productivity ($g_{sol} \bullet g_{cat}^{-1} \bullet h^{-1}$)	0.026	0.164

The g_{cat} is the weight sum of Fe and the charcoal support. The values of g_{lid} and g_{sol} indicate the weights of the isolated liquid oil and solid wax after reaction, respectively.

Table S3 Gas product yields of Cs promoted Fe_5C_2 on charcoal catalysts after 90 h on stream.

Catalyst	Gas product yield ($10^{-4} g_{HC} \bullet g_{Fe}^{-1} \bullet s^{-1}$)			
	CH_4	C_2-C_4 olefins	C_2-C_4 paraffins	Total
Cs/Fe = 0.025	2.95	1.94	3.67	8.56
Cs/Fe = 0.050	2.42	3.62	1.99	8.03

References)
1) H. M. T. Galvis, J. H. Bitter, C. B. Khare, M. Ruitenbeek, A. I. Dugulan and K. P. de Jong, *Science*, 2012, **335**, 835.
2) M. C. Bahome, L. L. Jewell, K. Padayachy, D. Hildebrandt, D. Glasser, A. K. Datye and N. J. Coville, *Appl. Catal. A: Gen.*, 2007, **328**, 243.