Supplementary Information (SI) for Journal of Materials Chemistry A.

Supporting Information

Embedding uniform Ni nanoparticles into Silicalite-1 zeolite for dry reforming of methane

Zhe Ma[a], Peng Xu[a], Chenzhao Wang[a], Jiaxu Wang[a], Yongxiao Tuo[a, *] and Hailing Guo[a, *]

[a] State Key Laboratory of Heavy Oil Processing, China University of Petroleum, Qingdao 266580, PR China

***Corresponding author**:

Email address: Yongxiao Tuo@upc.edu.cn

Hailing Guo@upc.edu.cn

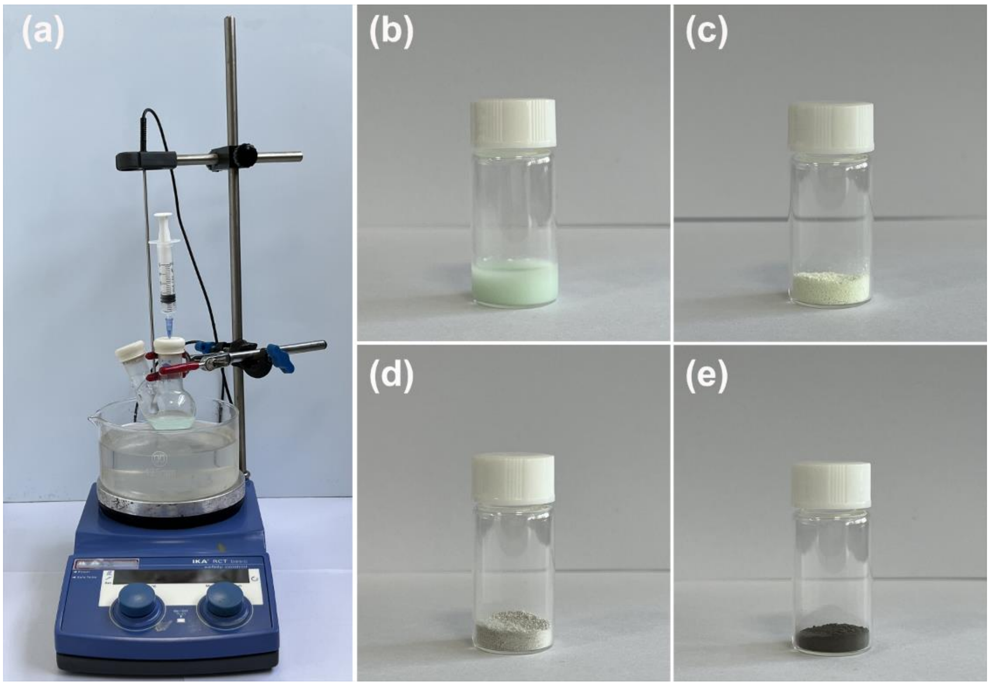

Figure S1. Ni-based Silicalite-1 catalysts prepared via deposition-precipitation and wet impregnation methods: (a) Ni/S-1-DP catalyst obtained by deposition-precipitation method; (b-e) Ni@S-1-WI catalyst prepared through wet impregnation method; (c) sample after drying; (d) sample after calcination; (e) sample after hydrogen reduction.

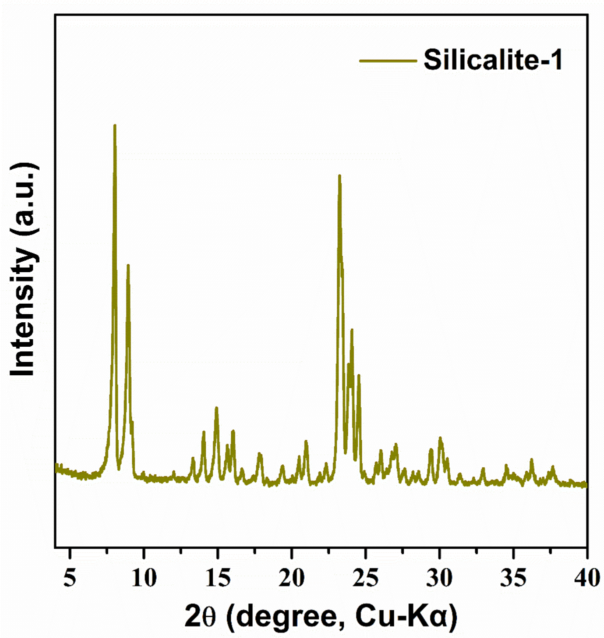

Figure S2. PXRD patterns of parent nanosized silicalite-1 zeolites.

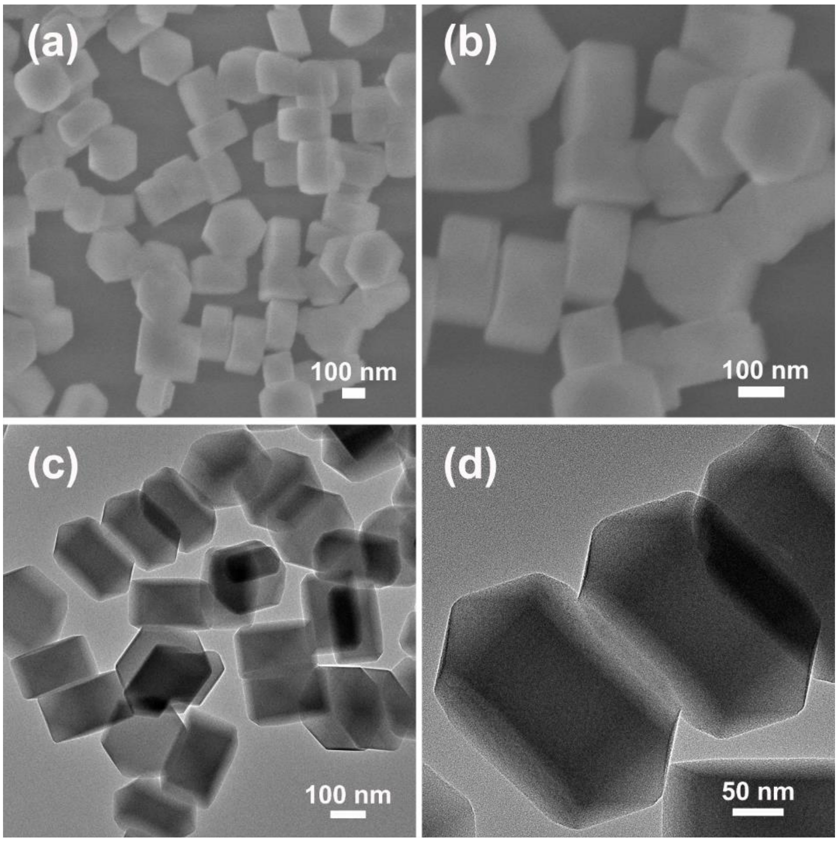

Figure S3. SEM images (a, b) and TEM images (c, d) of parent nanosized silicalite-1 zeolites.

Table S1. Data including binding energies and peak fitting areas from XPS analysis before and after H_2 reduction.

Sample	Ni $2P_{3/2}$			Ni $2P_{1/2}$		
	Binding Energy/eV	Raw area[a]	FWHM[a]	Binding energy/eV	Raw area[a]	FWHM[a]
5% NiO@S-1-WI	856.6	3208	3.6	874.3	1631	3.6
5% NiO/S-1-DP	856.1	23177	3.2	873.7	11732	3.2
5% Ni@S-1-WI	855.6	3496	3.4	872.5	1778	3.4
5% Ni/S-1-DP	855.7	12599	3.6	872.5	6314	3.6

[a] obtained by Gaussian fitting method.

Table S2. Metal loading and porous properties of two Ni-based zeolite catalysts.

Samples	Ni^{a} (wt%)	S_{BET}^{b} ($m^2\ g^{-1}$)	S_{micro}^{c} ($m^2\ g^{-1}$)	S_{ext}^{c} ($m^2\ g^{-1}$)
Silicalite-1	/	391	242	149
3% Ni@S-1-WI	2.32	298	210	88
5% Ni@S-1-WI	4.78	284	195	89
10% Ni@S-1-WI	9.26	266	183	83
3% Ni/S-1-DP	1.92	340	235	105
5% Ni/S-1-DP	4.11	333	214	119
10% Ni/S-1-DP	8.04	291	194	97

[a] obtained by ICP-AES. [b] S_{BET}: total surface area, calculated by the BET method. [c] S_{micro}: micropore surface area and S_{ext}: mesopore surface area, calculated by the t-plot method.

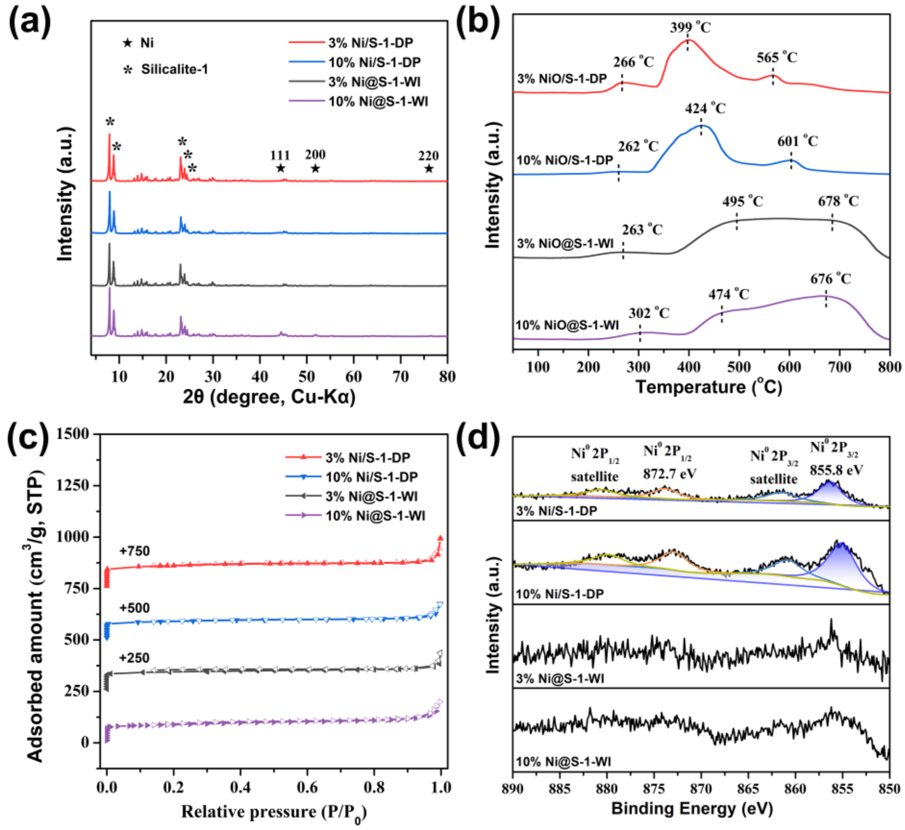

Figure S4. Characterization of the Ni@S-1-WI and Ni/S-1-DP with different Ni loadings. (a) PXRD patterns. (b) H_2-TPR profiles. (c) N_2 adsorption/desorption isotherm. (d) XPS spectra.

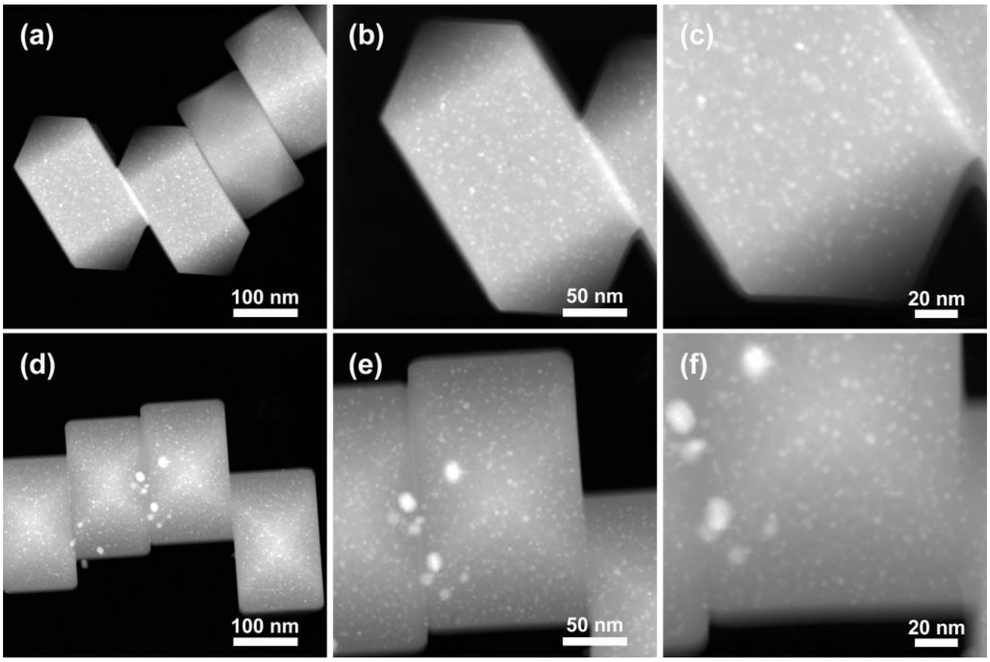

Figure S5. The HAADF-STEM images of catalysts 3% Ni@S-1-WI (a, b, c) and 10% Ni@S-1-WI (d, e, f).

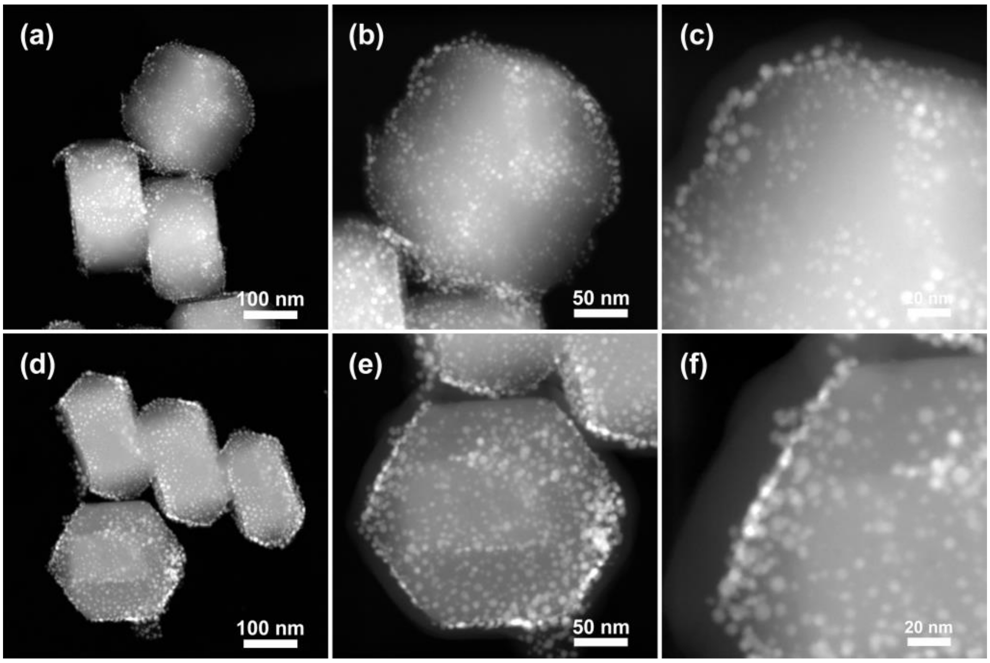

Figure S6. The HAADF-STEM images of catalysts 3% Ni/S-1-DP (a, b, c) and 10% Ni/S-1-DP (d, e, f).

Table S3. Comparative catalytic performance of representative DRM catalysts reported in literature versus the present work.

Catalysts	Reaction conditions			CH_4 Cov. %	CO_2 Cov. %	Reference
	Temperature (ºC)	WHSV ($L \cdot g^{-1} \cdot h^{-1}$)	Lifetime (h)			
5% Ni@S-1-WI	800	30	200	88	94	This work
Ni/ZSM-5	800	30	30	70	74	[1]
Ni-Ta/ZSM-5	784	33	60	80	90	[2]
Ni-Mo/ZSM-5	750	25	100	88	94	[3]
Ni-HAP-Ce	750	60	100	84	92	[4]
Ni/SiO_2	700	40	200	70	80	[5]
Ni-MCM-41	700	45	200	70	80	[6]
$0.5Ni/CeNi_xO_y$	800	36	140	80	87	[7]
$Ni@Al_2O_3$	800	36	50	79	82	[8]
NiMo-MgO	800	60	200	100	100	[9]

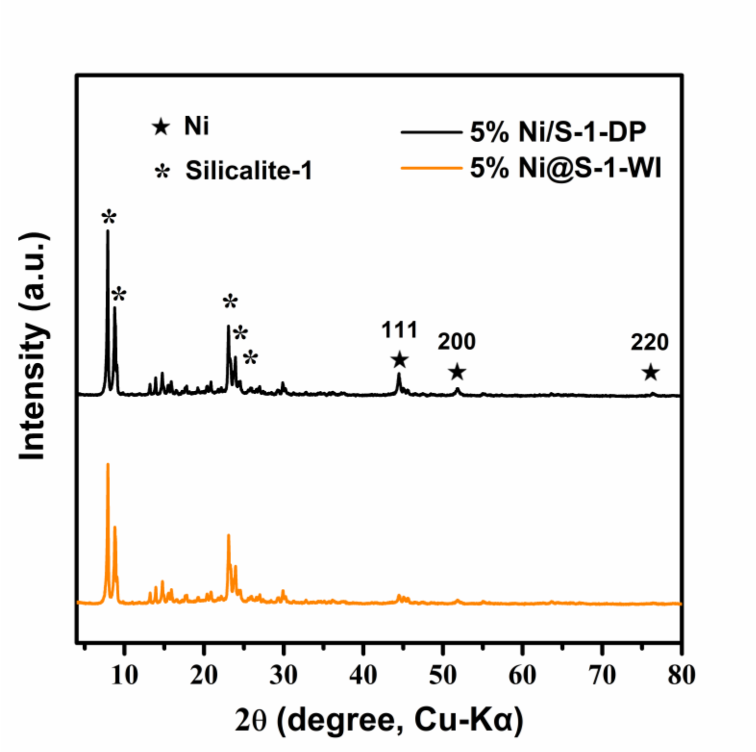

Figure S7. PXRD patterns of the spent 5% Ni@S-1-WI and 5% Ni/S-1-DP.

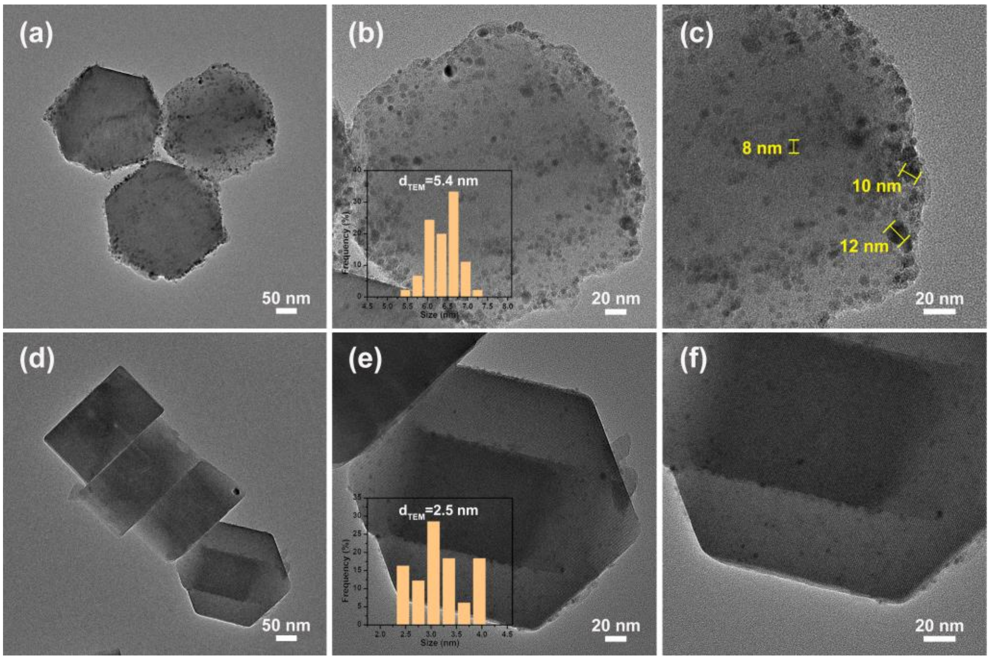

Figure S8. TEM images of the spent 5% Ni/S-1-DP (a, b, c) and5% Ni@S-1-WI (d, e, f).

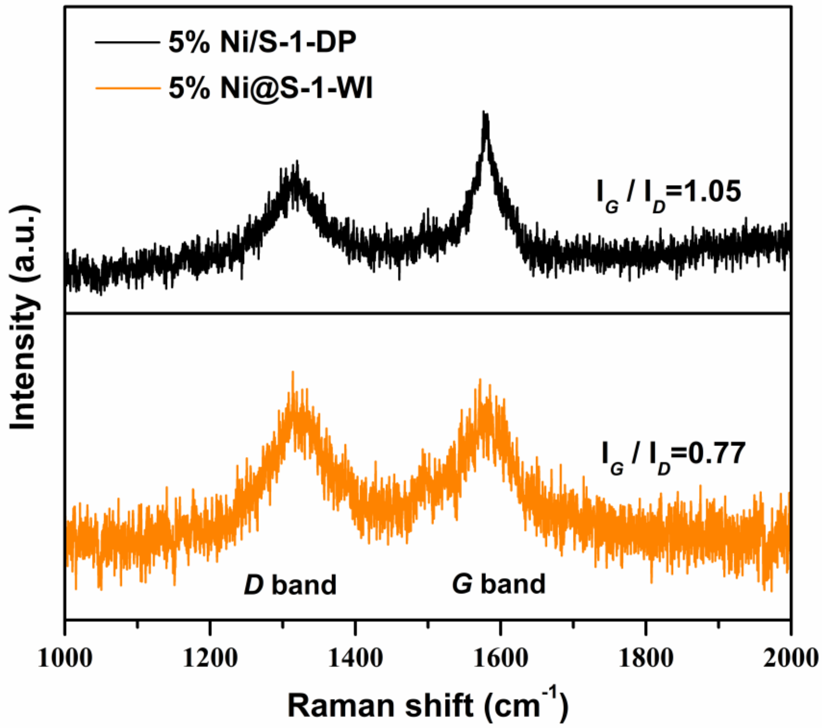

Figure S9. Raman spectra of the spent 5% Ni@S-1-WI and 5% Ni/S-1-DP.

References

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