Supporting Information

Ni/CeO_2 Catalyst Prepared via Microimpinging Stream Reactor with High Catalytic Performance for CO_2 Dry Reforming Methane

Yadong Wang[a], Qing Hu[b], Ximing Wang[b], Yanpeng Huang[b], Yuanhao Wang[b*], Fenghuan Wang[a*]

[a] School of Light Industry, Beijing Technology and Business University (BTBU), Beijing 100048, China.

[b] SUSTech Engineering Innovation Center, School of Environmental Science and Engineering, Southern University of Science and Technology, Shenzhen 518055

*Corresponding author：

Fenghuan Wang, wangfenghuan@th.btbu.edu.cn, Beijing Technology and Business University, 11 Fucheng Road, Haidian District, Beijing, China. 100048

Yuanhao Wang, yuanhaowang2011@gmail.com, SUSTech Engineering Innovation Center, School of Environmental Science and Engineering, Southern University of Science and Technology, Shenzhen 518055, China

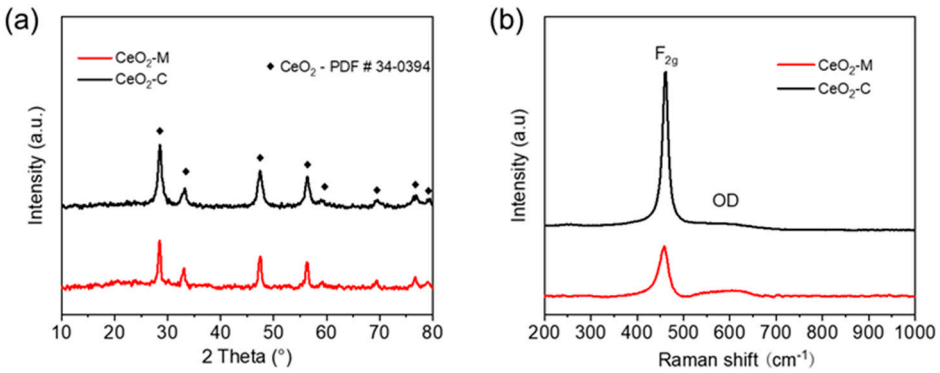

Figure S1. (a) XRD patterns and (b) Raman profile of CeO_2-C and CeO_2-M catalysts.

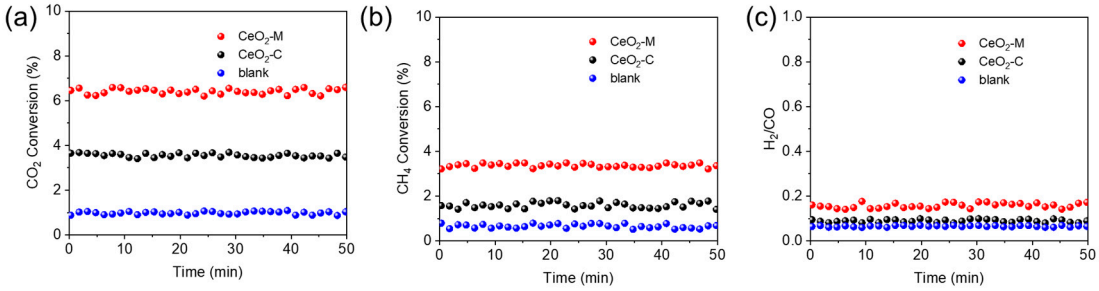

Figure S2. (a) CO_2 conversion during 50 h, (b) CH_4 conversion during 50 h, and (c) H_2/CO ratio during 50 h of the blank tube and pure CeO_2 support with different preparation methods

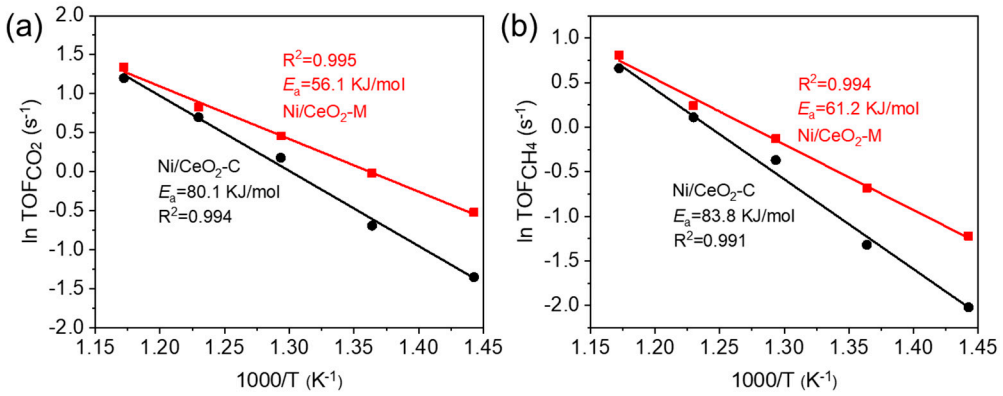

Figure S3. Apparent activation for: (a) CO_2 and (b) CH_4 of CeO_2-C and CeO_2-M catalysts.

Table S1. Comparisons of TOF for typical Ni-based catalysts.

Sample	CH_4:CO_2	T/°C	TOF_{CH4}/s^{-1}	Ref
Ni/CeO_2-M	1:1	800	3.1	This work
Ni/CeO_2-C	1:1	800	1.9	This work
NiCe13-ac25	1:1	750	3.6	[1]
NiCe26-ac25	1:1	750	2.6	[1]
Ni/CeO_2-BN	1:1	750	1.3	[2]
Ni/$Ce_{0.9}Eu_{0.1}O_{1.95}$	1:1	600	0.8	[3]
Ni/MgO-mSiO_2	1:1	700	0.4	[4]

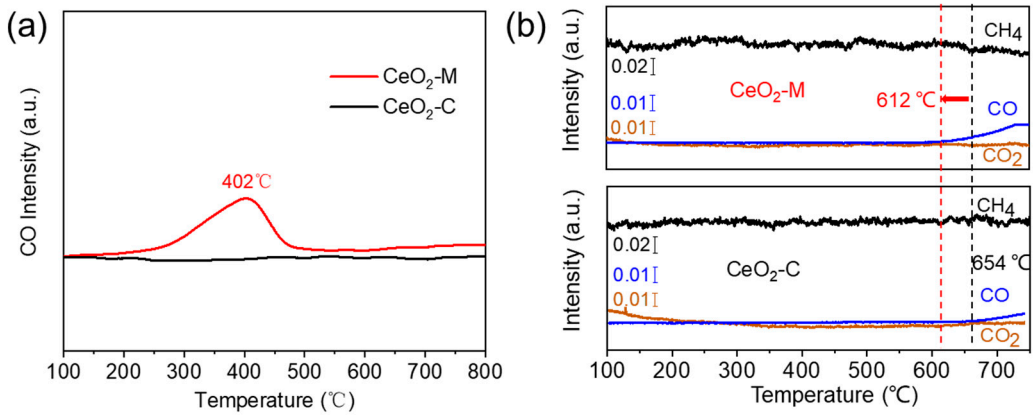

Figure S4. (a) CO_2-TPSR profile; and (b) CH_4-TPSR profile of CeO_2-C and CeO_2-M.

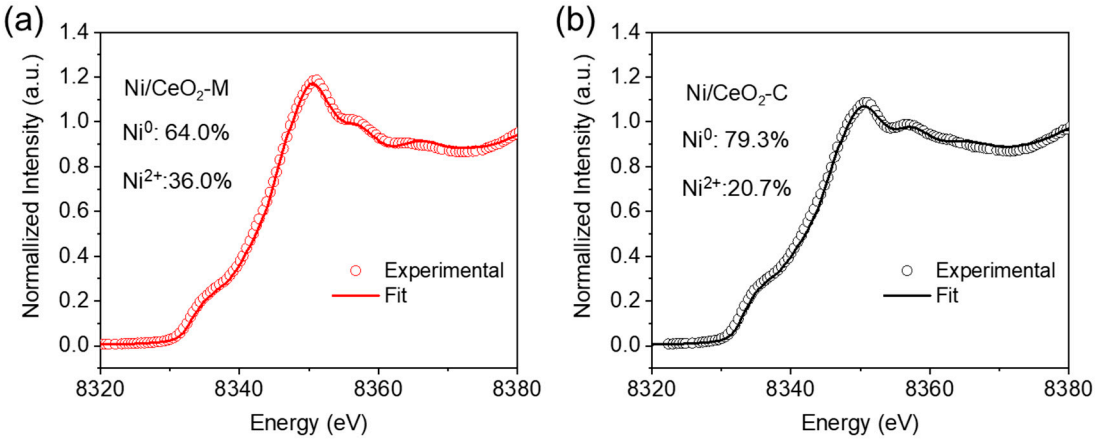

Figure S5. Linear combination fitting (LCF) of XANES spectra for the reduced catalysts.

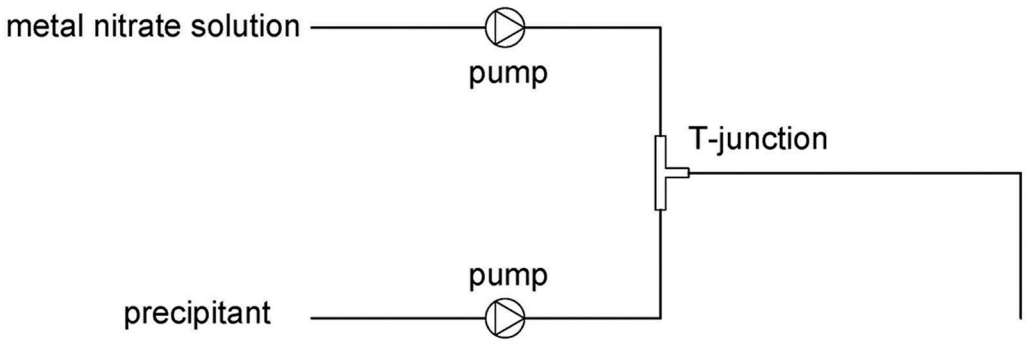

Figure S6. Scheme picture of microimpinging stream reactor system.

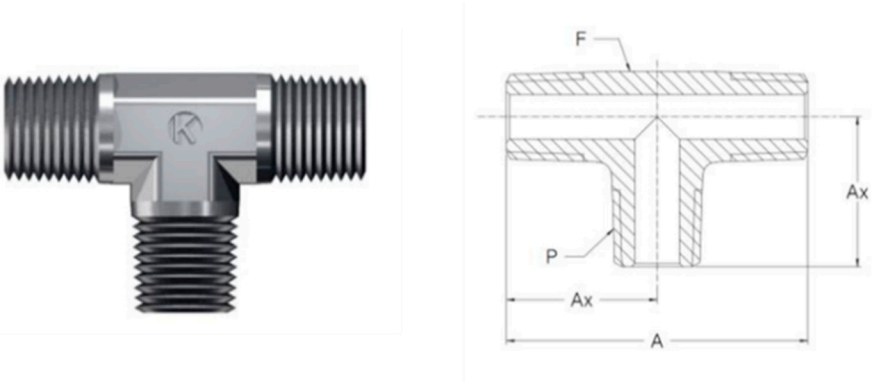

Figure S7. Photo and structure of the mini T-junction.

Table S2. Details of the microimpinging stream reactor system.

External diameter/in	Model number	Structure details				
		A/mm	Ax/mm	F/in	F/in	Tube diameter/in
1/8	SS-2MTF	44.8	22.4	7/16	7/16	1/8

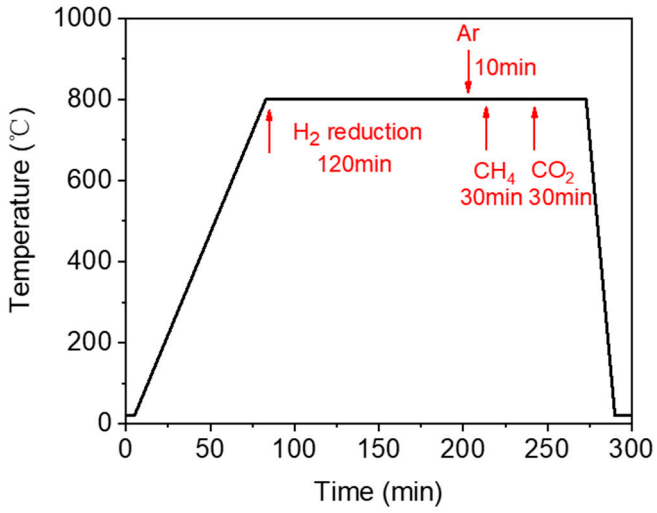

Figure S8. Schematic diagram of two-step transient surface reaction.

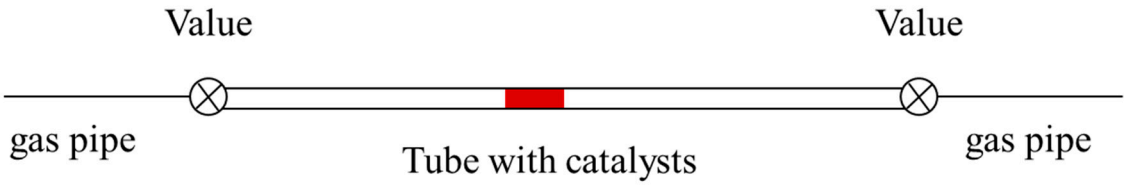

Figure S9. Diagrammatic sketch of the tube with values at the ends.

For the XAFS characterization, a series of procedures were carried out in order to avoid the effect of air to the greatest extent. The spent catalyst was cool down to the

ambient temperature with Ar atmosphere. Then the tube with the spent catalyst was sealed by two values at the ends of the tube (Figure S3), which was transferred to the glove box. The samples were laid on the 3M tape in the glove box filled with Ar and packaged without air in the sealed box. The XAFS test was quickly carried out to avoid the effect of air on the samples.

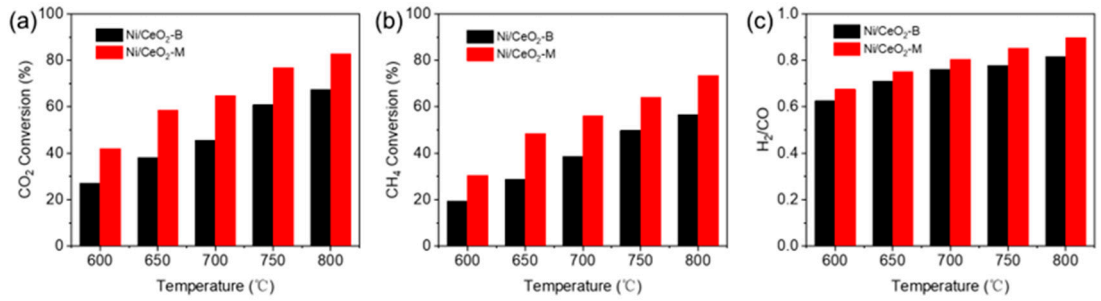

Figure S10. (a) CO_2 conversion (b) CH_4 conversion, and (c) H_2/CO ratio of Ni/CeO_2-B and Ni/CeO_2-M catalysts.

References

1. Gonzalez-Delacruz, V. M.; Ternero, F.; Pereñíguez, R.; Caballero, A.; Holgado, J. P., Study of nanostructured Ni/CeO_2 catalysts prepared by combustion synthesis in dry reforming of methane. *Appl. Catal. A Gen.* **2010,** 384, (1), 1-9.

2. Li, X.; Phornphimon, M.; Zhang, X.; Deng, J.; Zhang, D., Promoting Dry Reforming of Methane Catalysed by Atomically-Dispersed Ni over Ceria-Upgraded Boron Nitride. *Chem Asian J* **2022,** 17, (9), e202101428.

3. Wang, Y.; Zhang, R.; Yan, B., Ni/$Ce_{0.9}Eu_{0.1}O_{1.95}$ with enhanced coke resistance for

dry reforming of methane. *J. Catal.* **2022,** 407, 77-89.

4. Zeng, F.; Zhang, J.; Xu, R.; Zhang, R.; Ge, J., Highly dispersed Ni/MgO-mSiO_2 catalysts with excellent activity and stability for dry reforming of methane. *Nano Res.* **2022,** 1-10.