Supplementary Material

Enhanced Methane Dry Reforming with Ni/SiO_2 Catalysts Featuring Hierarchical External Nanostructures

Yong Jun Kim, Min-Jae Kim, Dong Hyun Kim, Anush Mnoyan * and Kyubock Lee *

Graduate School of Energy Science and Technology, Chungnam National University, 99 Daehak-ro, Yuseong-gu, Daejeon 34134, Republic of Korea; yjkimrelentless@gmail.com (Y.J.K.)

* Correspondence: anush.mnoyan@cnu.ac.kr (A.M.); kyubock.lee@cnu.ac.kr (K.L.); Tel.: +82-42-821-8610 (A.M. & K.L.)

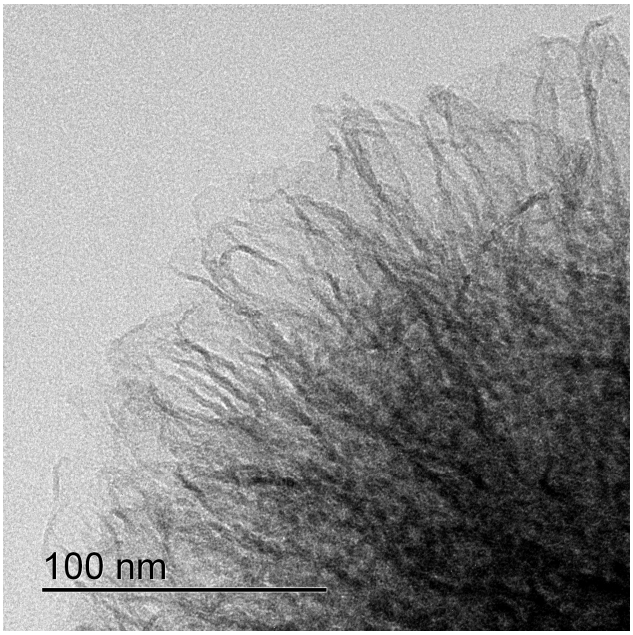

Figure S1. TEM image of reduced Ni/DMS.

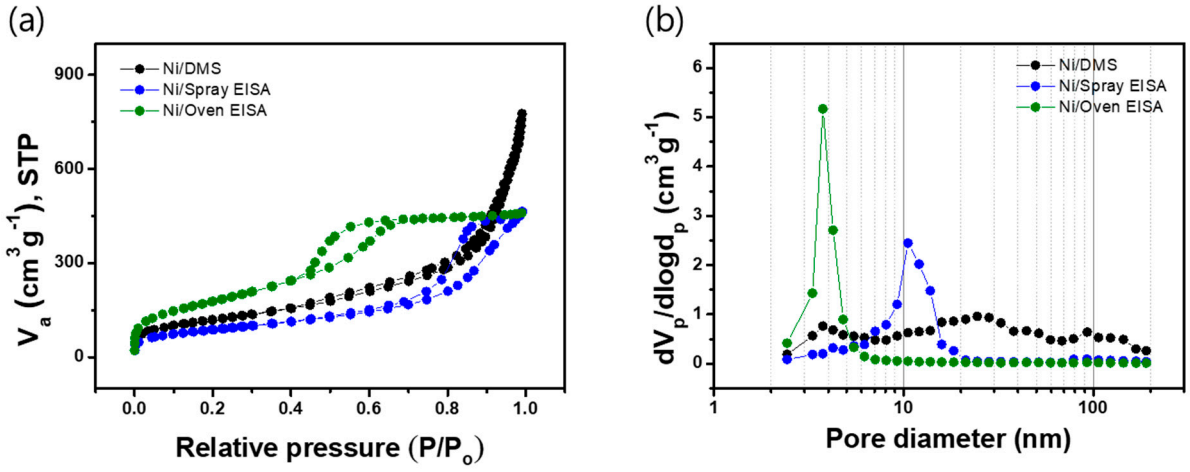

Figure S2. (a) N_2 adsorption/desorption isotherms and (b) pore size distribution of the calcined Ni/DMS, Ni/Spray EISA, and Ni/Oven EISA.

Table S1. Physical properties of prepared calcined Ni/DMS, Ni/Spray-EISA and Ni/Oven-EISA catalysts.

Samples	Specific surface area (m^2/g)	Pore volume (cm^3/g)	Pore Size (nm)
Ni/DMS	428.9	1.19	11.1
Ni/Spray-EISA	316.2	0.71	9.0
Ni/Oven-EISA	649.4	0.71	4.4

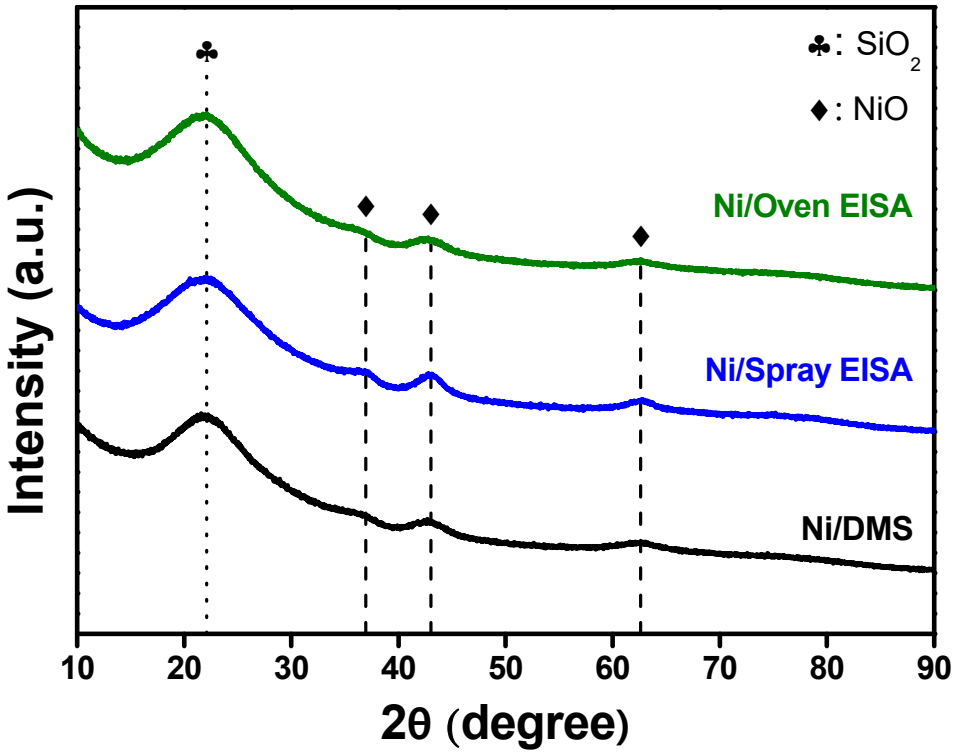

Figure S3. XRD patterns of calcined Ni/DMS, Ni/Spray EISA, and Ni/Oven EISA.

The Figure S3 displays typical XRD patterns of the prepared three catalyst samples. All reflections in the XRD patterns can be assigned to the face-centered cubic phase of NiO (JCPDS card no. #47-1049). The three distinctive peaks observed at 37.2°, 43.2°, and 62.8° correspond to the (111), (200), and (220) diffraction planes, respectively.

Table S2. Comparison of DRM performance for Ni/SiO_2 catalysts based on the process duration.

Catalysts	6 h reaction at 800℃						Long-term reaction (24 h) at 700 °C	
	CH_4 conversion (%)			CO_2 conversion (%)			CH_4 conversion (%)	CO_2 conversion (%)
GHSV ($L \cdot g_{cat}^{-1} h^{-1}$)	90	180	360	90	180	360	360	360
Ni/DMS	90.9	88.1	76.6	96.7	93.2	82.1	29.9	36.9
Ni/Spray EISA	88.8	85.2	67.1	95.7	90.2	72.8	23.9	32.3
Ni/Oven EISA	89.9	82.6	63.5	95.3	87.6	68.6	21.3	27.1

Regardless of the reaction flow rates, the Ni/DMS catalyst consistently demonstrated the highest conversion. Over the course of extended (24-hour) reaction experiments, all catalysts maintained stable conversion rates, with Ni/DMS consistently outperforming the others.