## Supporting Information

## Support Effect on Ni-Based Mono- and Bimetallic Catalysts in

## **CO<sub>2</sub> Hydrogenation**

Jihao Wang<sup>1</sup>, Shilong Chen<sup>1\*</sup>, Pierfrancesco Ticali<sup>1</sup>, Paulina Summa<sup>2</sup>, Simon Mai<sup>1</sup>,

Katarzyna Skorupska<sup>2</sup>, Malte Behrens<sup>1\*</sup>

<sup>1</sup> Institute of Inorganic Chemistry, Kiel University, Max-Eyth-Str. 2, 24118 Kiel, Germany

<sup>2</sup> Department of Inorganic Chemistry, Fritz-Haber-Institute of the Max-Planck-Society, Faradayweg

4-6, 14195 Berlin, Germany

\*Corresponding authors, email: <u>schen@ac.uni-kiel.de</u> (S. Chen), <u>mbehrens@ac.uni-kiel.de</u> (M. Behrens)

Sample	Total metal loading (wt.%)	Ni/(Fe+Ni) ( <sub>at.</sub> %)
Fe/MgO	4.9	1.7
Ni,Fe(33:67)/MgO	5.0	33.0
Ni,Fe(50:50)/MgO	5.1	51.4
Ni,Fe(67:33)/MgO	5.0	65.5
Ni,Fe(83:17)/MgO	4.9	82.3
Ni/MgO	4.9	99.3
Ni,Fe(83:17)/CeO <sub>2</sub>	4.3	80.8
Ni/CeO <sub>2</sub>	4.3	97.4

 Table S1. Metal compositions measured by ICP-OES for Ni/Fe catalysts supported on MgO

 and CeO2

The values for those catalysts supported on  $CeO_2$  are slightly smaller than the nominal values. This is likely due to the low solubility of  $CeO_2$  in nitric acid during the preparation of the samples for ICP measurements. Thus, both Ni and Fe that are strongly bonded to the support cannot be dissolved as well.

 Table S2. Metal compositions measured by SEM-EDX for Ni and Fe catalysts supported on

 ZrO2

Sample	Total metal loading (wt.%)	Ni/(Fe+Ni) ( <sub>at.</sub> %)
Ni,Fe(83:17)/ZrO <sub>2</sub>	4.14	83.4
Ni/ZrO <sub>2</sub>	5.98	100

Table S3. BET surface area for MgO, ZrO<sub>2</sub> and CeO<sub>2</sub> supports without metal loading

Sample	Surface area (m <sup>2</sup> /g)
MgO	14.9
ZrO <sub>2</sub>	25.7
CeO <sub>2</sub>	64.4



Figure S1. N<sub>2</sub> physisorption isotherm of three support materials before impregnation



Figure S2.  $CO_2$  conversion as a function of TOS for mono/bimetallic MgO,  $ZrO_2$  and  $CeO_2$ -supported catalysts for 16 h



**Figure S3.**  $CO_2$ -TPD profiles for **a** MgO, **b** ZrO<sub>2</sub>, **c** CeO<sub>2</sub> supports, and **d**~**f** their corresponding Ni loaded catalysts where grey lines represent the raw profiles, the blue lines indicate the smoothed data and the orange lines indicate the fitted curve



**Figure S4.** DRIFTS spectra of Ni/MgO collected during the CO desorption period. The color of the spectra changes as a function of time from red to purple.



**Figure S5.** DRIFTS spectra of Ni/ZrO<sub>2</sub> collected during the CO desorption period; Inset images representing the zoom-in spectra at features above 2110 cm<sup>-1</sup>. The color of the spectra changes as a function of time from red to purple.



**Figure S6.** DRIFTS spectra of Ni/CeO<sub>2</sub> collected during the CO desorption period; Inset images representing the zoom-in spectra at features above  $1800 \text{ cm}^{-1}$ . The color of the spectra changes as a function of time from red to purple.