

Supplementary Materials

Catalytic methanation over natural clay supported nickel catalyst

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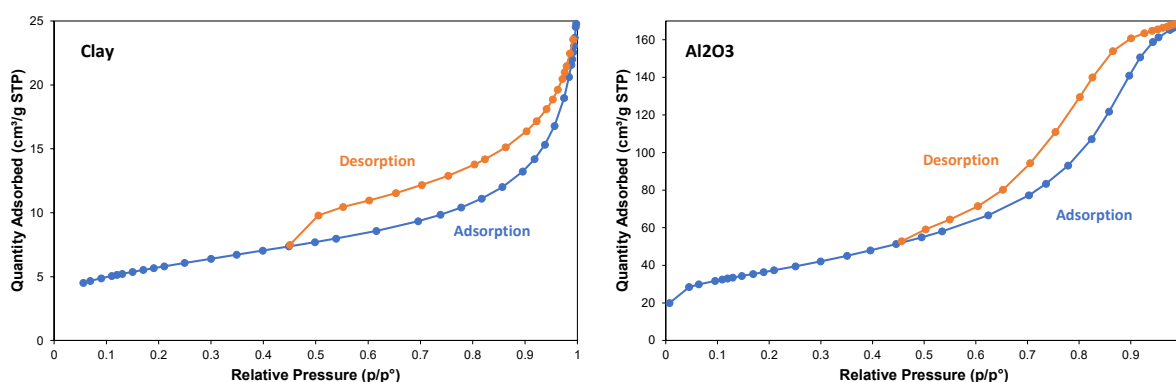


Figure S1. Nitrogen adsorption-desorption isotherms of the initial clay and Al₂O₃ supports.

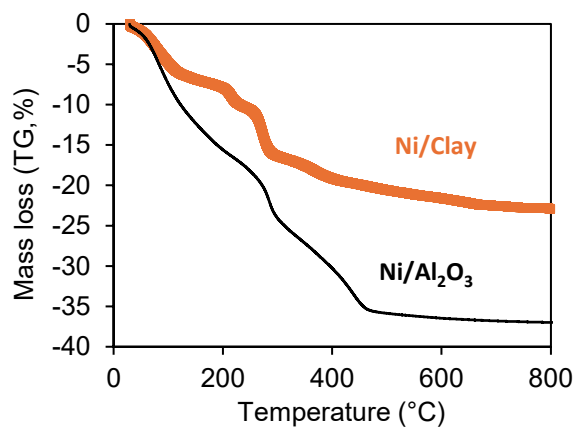
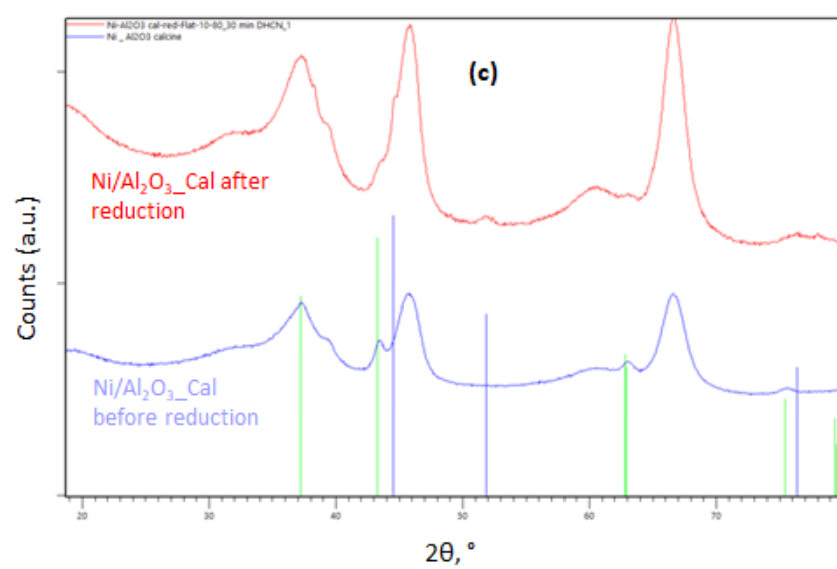
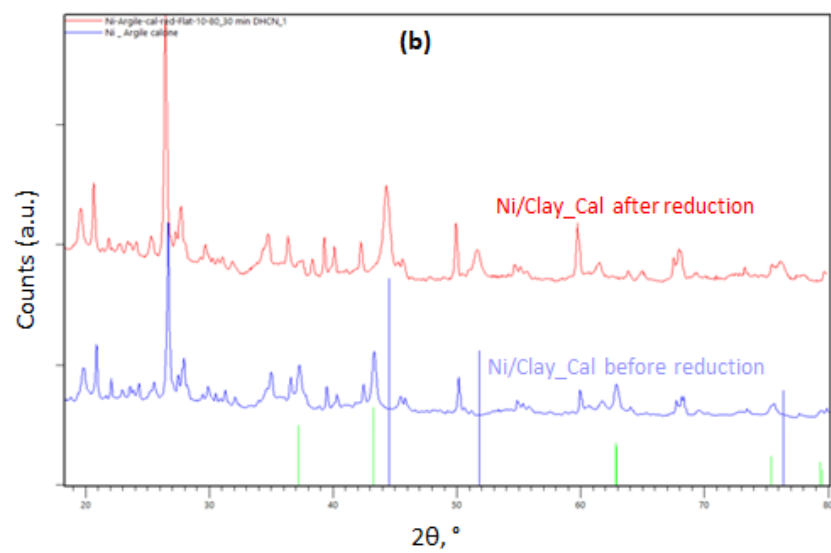
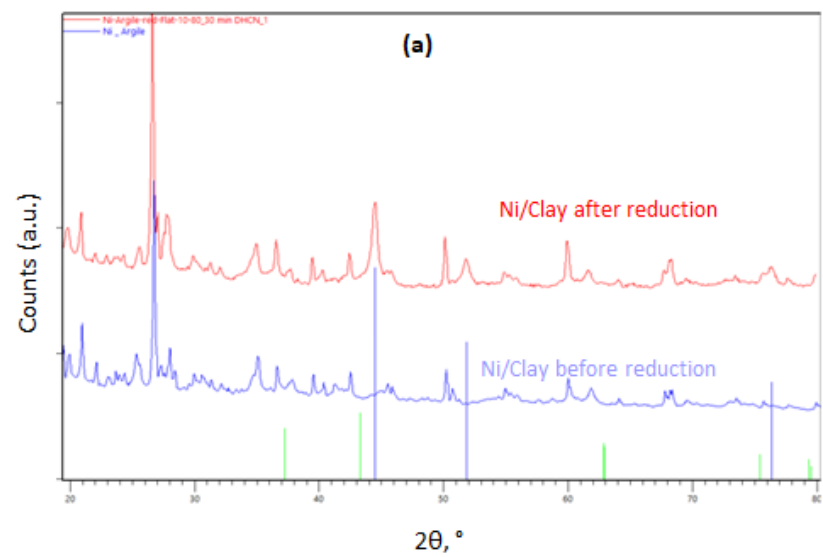


Figure S2. TG curves under the air atmosphere of the dried catalysts, showing the different dehydration phenomena of the natural clay and the alumina hydrate, and the thermal decomposition of the nickel precursor (Guggenheim et al., 1987), (Keely & Maynor, 1963).



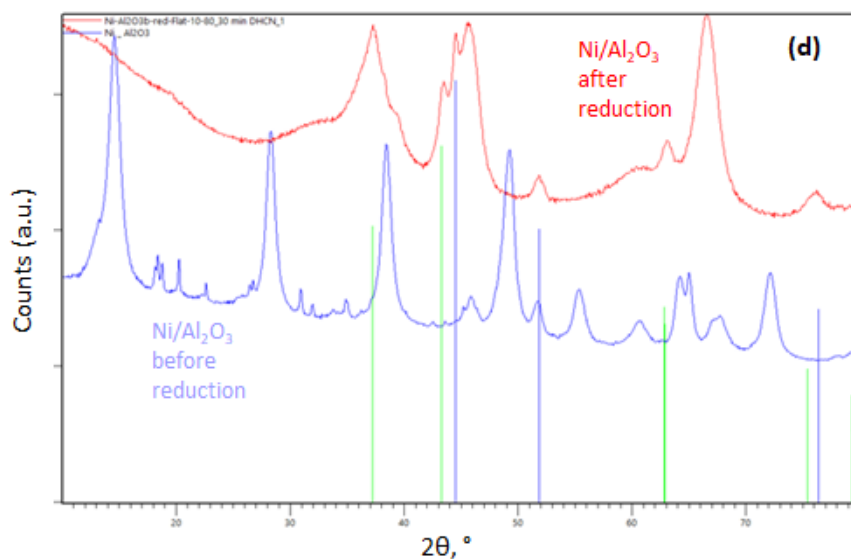


Figure S3. Comparison of XRD patterns of the catalysts before and after reduction under hydrogen at 500 °C: (a): Ni/Clay; (b): Ni/Clay_Cal; (c): Ni/Al₂O₃; (d): Ni/Al₂O₃_Cal. Vertical purple sticks: standard pattern of metallic nickel (peaks at 44.5, 51.8 and 76.3 degrees); vertical green sticks: standard pattern of NiO (peaks at 37.2, 43.3, and 62.8 degrees).

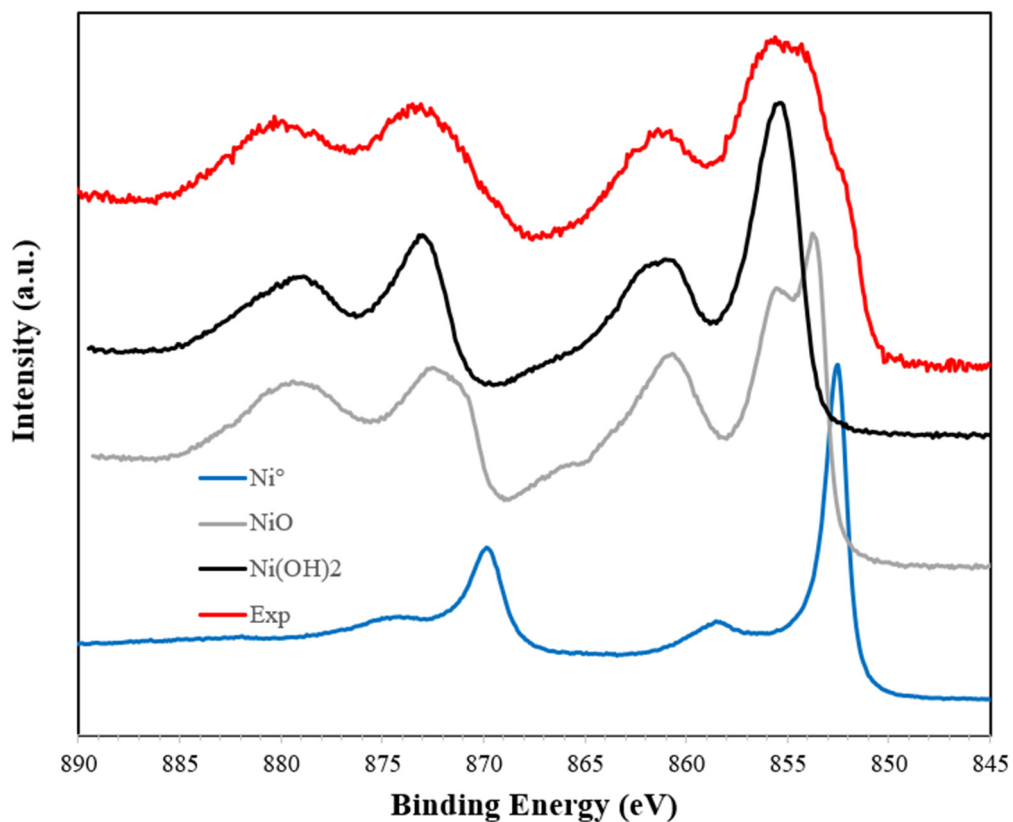


Figure S4. Comparison of Ni 2p XPS spectra recorded under identical experimental conditions for standard compounds (metallic Ni, NiO, and Ni(OH)₂) and the reduced Ni/Clay catalyst.

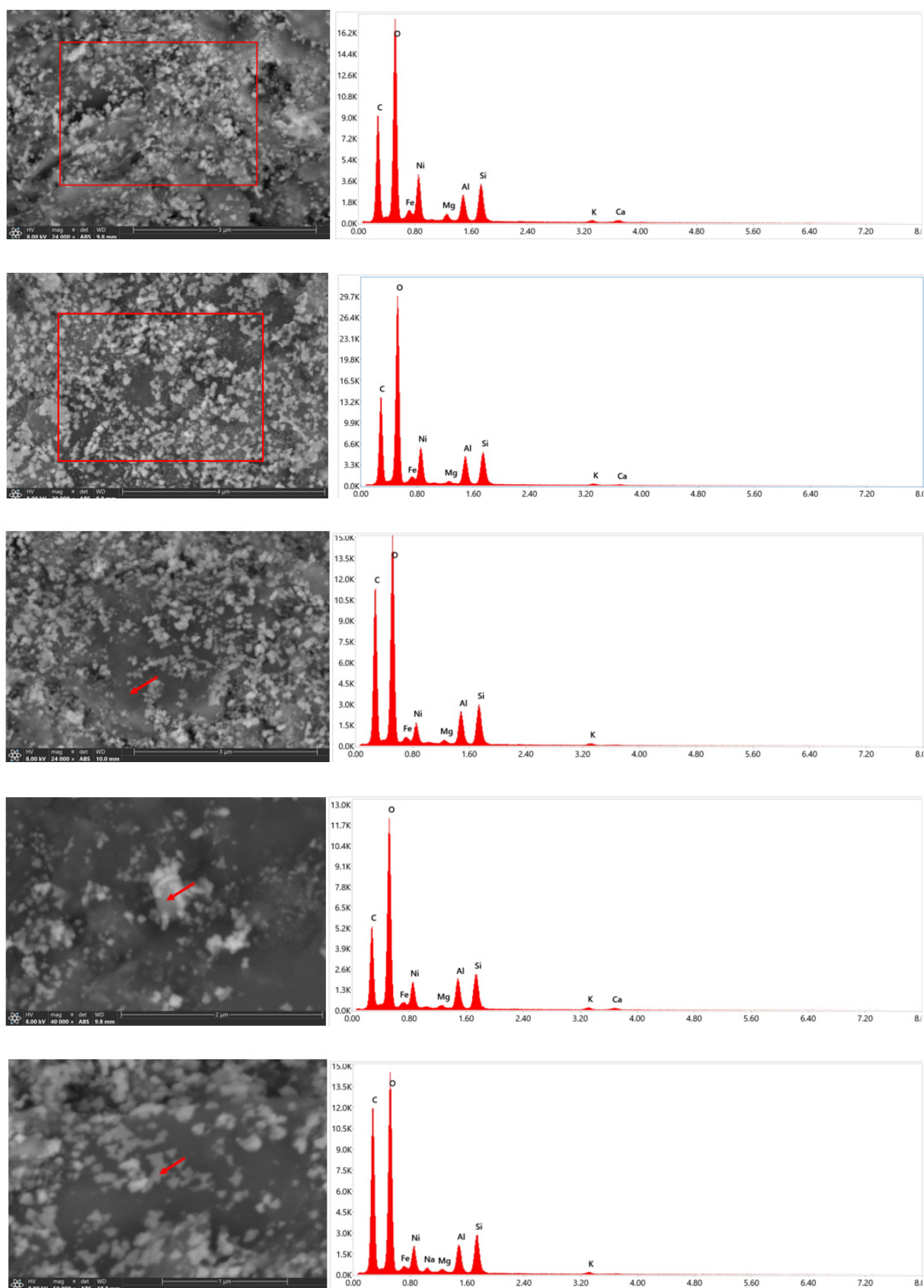


Figure S5. SEM-EDX analyses of the Ni/Clay catalyst, which highlighted the presence of minerals on the surface of the Ni/Clay catalyst.

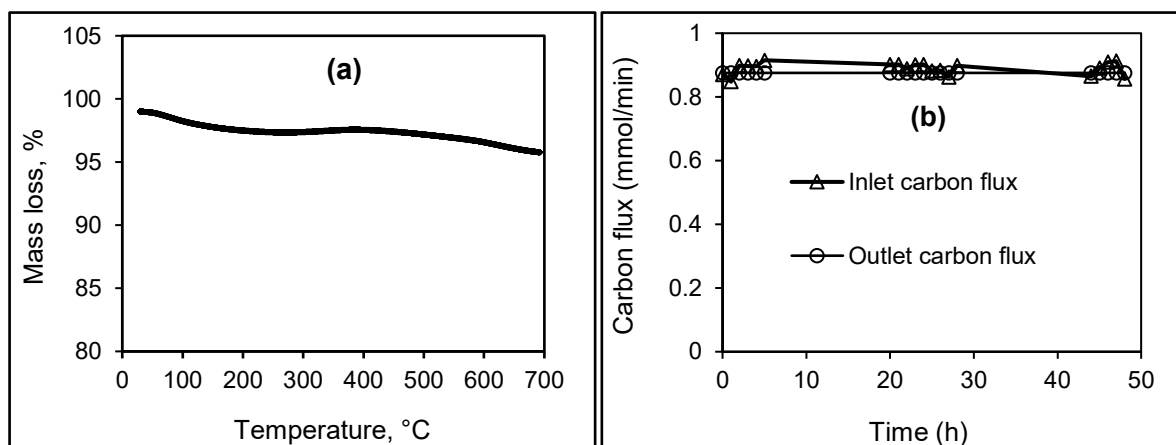


Figure S6. TG analysis (a) and carbon balance (b) in the methanation of the synthetic biogas over Ni/Clay for a long reaction time; reaction conditions: in-situ reduction at 500 °C, reaction temperature at 500 °C, 500 mg catalyst, inlet gas flowrate: 22.0 mL/min CO₂, 90 mL/min H₂, 3.75 mL/min N₂, and 33.75 mL/min CH₄; WHSV = 17940 mL·g_{cat}⁻¹·h⁻¹.

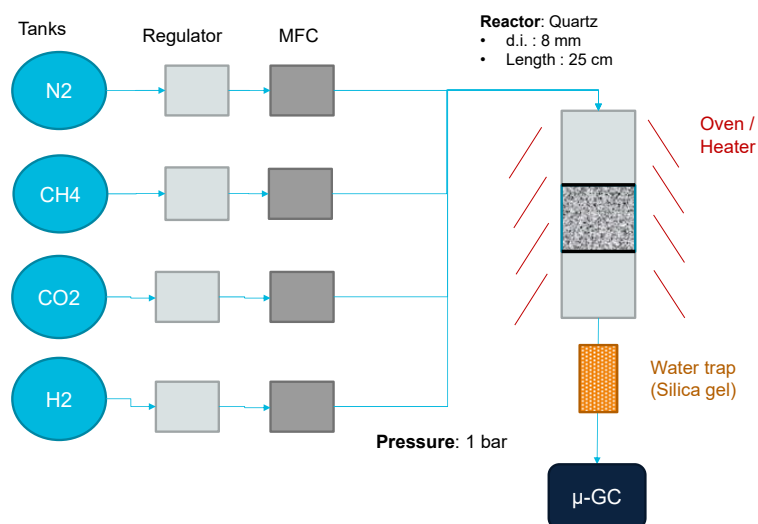


Figure S7. Schematic of the reactor system.

References

Guggenheim, S., Chang, Y.-H., & Koster van Groos, A. F. (1987). Muscovite dehydroxylation; high-temperature studies. *American Mineralogist*, 72(5–6), 537–550.

Keely, W. M., & Maynor, H. W. (1963). Thermal Studies of Nickel, Cobalt, Iron and Copper Oxides and Nitrates. *Journal of Chemical & Engineering Data*, 8(3), 297–300. <https://doi.org/10.1021/jc60018a008>