A highly competitive system for CO methanation over an active metal-free fibrous silica mordenite via *in-situ* ESR and FTIR studies

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ABSTRACT

Catalytic methanation of carbon monoxide (CO) offers a sustainable and attractive way to produce the synthetic natural gas (SNG), which can be a substitute for fossil fuels (coal, petroleum and natural gas) towards a low carbon future. This study focuses on CO methanation over a modified mordenite (FSMOR), which was synthesized through a microemulsion method. The Physico-chemical properties of the synthesized FSMOR were examined by field emission scanning electron microscope (FESEM), X-ray diffraction (XRD), transmission electron microscopy (TEM), N_2 adsorption-desorption isotherms, and electron spin resonance (ESR). The FSMOR showed a unique fibrous morphology, which has improved the CO conversion (73%), CH_4 selectivity (71%) and rate of formation (0.0491 µmol-CH_4/m^2s) remarkably due to enhancement in BET surface area, oxygen vacancies, and basicity. The FSMOR expressed high thermal stability and low carbon deposition compared to MOR, which was confirmed by thermogravimetric analysis (TGA), Raman and TEM observations. Besides, the *in-situ* ESR and FTIR observations proposed that the oxygen vacancies played a vital role to adsorb and activate the CO and H_2 molecules via linear adsorbed CO* as intermediates, which dissociated into adsorbed C* to form methane by hydrogenation. This study may open up new opportunities for metal-free heterogeneous catalysis systems to enhance the catalytic CO methanation to produce SNG.

KEYWORDS

CO methanation; SNG; Oxygen vacancy; Fibrous mordenite; *In-situ* ESR; *In-situ* FTIR

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