INTERNATIONAL JOURNAL OF HYDROGEN ENERGY 45 (2020) 24595–24603

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Effect of surface properties controlled by Ce addition on CO_2 methanation over Ni/Ce/Al_2O_3 catalyst

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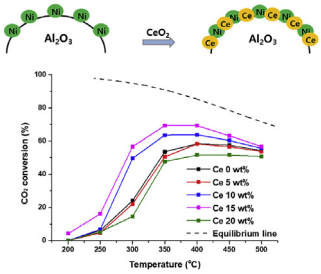
HIGHLIGHTS

- Effect of CeO_2 addition to Ni/γ-Al_2O_3 catalysts on CO_2 methanation is investigated.
- Ni/15Ce/Al_2O_3 showed good selectivity toward CO_2 methanation at low temperatures.
- Physical properties of the catalyst have little influence on CO_2 methanation.
- Oxidation state and chemical properties significantly affect CO_2 methanation.
- CO_2 methanation efficiency is independent on the amount of Ce^{3+}.

GRAPHICAL ABSTRACT



ARTICLE INFO

Article history:
Received 8 April 2020
Received in revised form
9 June 2020
Accepted 15 June 2020
Available online 11 August 2020

Keywords:
CO_2 methanation

ABSTRACT

Ce-promoted Ni/Al_2O_3 catalysts with Ce contents of 0, 5, 10, 15, and 20 wt% were investigated for CO_2 methanation. Ni/15Ce/Al_2O_3 showed good selectivity and catalytic performance in CO_2 methanation and remained stable at 350 °C for 80 h with minor fluctuations. Interactions between Ni and the Ce/Al_2O_3 support was characterized using X-ray diffraction, temperature-programmed reduction of H_2, temperature-programmed desorption of CO_2, X-ray photoelectron spectroscopy, Raman spectroscopy, and thermogravimetric analysis. Addition of Ce did not increase the catalytic surface area, which can significantly enhance the heterogeneous catalytic activity. However, XPS analysis showed that the Ce on the Ni/Al_2O_3 catalyst changed the surface electron states of Ni, Ce, and O. Additionally,

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https://doi.org/10.1016/j.ijhydene.2020.06.144