Promising hydrothermal technique for efficient CO2 methanation over Ni/SBA-15

Syahida Nasuha Bukhari[a], Chi Cheng Chong[a], Lee Peng Teh[b], Dai-Viet N. Vo[a,c], Nurul Ainirazali[a], Sugeng Triwahyono[d], Aishah Abdul Jalil[e,f], Herma Dina Setiabudi[a,c,]*

[a]Faculty of Chemical and Natural Resources Engineering, Universiti Malaysia Pahang, 26300, Gambang, Kuantan, Pahang, Malaysia

[b]School of Chemical Sciences and Food Technology, Faculty of Science and Technology, Universiti Kebangsaan Malaysia, 43600 UKM, Bangi, Selangor, Malaysia

[c]Centre of Excellence for Advanced Research in Fluid Flow, Universiti Malaysia Pahang, 26300, Gambang, Kuantan, Pahang, Malaysia

[d]Department of Chemistry, Faculty of Science, Universiti Teknologi Malaysia, 81310 UTM, Johor Bahru, Johor, Malaysia

[e]Department of Chemical Engineering, Faculty of Chemical and Energy Engineering, Universiti Teknologi Malaysia, 81310 UTM, Johor Bahru, Johor, Malaysia

[f]Centre of Hydrogen Energy, Institute of Future Energy, Universiti Teknologi Malaysia, 81310 UTM, Johor Bahru, Johor, Malaysia

ABSTRACT

The comparative study of different hydrothermal treatment techniques (Reflux (R) and Teflon (T)) and without hydrothermal technique (W) towards efficient CO2 methanation over Ni/SBA-15 was discussed. X-ray diffraction (XRD), inductive coupling plasma-atomic emission spectroscopy (ICP-AES), N2 adsorption-desorption isotherms (BET), Fourier transform infrared (FTIR) spectroscopy, UV-vis diffuse reflectance spectroscopy (UV-Vis DRS), scanning electron microscope – energy dispersion x-ray (SEM-EDX), and transmission electron microscope (TEM) analysis showed that Ni/SBA-15(R) possessed fascinating catalytic properties owing to the highest surface area (814 m2/g) and pore diameter (5.49 nm) of SBA-15(R), finest metal particles (17.92 nm), strongest metal-support interaction and highest concentration of basic sites. The efficacy of Ni/SBA-15 towards CO2 methanation was descending as Ni/SBA-15(R) > Ni/SBA-15(T) > Ni/SBA-15(W), implying the outstanding performance of Ni/SBA-15(R) which in parallel with the characterization results. The lowest performance of Ni/SBA-15(W) was due to the poorest properties of support; lowest surface area and pore diameter, largest Ni sizes, weakest metal-support interaction and lowest concentration of basic sites. This study successfully developed fascinating Ni/SBA-15 through the reflux hydrothermal treatment technique for CO2 methanation.

KEYWORDS: Ni/SBA-15; CO2 methanation; Hydrothermal; Si-O-Ni formation