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Basic surface sites of various Ni-supported catalysts for methanation of CO_2

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Carbon dioxide (CO_2) is considered to be a major factor in the greenhouse effect and its concentration in the atmosphere is increasing. Thus, decrease of CO_2 in the atmosphere is very important. Many techniques for CO_2 reduction and fixation have been developed and studied over the last decade. In these techniques, the process of CO_2 methanation is a practical approach to effectively decrease CO_2, because CO_2 is converted into reusable chemicals and an appropriate catalyst can promote the reaction under relatively moderate conditions at ambient pressure. Extensive studies have been carried out on the methanation reaction under various catalytic systems[1-3].

In this study, the catalysts containing 0.5 wt% Ni supported on Mesostructured silica nanoparticles (MSN), Silica, MCM-41 (Mobile Crystalline Material), HY (protonated Y zeolite) and γ-Al_2O_3 were prepared by impregnation method for the methanation of CO_2. Catalytic testing was conducted in the temperature range of 423-723 K under atmospheric pressure in the presence of H_2. The activity of CO_2 methanation followed the order: Ni/MSN > Ni/MCM-41 > Ni/HY > Ni/SiO_2 > Ni/γ-Al_2O_3. The high activity of Ni/MSN is due to the presence of both intra- and interparticle porosity which led to the high concentration of basic sites evidenced by N_2 isotherm and pyrrole adsorbed IR spectroscopy results. The methanation activities were found to be correlated to the concentration of basic sites as the basic sites were determined from the IR peak intensity of FTIR pyrrole adsoprtion (Figure 1). Therefore, high basic sites is essential for high carbon dioxide adsorption on the catalyst to form carbon species, while Ni sites dissociated hydrogen to form atomic hydrogen. The surface carbon species then interacted with atomic hydrogen to form methane.

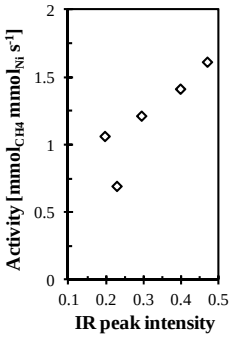

Figure 1 Variations in the FTIR signal intensities with activity.

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