Catalytic decomposition of methane into hydrogen and carbon nanotubes over mesostructured silica nanoparticle-supported nickel catalysts

ABSTRACT

Hydrogen is an alternative source of renewable energy that can be produced by methane decomposition without any COx formation. In this work, an impregnation method was used to prepare a set of Ni-based catalysts (5% to 50%) supported on mesostructured silica nanoparticles (MSNs) for its application in methane decomposition. The use of MSN as an effective support for nickel in methane decomposition was reported here for the first time. The physical, chemical and structural properties of the catalysts was studied and the results indicated that NiO was the active species in the fresh catalyst that were effectively distributed on the mesoporous surface of MSN. The reduction temperature of Ni/MSN catalysts were shifted to low temperatures with increased loading of nickel. The hydrogen yield increased with the increment of Ni amount in the catalysts. The catalytic activity of the 50% Ni/MSN catalyst showed that this catalyst was highly efficient and stable compared with other catalysts. The catalyst showed the highest hydrogen yield of 68% and remained more or less the same during 360 min of reaction. Approximately 62% of hydrogen yield was observed at the end of reaction. Further analysis on the spent catalysts confirmed that carbon nanotubes was formed over Ni/MSN catalyst with high graphitization degree.

Keyword: Hydrogen production; Mesostructured silica nanoparticles; Ni/MSN catalysts; Carbon nanotubes; Surface catalysis