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Natural gas conversion to chemicals over a novel Ni catalyst

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Natural gas (methane) can be converted to syngas through the reaction of CO_2 reforming of methane (DRM), and Ni-based catalysts have been considered to be potential commercial catalysts. However, the sintering of Ni particles and carbon deposition on Ni-based catalysts limited their applications. Therefore, to develop highly active and stable Ni-based catalysts are of vital importance. Various methods have been proposed to improve the performances of Ni-based catalysts, among which the dispersion of active sites has been mostly focused. In present research, we report a P123 (PEG-PPG-PEG triblock copolymer) modified wet impregnation method for preparing highly-dispersed supported Ni catalysts and the results of the catalytic performances of these Ni catalysts in DRM reaction.

The silica-based ordered mesoporous SBA-15 was used as the support and synthesized using TEOS as the precursor and P123 as the template. Supported Ni catalysts were prepared by adding P123 solution into Ni $(NO_3)_2{\cdot}6H_2O$ aqueous solution for the impregnation of the support, and the final obtained Ni catalysts were denoted as Ni/SBA15-P123 (1/X), in which 1/X indicates the molar ratio of n_{P123}/n_{Ni}. The crystalline phases of the catalysts were investigated by X-ray diffraction (XRD), and the morphologies were observed by Transmission Electron Microscopy (TEM). The catalytic performances of the catalysts in CRM reaction were evaluated with a vertical fixed-bed quartz tube reactor.

The characterization results of as-prepared Ni/SBA15-P123 showed that P123 addition could dramatically promote the dispersion of Ni on SBA-15, with addition of an optimized amount of P123 (n_{P123}/n_{Ni}) from 1/100 to 1/50. The reaction results of carbon dioxide reforming of methane revealed that the optimized Ni/SBA15-P123 (1/X) catalysts (1/X=1/100 - 1/50) exhibited much better stability than others during the 50 h test. The results of Raman, ^{1}H-NMR, UV-Vis, FTIR, and TPO suggested that the oxygen atoms of PEO blocks would coordinate with Ni^{2+}, NO_3^- and H_2O to form crown-ether-type complexes, which improved the dispersion and stabilization of the precursor, and this kind interaction of $Ni(NO_3)_2{\cdot}6H_2O$ and P123 would lead to a significantly improvement of Ni dispersion on SBA-15 support.

Biography:

Dr. Dehua He is currently a professor in the Department of Chemistry at Tsinghua University. He received his Bachelor degree on January 1982 at East China University of Science and Technology located in Shanghai, and completed his Master degree study on March 1987 at Okayama University, Japan. He obtained his Ph.D. degree on March 1990 at Tokyo Institute of Technology, Japan. He worked as a postdoctoral associate at Sagami Chemical Research Center (Japan) during April 1991 to August 1994. In 1995 he joined the Department of Chemistry at Tsinghua University as an associate professor. He was a guest researcher at Research Institute of Innovative Technology for the Earth (Japan) from April 1999 to March 2000, and a visiting scholar at The University of Virginia (USA) from November 2003 to May 2004. Dr. HE holds over 20 patents and publishes more than 150 papers in refereed professional journals.