World Academy of Science, Engineering and Technology
International Journal of Materials and Metallurgical Engineering
Vol:9, No:03, 2015

Selective Synthesis of Pyrrolic Nitrogen-Doped Carbon Nanotubes Its Physicochemical Properties and Application as Pd Nanoparticles Support

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Abstract : Understanding the role of nitrogen species on the catalytic properties of nitrogen-doped carbon nanotubes (N-CNTs) as catalysts supports is critical as nitrogen species influence the support's properties. To evaluate the influence of pyrrolic nitrogen on the physicochemical properties and catalytic activity of N-CNTs supported Pd (Pd/N-CNTs); N-CNTs containing varying pyrrolic contents were synthesized. The catalysts were characterised by the use of transmission electron microscope (TEM), scanning electron microscope, X-ray photoelectron spectroscopy (XPS), X-ray diffraction, Fourier transform infrared spectroscopy, and temperature programmed reduction. TEM analysis showed that the Pd nanoparticles were mainly located along the defect sites on N-CNTs. XPS analysis revealed that the abundance of Pd0 decreased while that of Pd2+ increased as the quantity of pyrrolic nitrogen increased. The increase of Pd2+ species was accredited to the formation of stable Pd-N coordination complexes which prevented further reduction of Pd2+ to Pd0 during synthesis. The formed Pd-N complexes increased the stability and dispersion of Pd2+ nanoparticles. The selective hydrogenation of nitrobenzophenone to aminobenzophenone over Pd/N-CNTs was compared to that of Pd on carbon nanotubes (Pd/CNTs). Pd/N-CNTs showed a higher catalytic activity and selectivity compared with Pd/CNTs. Pyrrolic nitrogen functional groups significantly promoted the selectivity towards aminobenzophenone formation.

Keywords : pyrrolic N-CNTs, hydrogenation reactions, chemical vapour deposition technique
Conference Title : ICNMN 2015 : International Conference on Nanostructured Materials and Nanotechnology
Conference Location : Miami, United States
Conference Dates : March 09-10, 2015