Synthesis and Characterization of Ordered Microporous Carbon Materials Containing Dispersed Transition Metal Particles

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Abstract.
Carbon has long been deemed a good catalyst support material because of its unique physical and chemical properties. However, traditionally used activated carbon based materials have a broad pore size distribution ranging from micropores to macropores, which severely limited their application.\textsuperscript{[1]} In recent years, porous carbon materials prepared by soft templating and hard template casting have gained much attention for their potential as support materials for heterogeneous catalysts because of their large specific surface area, uniform pore size distribution, tunable porosity, and well-defined surface properties.\textsuperscript{[2]}

In our current work, nano-structured microporous carbons containing dispersed transition group VIII metal nano-particles are synthesized by a direct hard templating approach. This is done by using transition metal impregnated zeolites as templates and acetylene gas as the carbon precursor. Scanning electron microscopy images for the produced carbons show that the carbon particles have retained their parent zeolites’ crystal-like morphology. The texture properties of the final carbon products are analysed and confirm that most of the produced carbons possess a high surface area and high micropore volume. Very few mesopores are detected. Transmission electron microscopy results have revealed most of the templated carbons contain fringes, suggesting an ordered structure. Some carbons exhibit graphitic nature, which we believe results from the metal which has a strong ability to form graphitic carbon. It is also clear that metal particles are distributed in the carbon matrix with some of the metals well dispersed and others in bigger clusters. XRD results have further confirmed the presence of metal. A small, broad diffraction peak at around 2 theta ~ 6° suggest some of the regular structure has formed a longer periodical order detectable by XRD. Hydrogen adsorption properties of the developed carbons are also investigated. The binding energy between the different transition metals and the hydrogen gas molecule is calculated and thoroughly compared. Metal active surface area and metal dispersion have been measured by temperature programmed desorption by using a Micromeritics AutoChem 2950HP instrument. Natural gas conversion to hydrogen and catalyst coking are also investigated in this work to test the catalytic properties of the carbon supported catalysts.

References