Preparation and Characterization of Ruthenium/Carbon Aerogel Nanocomposites via a Supercritical Fluid Route

Ying Zhang,[†] Dafei Kang,[‡] Mark Aindow,[‡] and Can Erkey*[,†]

Department of Chemical Engineering, Environmental Engineering Program, University of Connecticut, Storrs, Connecticut 06269, and Department of Materials Science and Engineering, Institute of Materials Science, University of Connecticut, Storrs, Connecticut 06269-3136

Received: July 21, 2004; In Final Form: November 5, 2004

Carbon-aerogel-supported ruthenium nanoparticles were synthesized by impregnating carbon aerogels with $Ru(acac)_3$ or $Ru(cod)(tmhd)_2$ from supercritical carbon dioxide ($scCO_2$) solutions, followed by thermal reduction of these precursors. Two different carbon aerogels with pore diameters of 4 and 21 nm were synthesized. The kinetics and the thermodynamics of impregnation of carbon aerogels with the ruthenium coordination complexes were studied. The approach-to-equilibrium data indicated very fast adsorption, and the adsorption isotherms were found to follow the Langmuir model. The impregnated carbon aerogel complexes were reduced thermally at different temperatures between 300 and 1000 °C in the presence of nitrogen. The resulting nanocomposites were characterized using transmission electron microscopy (TEM) and hydrogen chemisorption. TEM micrographs showed that the ruthenium nanoparticles were dispersed homogeneously throughout the porous carbon aerogel matrix, and the average sizes obtained under different conditions ranged from 1.7 to 3.8 nm. Once complete decomposition of the precursor had been achieved, the mean size of the ruthenium particles increased with increasing reduction temperature.