



Chemical Vapor Deposition and Synthesis on Carbon Nanofibers: Sintering of Ferrocene-Derived Supported Iron Nanoparticles and the Catalytic Growth of Secondary Carbon Nanofibers

Wei Xia¹, Dangsheng Su², Alexander Birkner³, Lars Ruppel³, Yuemin Wang¹, Christof Wöll³, Jun Qian¹, Changhai Liang¹, Gabriela Marginean⁴, Waltraut Brandl⁴, and Martin Muhler¹

¹Laboratory of Industrial Chemistry, Ruhr University Bochum, D-44780 Bochum, Germany,

²Department of Inorganic Chemistry, Fritz Haber Institute of the Max Planck Society, D-14195 Berlin, Germany

³Lehrstuhl für Physikalische Chemie I, Ruhr University Bochum, D-44780 Bochum, Germany,

⁴Material Science and Testing, University of Applied Sciences Gelsenkirchen, D-45877 Gelsenkirchen, Germany

Abstract

The synthesis of homogeneously distributed carbon nanofibers with well-defined morphology on vapor-grown carbon nanofibers was achieved by a sequence of gas-phase steps, thus fully avoiding wet chemistry: first, carbon nanofibers were exposed to oxygen plasma to introduce oxygen-containing functional groups. Then, the chemical vapor deposition of ferrocene was carried out under oxidizing conditions, yielding nanofiber-supported iron oxide nanoparticles. Secondary carbon nanofibers with diameters in the range from 10 to 20 nm were subsequently grown from cyclohexane catalyzed by the sintered metallic iron nanoparticles under reducing conditions. XPS was applied to monitor the chemical changes of the surface composition and the sintering of the metallic iron particles in hydrogen. The morphology and the height distribution of the sintered iron oxide nanoparticles was derived by a unique combined application of scanning electron microscopy and scanning tunneling microscopy. The specific surface area of the nanocomposite was enhanced strongly due to the growth of secondary nanofibers, and it was possible to tune the morphology of the nanofiber-nanofiber composites by the process parameters. Thus, a significant advance in the reproducible synthesis of branched carbon fiber nanocomposites was achieved.