331g Kinetic Investigations of Co Disproportionation on Co-Mo/Mgo Bimetallic Catalyst for Single Wall Carbon Nanotubes Production

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Single wall carbon nanotubes (SWNT) have been intensively investigated due to their unique electrical, thermal and mechanical properties. However, due to the high cost of current production and purification methods, the transfer of such technologies to commercial scale has been hindered. Various methods, namely electric arc discharge, laser ablation, plasma discharge, plasma enhanced chemical vapor deposition and thermal chemical vapor deposition have been employed for synthesis of SWNT. Electric arc discharge method results in formation of fullerenes together with nanotubes as well as embedded catalyst particles within nanotubes. Plasma discharge and plasma enhanced CVD methods produce good quality nanotubes but are limited to gram scales. For bulk growth of carbon nanotubes thermal chemical vapor deposition process may be the best choice for large scale production, owing to its low cost, high purity, controlled growth and better yields. In this talk we will report on a study of the rate of CO disproportionation over bimetallic Co-Mo catalysts with Magnesium oxide (MgO) as support, at temperatures between 650 °C to 750 °C and atmospheric pressure. Effects of temperature, CO/CO_2 composition, flow rates and catalyst deactivation have been investigated in order to determine kinetic constants. Nanotubes were synthesized in a three step procedure namely calcination at 500 °C under air, system was pumped followed by back filling with hydrogen for reduction of metal oxides also at 500 °C. Hydrogen was removed and deposition of nanotubes was carried out using CO as carbon source at temperatures between 650- 750 °C. The system was allowed to cool under argon to room temperature. CO_2 concentrations were monitored at the reactor exit using a calibrated CO_2 gas analyzer. A kinetic mechanism and rate law is proposed over the temperature range studied. SWNT and catalyst were characterized using Raman spectroscopy, X-ray diffraction, and scanning and transmission electron microscopy.