Synthesis and characterization of metal nanoparticles using supercritical methanol in a continuous system

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Nickel (Ni), cupper (Cu) and silver (Ag) nanoparticles were synthesized continuously in supercritical methanol (scMeOH) without using reducing agents at a pressure of 30 MPa and at various reaction temperatures ranging 150-400 oC. Wide angle X-ray diffraction (WAXD) analysis revealed that metallic Ni nanoparticles were synthesized at a reaction temperature of 400 oC while mixtures of nickel hydroxide (-Ni(OH)2) and metallic Ni were produced at lower reaction temperatures of 250-350 oC. In contrast, metallic Ag nanoparticles were produced at reaction temperatures above 150 oC while metallic Cu nanoparticles were produced at reaction temperature above 300 oC. Mixtures of copper oxide (CuO and Cu2O) and metallic Cu were produced at lower reaction temperatures of 250 oC. Scanning electron microscopy (SEM) showed that the particles size and morphology changed drastically as the reaction temperature increased. The average diameters of Ni, Cu and Ag particles synthesized at 400 oC were 119 ± 19 nm, 240 ± 44 nm, and 148 ± 32 nm, respectively. The scMeOH acted both as a reaction medium and a reducing agent.