Preparation, characterization and catalytic activity of biomaterial-supported copper nanoparticles

ABSTRACT

Synthesis of copper nanoparticles was carried out with nanocrystalline cellulose (NCC) as a support by reducing CuSO4·5H2O ions using hydrazine. Ascorbic acid and aqueous NaOH were also used as an antioxidant and pH controller, respectively. The synthesized copper nanoparticles supported on NCC (CuNPs@NCC) were characterized by UV–vis, XRD, TEM, XRF, TGA, DSC, N2 adsorption-desorption method at 77 K and FTIR. The UV–vis confirmed the formation and stability of the CuNPs, which indicated that the maximum absorbance of CuNPs@NCC was at 590 nm due to the surface plasmon absorption of CuNPs. Morphological characterization clearly showed the formation of a spherical structure of the CuNPs with the mean diameter and standard deviation of 2.71 ± 1.12 nm. Similarly, XRD showed that the synthesized CuNPs@NCC was of high purity. The thermal analysis showed that the CuNPs@NCC exhibited better thermal behaviors than NCC. BET surface area revealed that the N2 adsorption–desorption isotherms of CuNPs@NCC featured a type IV isotherm with an H3 hysterisis loop. This chemical method is simple, cost effective, and environmentally friendly. Compared to NCC-supported CuNPs and unsupported CuNPs, the as-prepared CuNPs@NCC exhibit a superior catalytic activity and high sustainability for the reduction of methylene blue with NaBH4 in aqueous solution at room temperature. The CuNPs@NCC achieved complete reduction of MB with completion time, rate constant and correlation coefficient (R 2) of 12 min, 0.7421 min−1 and 0.9922, respectively.

Keyword: Nanocrystalline cellulose; Copper nanoparticles; Hydrazine hydrate; Methylene blue; Catalyst