Scientific paper

Synthesis and Characterization of Zinc Oxide Nanoparticles with Small Particle Size Distribution

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Abstract

Solvothermal synthesis has shown to have a great potential to synthesize Zinc Oxide nanoparticles (ZnO NPs) with less than 10 nm size. In this study, we present a rapid synthesis of ZnO NPs in which ZnO NPs with more uniform shape and highly dispersed were synthesized using zinc acetate dihydrate ($Zn(CH_3COO)_2\ 2H_2O$) and potassium hydroxide (KOH) as a precursor and absolute ethanol as solvent via solvothermal method. Few techniques were exploited to characterize synthesized ZnO NPs including X-ray diffraction (XRD), transmission electron microscope (TEM), Brunauer-Emmett-Teller (BET), energy-dispersive X-ray spectroscopy (EDX), fourier transform infrared (FT-IR) spectroscopy, and ultraviolet visible (UV-Vis) spectroscopy. Synthesized ZnO NPs that were prepared via solvothermal synthesis method at 60 °C for 3 hours exhibited a wurtzite structure with a crystalline size of 10.08 nm and particle size of 7.4 ± 1.2 nm. The UV-vis absorption spectrum has shown peak at 357 nm indicate the presence of ZnO NPs. Hence, better quality with uniform size ZnO NPs can be easily synthesized with reduced amount of time via solvothermal synthesis method rather than using other complicated and lengthy synthesis methods.

Keywords: Zinc Oxide nanoparticles; Solvothermal method; Small particle size; Spectroscopy

1. Introduction

High demands of nanomaterials have produced enormous applications in global industries. Due to high demand as NPs based products, various types of engineered nanoparticles (ENPs) are synthesized for myriad of applications.[1] These days, ZnO NPs have become a promising candidates and gained more attention especially in nanomedicine and nano-semiconductors.[2–4] ZnO NPs exhibit wurtzite crystal structure that has been widely used in industries due to its unique optoelectric properties.[5] ZnO NPs are among of various semiconductivity materials with a distinctive electronic and photonic wurtzite semiconductor with a wide direct band gap (3.37eV) and high exciton binding energy (60 meV) at room temperature.[6] This makes ZnO NPs particularly popular for use in commercially available especially in sunscreens and cosmetics which able to block UV radiation when they are less than 50 nm.[7–9] Heiligtag *et al.*[10] stated that smaller size of NPs provide a better protection of skin against UV damage.

Besides, high optical absorption UVA and UVB in ZnO NPs are also beneficial in antimicrobial products in nanomedicine as nowadays various nanomaterials development have been applied to improve drugs and other medicine.[11] Among other MO NPs, Salem *et al.*[12] stated that ZnO NPs are the most recommended for antibacterial agent. Hence, the increase productions of consumer products eventually increase the productions of ZnO NPs. Heiligtag *et al.*[10] has also stated that the potential applications of ZnO NPs make them one of a primary focus in NPs research. Naveed Ul Haq *et al.*[13] also described that ZnO NPs is one of the cheap materials that this causes the extensive productions in industries. Morphologically, ZnO NPs is an attractive compound that possess thermal and chemical stability.[14] ZnO NPs are made into various shapes and sizes depending on the use of NPs in industries including textile, energy, food, cosmetics, and medicines and other characteristics that make them attractive for broad range of application.[15]