CHAPTER 4

CONCLUSIONS AND SUGGESTIONS

4.1 Conclusions

4.1.1 Synthesis of zinc oxide (ZnO) by a hydrothermal method with different alkaline base solution

1) Synthesis of ZnO with NaOH by a hydrothermal method

The good crystalline hexagonal prism ZnO nanorods with high density were synthesized on Zn substrates by the 120°C and 24 h hydrothermal reaction without the use of any catalysts or additives. Phases of the products were investigated by XRD, specified as wurtzite hexagonal ZnO structure on Zn plates. SEM and TEM images revealed the presence of the hexagonal prism ZnO nanorods, preferentially grown along the [001] direction. Room temperature PL spectra were sharp and strong with the green-yellow emission at 543 nm.

2) Synthesis of ZnO with LiOH by a hydrothermal method

Wurtzite ZnO solids were successfully synthesized on zinc substrates by a simple hydrothermal method at 120 °C for 24 h using 0.05–0.40 g LiOH. The phase, morphology and photoluminescence were characterized by X-ray diffraction, electron microscopy and spectrophotometry. In this part, the products were hexagonal wurtzite ZnO structure with the as-grown flower-like clusters composed of hexagonal prisms with planar and hexagonal pyramid tips on Zn substrates grown along the [0001] direction. Photoluminescence spectra exhibited

strong green emission at 543 nm due to the presence of oxygen vacancies in the solid.

3) Comparing the antibacterial activity of ZnO, synthesized with different kind of base by a hydrothermal method

ZnO nanostructures have been successfully synthesized on Zn plate through a simple hydrothermal method at 120 °C for 24 h. The morphologies of the hexagonal wurtzite structure were controlled by utilizing different alkaline precursors, which dramatically influenced crystallization progress, precipitation, recrystallization, crystal growth and morphology formation. The as-synthesized products, which were shaped as rods, pencils and stars, were obtained in solutions containing NaOH, LiOH and NH4OH, respectively. These products emit a green-yellow band at 540 nm, and they exhibit antibacterial activity.

The application of the as-synthesized nanostructured ZnO films was investigated in terms of qualitative antibacterial activity by applying the Kirbey–Bauer method. The bactericidal activity was determined based on an inhibition zone. ZnO could be used as an antibacterial agent for both gram-negative (Escherichia coli) and gram-positive (Staphylococcus aureus) bacteria. ZnO products with different nanostructures have different physical and chemical properties that promote bactericidal effects. For these nanostructured ZnO products with different morphologies (rod-like, pencil-like and star-like), there were some differences in emission intensity, photo-generated e^{-}-h^{+} pairs and concentration of the generated ROS, which caused different extent in making harm to bacteria.

4.1.2 Synthesis of copper oxide (CuO) by solution chemistry at room temperature

CuO thin films on Cu foils were successfully synthesized by a simple wet chemical method by emersion of the foils in the 10 ml alkaline (10 M NaOH) solution with the pH of 13 at room temperature for different lengths of time. For two weeks long, the Cu foil was covered with assemblies of nanospindles with different orientations of pure CuO on top. This film showed two strong violet emission intensities at 400 nm (3.10 eV) and 413 nm (3.00 eV) with broad tails in the green spectral region. Due to the UVA radiation, assemblies of pure CuO nanospindles film of the bottom side showed antimicrobial activity against S. aureus better than E. coli by generating reactive oxygen species (ROS) to disrupt them.

4.2 Suggestions

1) Synthesis and characterization of the other transition metal oxides, such as Fe_2O_3 on Fe plate and etc.

2) Change the synthetic method which used low temperature and shorter reaction time such as sonochemical method

3) Investigate other application such as photocatalysis and gas sensor.