CHAPTER V
CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

The synthesized particles fabricated at pH 5-9 and at temperatures between 60-100 °C for 1h are confirmed to be the single phase hexagonal structure and highly crystalline hematite. The physical morphology of the synthesized hematite seems to be composed of a large number of very small particles with the highest specific surface area of 55.4 m^2/g and consisting of the hydroxyl (OH) surface structure. The particle size of the synthesized hematite decreases with decreasing of the precursor concentration and the amount of catalyst. The solution pH provides the maximum particle size at the neutral pH, which is preferred for the growth step by dissolution/reprecipitition process. The effect of the transformation mechanism from ferrihydrite to hematite can overcome the effect of the ionic strength of the reaction system. The reaction temperature and the reaction time have no significant effect on the hematite particle size. The synthesized hematite particles can be successfully controlled to be in the range of 50-150 nm possessing three different morphologies, consisting of the spherical-like, the cubic-like, and the ellipsoidal shapes. The particle size and shape of the synthesized hematite critically affect their electrical and magnetic properties. The specific conductivity (σ) increases with decreasing of the hematite particle size and the smallest particle possesses the highest conductivity of 5.2×10^{-3} S/cm. The large hematite particles exhibit hysteresis loops indicated the weak ferromagnetic behavior at room temperature with the highest M_s of 1.94 emu/g, and change from multidomain to single domain exhibited the superparamagnetism as the particle size further decreases. Moreover, the different shape hematite also shows varying magnitudes of the magnetic parameters in the hysteresis loops as discussed.

5.2 Recommendations

In this work, the synthesized hematite nanoparticles were successfully prepared by using this simple chemical precipitation method with low reaction temperature (60-100°C) and a very short reaction time within 1 h. This synthesis method employed with controlling synthesis conditions can be easily controlled the particle size and morphology of the hematite nanoparticles.

Generally, the synthesized hematite particles have been used only in pigments, gas sensors, catalysts, photoelectrolysis reactors, photoanode for photoelectrochemical cells, and so on, excluding magnetic application because of its weak ferromagnetic behavior. The method to improve their magnetic properties is by doping some foreign atom such as Ti^{4+} substituting some Fe^{3+} in hematite structure which is well known as titanohematite ($Fe_{2-y}Ti_yO_3$) occurred in the nature as Hematite-Ilmenite (Fe_2O_3-$FeTiO_3$). However, the doping process usually carries out at high temperature and pressure. The further study maybe focused on the possibility of using this simple synthesis method to improve the magnetic properties of hematite.