Effect of Surfactants on Growth Kinetics of ZnO Nanoparticles

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Abstract

The growth of ZnO nanoparticles (NPs) reverse micelle has been investigated. NPs of controlled particle sizes (1.50–2.65 nm) were synthesized by adding surfactant stabilized propanol-2 + water mixed solvent to basic solution of zinc acetate at critical micelle concentration (CMC). The reaction time was 2 hours. The compositions where reverse micelle formed were used to determine the effect of surfactant on the growth of NPs. The particle sizes calculated from UV-visible spectrum using Effective Mass Model agreed fairly well with those reported in the literature. UV-visible spectrum has evidenced the gradual shifting of the absorption edge towards blue region with time and the results suggested that the increase of reaction time was necessary to obtain uniform ZnO NPs. The ZnO NPs were capped in the polar core of the reverse micelle which might have formed surface ion - pair by electrostatic interaction to ensure a suitable reactor to synthesize NPs.

Introduction

A number of methods have been employed to synthesize ZnO NPs with varying morphologies to manipulate electric, optical and magnetic properties of the NPs. Among the various methods, the reverse micelle method [1] has turned out to be a versatile route and relatively simple method for synthesizing ZnO NPs [2-3]. This synthetic approach is expected to produce uniform NPs with minimum structural and surface defects. The influence of solvent on the growth kinetics of ZnO NPs has been previously reportred [4]. Therefore, the aim of this research is to study the effects of surfactant on the growth kinetics of ZnO NPs by using propanol-2 + water mixed solvent by reverse micelle method.

Experimental

Basic solution of Zn^{2+} was prepared from zinc acetate and NaOH in propanol-2. The surfactant sodium dodecyl sulphate (SDS) or cetyl trymethyl ammonium bromide (CTAB) solution was added to the prior solution in such a way that the CMC is reached which was previously determined. The reaction was carried out under this condition for 2 h. The synthesized ZnO NPs were characterized by UV-Visible spectrophotometer (Shimadzu 1650-PC, Japan).

Results and discussion

The growth of ZnO NPs was monitored by an UV-visible spectrophotometer. When the ZnO NPs were prepared in absence of any surfactant a non-uniform mixture of ZnO nanoparticles having final particle radius 2.16 nm was obtained. However, in the event of surfactant, SDS, sizes of ZnO NPs were found to be increased from 2.16 to 2.43 nm. This indicates the micelle core of the surfactant favors the growth process of ZnO NPs, evidenced by the absorption spectrum, which shows the gradual increase of the particle size with time as shown in Figure 1(a) & 1(b). Similar observation was found for other systems. Similar results were observed in

case of cationic surfactant, CTAB (results were not shown here). It is interesting to observe from the absorption edge at 1.30 h and at 2 h almost same.

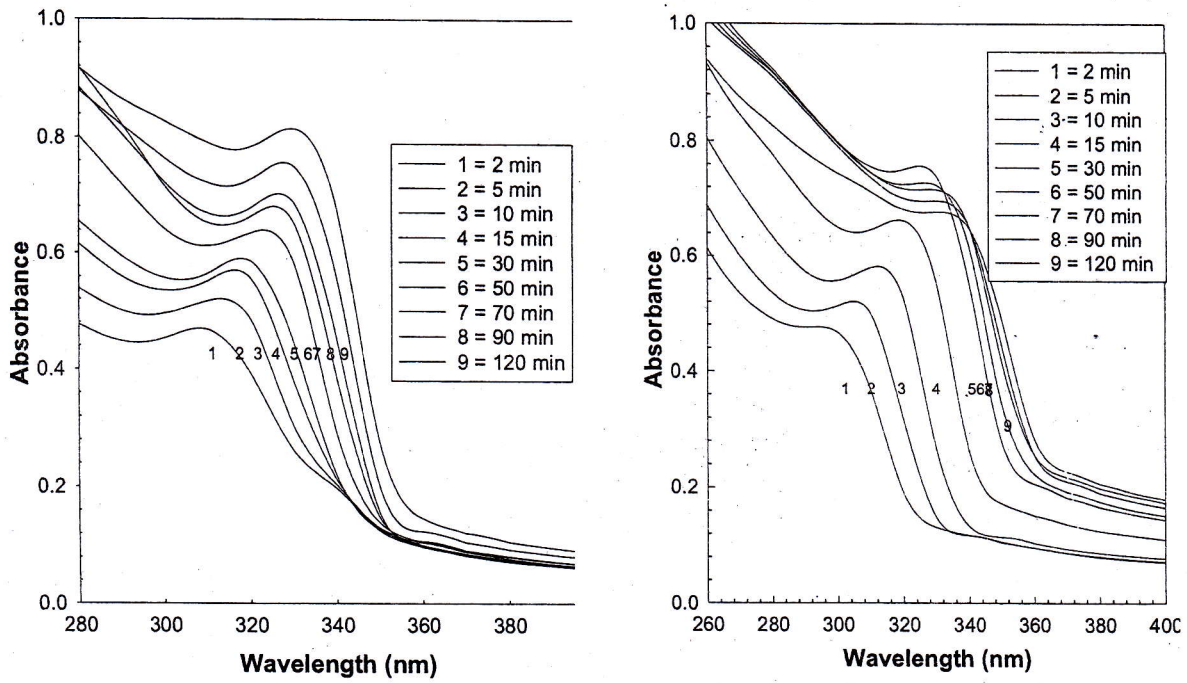

Fig. 1 Absorption spectrum for the growth of ZnO NPs (a) in absence of any surfactant (b) in presence of SDS The surfactant solution was prepared in Propanol-2 : H_2O (18:2)

Conclusion

Effect of surfactants on the growth process of ZnO NPs has been successfully studied through reverse micelle method. Both SDS (anionic) and CTAB (cationic) effectively influenced the growth kinetics of ZnO NPs and the particle size increased upon the addition of surfactant solution. This method gives us preliminary information to synthesis uniform NPs in the reverse micelle core of the surfactants. Further studies are underway to synthesize uniform ZnO NPs.

References

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