Journal Homepage: -www.journalijar.com
INTERNATIONAL JOURNAL OF ADVANCED RESEARCH (IJAR)
ISSN NO. 2320-5407
Article DOI:10.21474/IJAR01/1533
DOI URL: http://dx.doi.org/10.21474/IJAR01/1533

*RESEARCH ARTICLE*

# TEMPERATURE AND PARTICLE SIZE DEPENDENT D.C CONDUCTIVITY OF ZINC SULFIDE NANOMATERIALS PREPARED BY USING INDIAN OLIVE LEAF EXTRACT.

**Uday Sankar Senapati.**
Department of Physics, Handique Girls' College, Guwahati-781001, India.

***Manuscript Info***

***Manuscript History***

Received: 12 July 2016
Final Accepted: 19 August 2016
Published: September 2016

***Key words:-***
Green Synthesis, ZnS, D. C. conductivity.

***Abstract***

Green synthesis materials are considered as the substantial alternative of chemical based materials as they are environment friendly and cost effective. Study of electrical properties of engineering material is very important as it helps in optimizing sample parameters for better device applications. In this article effect of average particle size and temperature on D.C conductivity of Zinc Sulfide nano materials prepared by using a green synthesis route is reported.



## Introduction:-

Zinc Sulfide (ZnS) has been largely investigated as an important wide band gap semiconductor (3.68 eV). It is one of the most important materials in the electronics industry with a wide range of applications. From the viewpoint of device performance it is important to study D. C conductivity of ZnS nanomaterials at different temperature. Along with, properties of ZnS nanomaterials depend on their average particle size. Therefore, in this present study we report temperature and size dependence of D. C. conductivity of ZnS nanoparticle prepared by using a green synthesis route which is great concern now a days.

## Results and Discussion:-

The variation in the $\sigma_{dc}$of ZnS samples with different average particle sizes (8, 6 and 3 nm respectively for ZnS I, ZnS II and ZnS III (Senapati and Sarkar, 2015)) in the temperature range of 303K- 373K was shown in Figure1. From the Figure it was found that there was an increase in $\sigma_{dc}$ with an increase in temperature as well as decrease in average particle size. $\sigma_{dc}$ values of ZnS nanoparticles were much higher ( of the order of $10^{-5}\ \Omega^{-1}\ cm^{-1}$ ) than that of bulk ZnS which is reported to be of the order of $10^{-13}\ \Omega^{-1}\ cm^{-1}$ (Nair and Khadar, 2008). To explain the increase in $\sigma_{dc}$ with temperature, the carrier trapping model (Saravanan et al., 2012) can be applied. According to this model the presence of defects play a key role in conductivity of polycrystalline wide band gap semiconductor materials. In ZnS nano materials a significant amount of defects were trapped and immobilized across the grain boundaries. Therefore significant space near the grain boundary was charge depleted and potential barrier was thus created across the grain boundary. This barrier resisted the transport of free carriers between the grains. Since the grain boundaries were charged with electrons, when the temperature increased the electrons emitted thermionically and tunnelled across the thin barriers. The increase in $\sigma_{dc}$ with decrease in average particle size was described with the help of another simple model. In this model the total interfacial region ($V_{if}$), grain boundaries ($V_{gb}$) and triple junctions ($V_{tj}$) of nanostructured ZnS samples were calculated by assuming that grains had a regular 14 sides tetrakaidecahedron shape. Earlier worker had employed this model for calculating the interfacial volume fractions of nickel oxide (NiO) nanomaterial (Biju and Khadar, 2001). However, to the best of our knowledge this model had not been employed for ZnS nanomaterial. Therefore, it was worthwhile to apply this model in case of ZnS nanomaterial. The volume fractions are given by (Nair and Khadar, 2008):

**Corresponding Author:-Uday Sankar Senapati.**
Address:-Department of Physics, Handique Girls' College, Guwahati-781001, India.

$$V_{if} = 1-\left[\frac{(d-D)}{d}\right]^3 \quad (1)$$

$$V_{gb} = \frac{[3D(d-D)^2]}{d^3} \quad (2)$$

$$V_{tj} = [V_{if} - V_{gb}] \quad (3)$$

where d is the average particle size and *D/2* is the thickness of the interfacial region. *D/2* was taken as 0.5 nm which was realistic in the size range of the particles in the present study. Figure 2 showed the variation of $V_{if}$, $V_{gb}$ and $V_{tf}$ with average particle size of ZnS nanoparticles. From this Figure it was found that $V_{if}$ was maximum for ZnS III with a minimum average particle size of 3 nm and decreased gradually as the average particle size increased to 8 nm for ZnS I. $V_{gb}$ and $V_{tf}$ were also higher for smaller particles. The increased of volume fractions with decreasing particle size was due to the more charge carriers being trapped at shallow levels of the grain boundary. As a result the barrier height of the grain boundaries decreased so that the thermionic emission of the charge carriers from one grain to another became easier. Therefore $\sigma_{dc}$ increased with decreased in average particle size of nanostructured ZnS samples.

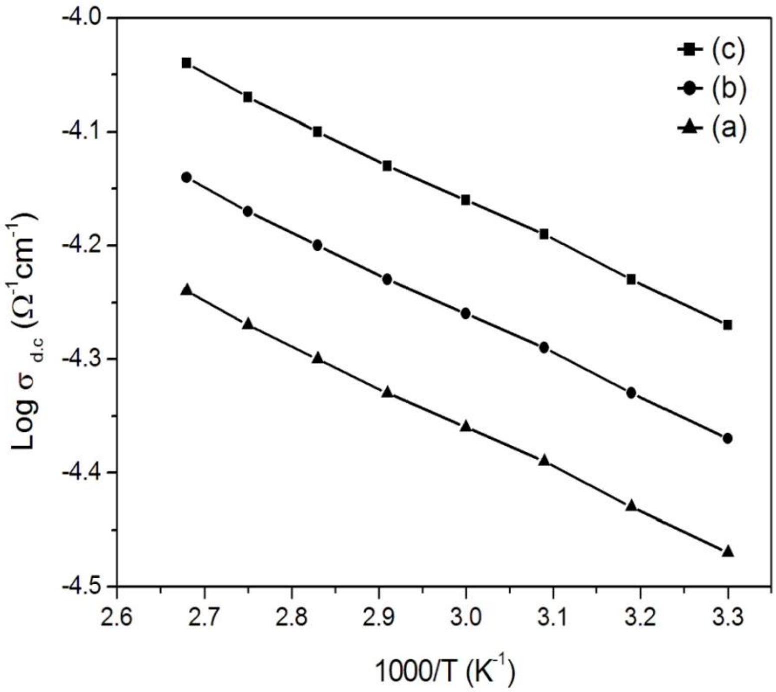


**Figure 1:-** Variation of $\sigma_{dc}$ with temperature for (a) ZnS I, (b) ZnS II and (c) ZnS III. The experimental procedure of this present work was similar to as described in the reported work (Senapati and Sarkar, 2015). ZnS I, ZnS II and ZnS III were obtained by using 10, 20 and 30 ml olive leaf extract respectively. I-V measurements of compressed pellet of powdered samples were carried out using Keithley sourcemeter (model 2400).

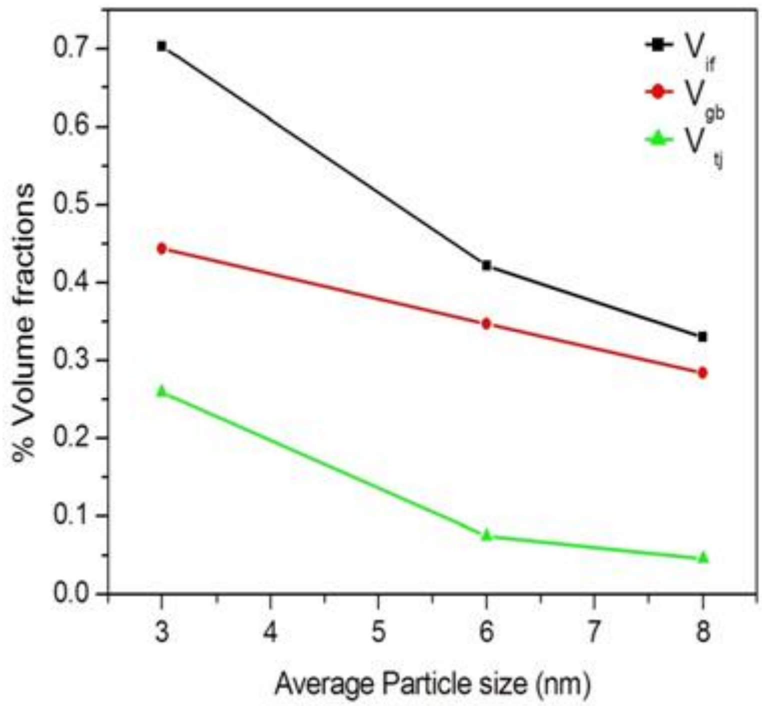


**Figure 2:-** Variation of the calculated volume fractions of total interfacial region ($V_{if}$), grain boundaries ($V_{gb}$) and triple junctions ($V_{tj}$) as a function of the average particle size of ZnS nanoparticles.

## Conclusion:-

D. C conductivity of ZnS nanoparticles prepared by using Indian olive leaf extract as a capping agent was determined. It was observed that there was an increased in $\sigma_{dc}$ with an increased in temperature as well as decreased in particle size of ZnS nanomaterials. The results were discussed with the help of two established models.

## Acknowledgements:-

Authoracknowledged Biotech Hub, Handique Girls' College, Guwahati and CMP Research Laboratory, department of Physics, Gauhati University for providing Laboratory and electrical characterization facilities.

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