Structural, Optical and electrical properties of Cus nanorods

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ABSTRACT: - This work presents the manufacture and potential application of the Cus films in recent literature and patents and then focus on the chemical bath deposition Cus CTAB capped copper sulphide nanorods of size 6-8 n width. And 40-60 nm length has been syntesized by a sample aqueous co-precipitation method at room temperature. Power X-ray diffraction pattern suggests the product obtained is pure hexagonal phased Cus (covellite) the AC electrical parameters viz., dielectric constant, dielectric loss factor and AC electrical conductivity increase with the increase in temperature. Also a higher dielectric constant and a lower AC electrical conductivity were observed. Results obtained indicate that quantum sized Cus nanorods with useful optical and electrical properties can be prepared by the simple method adopted in the present study.

Key words: - Electronic Materials semiconductors, nanomaterials, optical materials and properties, electrical properties, diffraction peak.

INTRODUCTION

Copper sulphide is significant binary compound semi-conductor that attract many attentions due to their wide range of applications in various optoelectronic devices. Copper sulphide is a p-type semiconducting material which belongs to I-VI compound semiconductor metals crystals of size in the order of a few nanometers in a least on dimension are nano crystals. It has been proved that as particle become smaller in size they may take on different chemical and physical properties the nano crystals exhibit higher chemical reactivity than conventionally prepared samples (12-13) semiconductor nanoparticles are currently an active subject of research (14) in nanoscience and nanotechnology copper nano sulphide is one of the important semiconductor transition-metal chalcogenides. It has gained more attention in material science because of its excellent optical, electronic and other physical and chemical properties (15) they have potential applications is solar radiation observer (2)coating on polymer surface to increase its conductivity (16)high capacity cathode material in lithium secondary batteries (17) nanoscale switches optical filter photo electric transformers, sensors, super ionic materials and catalyst

In the present study an attempt has been made to prepare quantum sized Cus nanorods at room temperature by a simple aqueos co-precipitation methods using CTAB(cetyl trimethyl ammonium bromide) as the copping agent. The prepared nanorods were characterized chemically structurally, optically and electrically. The details are presented in the paper.

MATERIALs AND METHOD

Analytical grade reagents used los the Cus then film deposition include copper sulphate $Cuso_4$ as the precursor for copper ions, tri ethanol amine (TEA) as a complexing agent, thiourea (Cs $(NH_2)^2$) as the precussor for sulphur ions and ammonia as the PH adjuster.

All chemical used in the present study were of analytical reagent (AR) grade. Copper acetate and thiourea were used as the Cu^{2+} and S^{2-} precursors respectively NaoH was used to adjust the PH value of the solution. CTAB was used as surfactant. Acetone was used for washing purpose.

In copper acetate and 5wt% CTAB were dissolved in 250 ml distilled water with constent stirring. In thiourea was dissolved in 50 ml and 5wt% sodium hydroxide was dissolved in 10 ml distilled water. First thiourea solution was added with copper acetate slowly with constant stirring. Then NaoH solution was added to the original solution drop by drop to maintain a pH value of 7. The colloidal solution obtained was centrifuged washed sequentially with distilled water and acetone several times. The sample was annealed at 60^0 c for 1 hr to improve ordering.

The optical properties were determined by making UV- Vis- NIR transmitlance (using varian, cary5000 spectrometer) and photoluminescence (PL) reflectance (using centarum 10x microscope) spectral measurement in the wavelength range 200-1000 nm the electrical precision LCR meter at various temperatures ranging from 40-120^0 c with five different frequencies viz, 100Hz, 1KHz, 100 KHz and 1MHz in a way similar to that followed by Mahadevan and his co-workers (17,18)

Results and Discussion: -

The PXRD pattern (fig- 1) corresponds to typical Cus (covellite) with hexagonal structure. The estimated lattice parameters are a= 3.806 and c= 16.544 A^0 which are in good agreement with those reported in the literature (JCPDS file no: 06-0464) for covellite. The broad peak observed indicate the reduced crystallite size of the prepared sample. A rough estimate of the average crystallite size using the scherrer formula gives a value of 3 nm.

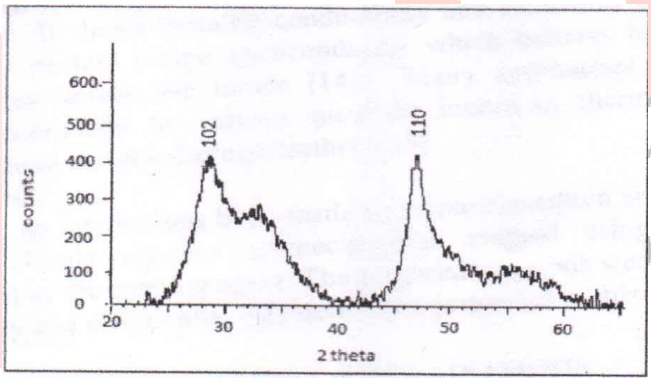

Figure 1: PXRD patterns of Cus nanorods

The dielectric parameters observed viz dielectric constats (E_r) dielectric loss factor (tan·) and AC electrical conductivities are shown in figure 2. The dielectric parameters are found to increases with the increases in temperature. The (E_r) and tan values where as the value increase with the increases in frequency.

The average crystallite size obtained for the system studied is small and hence the polarization mechanism in the nanocrystal considered can be understood as mainly due to the space charge polarization. Thus it can be understood that the space charge contribution plays an important role in the charge transport process and polarizability in Cus nanorods prepared in the present study.

The electrical conductivity of nanocrystalline material is lower than that of both conventional course gained polycrystalline materials and alloys. If the crystal size is smaller than electrons mean free path, grain boundary scattering dominates and hence electrical conductivity is decreased. The AC conductivity values observed for Cus nanoroads in the present study (fig $2_{(c)}$) are at the order of 10^{-5} mho/m .

This agrees with the above theory .The values of dielectric constant, AC electric conductivity and crystalline size observed in the present study indicate that the Cus nanorods studied exhibit the possible occurrence of nano confined states.

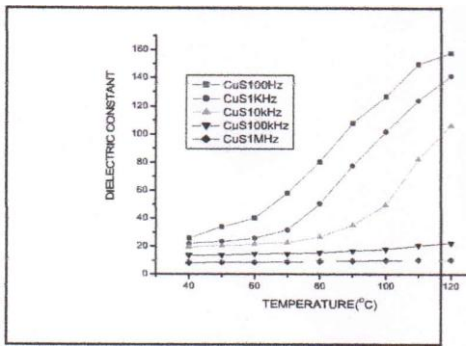

Figure : 2 (a) The dielectric constants

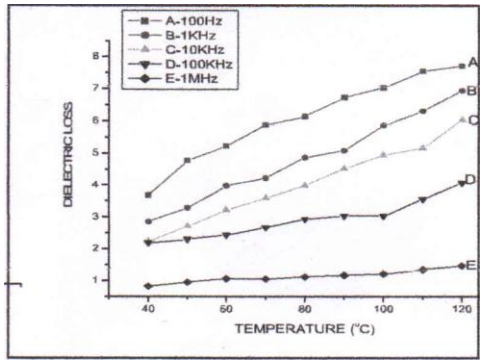

Figure : 2 (b) The dielectric loss

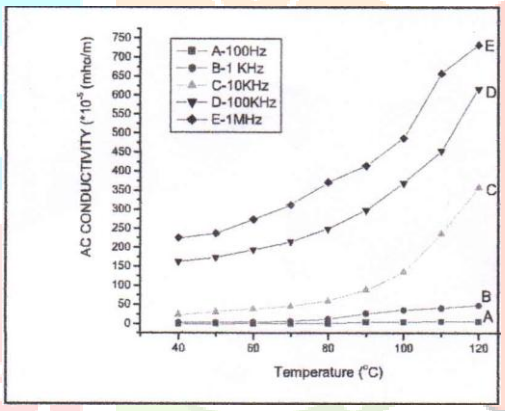

Figure: 2 (c) The AC electrical conductivity of Cus nano rods

Krityk et al (06) have found a giant linear electro-optic (pockel's) effect upto 17 pm/v for wavelengths around 435 nm in Zno crystalline films doped with fluorine and deposited on base glass. This was explained to be due to the presence of Zno. It is a known fact that the electro-optic co-efficient is directly proportional to the dielectric constant of the material. We have observed significantly higher dielectric constant for the Cus nanorods which indicate a higher electro-optic co-efficient for them. Also it is found that the Er value is very high at higher temperatures.

Results obtained in effect indicate that quantum sized Cus nanorods with useful optical and electrical properties can be prepared with high purity by the simple method adopted in the present study.

CONCLUSION

Quantum sized Cus nanorods could be prepared with high purity by the reaction of copper acetate with thiourea in the presence of NaoH and CTAB at 30^0 c. The method of preparation is found to be expensive . Simple and environmental friendly. The observed optical properties indicate the possible occurrence of nano confined states. The higher dielectric constants observed indicate a higher electro-optic co-efficient for the Cus nanorods prepared. The higher optical transmittance in the visible and NIR regions indicate the utility in spectrally selective window coatings.

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