IOSR Journal Of Applied Physics (IOSR-JAP)
e-ISSN: 2278-4861.Volume 15, Issue 6 Ser. I (Nov. – Dec. 2023), PP 49-51
www.Iosrjournals.Org

Investigating The Transmittance Of Silar Synthesised Iron Copper Sulphide(Cus) Thin Films For Poultry Farms In Amaeze-Ishiagu-Ebonyi State-Nigeria

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ABSTRACT
The doping effect of iron on copper sulphide(CuS) thin films deposited on glass substrates via successive ionic layer adsorption and reaction (SILAR) Technique in alkaline medium annealed between 283K and 500K was investigated. The X-ray diffraction (XRD) Analysis and scanning electron microscopy(SEM) were studied to determine the structure and morphology respectively for use in poultry farms in (Asa Road) Ishiagu- Ebonyi State. The XRD showed PbS thin films being cubic and crystalline nanoparticles. The transmittance was high and the absorbance low.

Keywords*: Doping: lead sulphide structure; XRD studies; SEM Analysis*

Date of Submission: 24-11-2023 Date of Acceptance: 04-12-2023

I. INTRODUCTION

Energy crisis in the world has given rise to the thin film growth research as a way to cushion problems associated with it. The continuous increase in population and industrialisation in almost every country in the world, has been very responsible for the ever growing or increasing energy demand. In Nigeria, less than 40% of the country is connected to the national electric grid and less than 60% of the energy demand by this group is generated and distributed (1-4). The advantage of energy is facilitation of the provision of those things which are necessary for the welfare of human existence: health, heat, food, light, clothing, shelter and transport, etc. Energy availability improves the standard of living (5-14). Solar energy, an energy obtained from the sun, is the world's most abundant and cheapest source of energy available from Nature (15). It is free and automatically renewable every day. In the world over, emphasis has shifted from the use of hydro and fossil-powered electricity generation to renewable energy such as solar source through nanotechnology involving growing of thin films from the abundant transition metals, resulting in getting ones with excellent properties that will be useful in solving the problem of energy crisis (16-19). In the present study, lead sulphide and copper sulphide are studied to ascertain the structural and morphological properties when doped with iron. These new assumed properties will help determine their best areas of applicability. Lead sulphide (PbS) is groups IV-VI compounds of semiconducting materials(20-24) that have drawn attention of many researchers because of its properties that have been applied widely in optoelectronic devices, photoconductors, sensors, infra-red detector devices solar cells, solar control and solar absorber coatings (25).

The present study describes successive ionic layer adsorption and reaction method for the synthesis and deposition of PbS, $(PbS)_x(Fe)_{1-x}$, ternary thin films and the influence of iron added to the halide thin films structurally and morphologically. Variety of materials such as insulators, semiconductors, metals and temperature sensitive materials like polyester can be used as a substrate since the deposition is carried out at or near to room temperature. As it is a low temperature process, it avoids oxidation and corrosion of the substrate. In spite of this SILAR having a number of advantages as compared to other methods; it does not require vacuum at any stage, doping of any element can be achieved easily, film thickness can be easily controlled by adjusting the number of deposition cycles, operating at room temperature, no restrictions on substrate material, dimensions or its surface profile etc. The prime requisite for obtaining good quality thin film is the optimization of various preparative parameters viz. concentration of precursors, nature of complexing agent, pH of the precursor solutions and adsorption, reaction and rinsing time durations etc.(27)

II. EXPERIMENTAL PROCEDURE:

The layer-by-layer growth of the material is achieved by dipping the substrate alternately into separately placed cationic and anionic precursors. After every cationic and anionic immersion the substrate is rinsed in deionised water to remove the un-adsorbed ions from the surface.

The synthesis and deposition of CuS involved four steps while that of CuSFe thin films involved six steps. Ammonia was used to control the pH. It was done between pH between 8.5 and 11.5. The iron ions were got from iron(II) chloride dehydrate. .

After repeating for sufficient number of cycles(90 cycles), $CuS_x Fe_{(1-x)}$ composite thin films were deposited.

$[Cu(OH)_4]^{2-} + SC(NH_2)_2 \rightarrow CuS + 2OH^- + CN_2H_2 + 2H_2O$ (2)

$CuS + 2OH^- + CN_2H_2 + 2H_2O + 2FeCl_2.2H_2O \rightarrow 2CuSFe(s)\downarrow + 4HCL + 6H_2O$ (3)

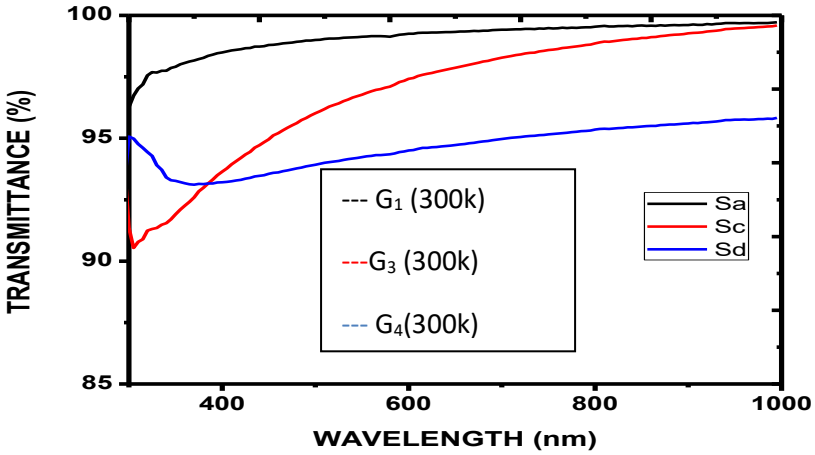

Figure 1: Plot of Transmittance against Wavelength for CuS-Fe thin Films

Characterisation:

The structural characterizations of $(CuS)_x(Fe)_{(1-x)}$ thin films were carried out using X-ray diffraction (XRD) technique. The peaks of XRD patterns have been assigned from the x-ray diffraction files ref. number INEL/EZEMA/18-171343 . Using this CuSFethin films as case study,the crystallite size of the deposited material was calculated by using Debye- Scherer's formula (3)

$$D = K\lambda / B\cos\theta, \quad (3)$$

where D is the average crystallite size, *k* is the particle shape factor that varies with the method of taking the breadth and shape of crystallites , λ is the X-ray wavelength used

(0.1542 nm), β is the angular line width of half-maximum intensity (FWHM) of the diffraction peak, and θ is the Bragg's angle in degrees.

Copper sulphide thin film has six diffraction peaks (111)(200 (220) (311) (222)(400) , which corresponds to 2θ angles ranging from18.012-80.012. The XRD of doped CuS annealed.

Thickness for CuS , $(CuS)_{0.8}(Fe)_{0.2}$, $(CuS)_{0.5}(Fe)_{0.5}$, $(CuS)_{0.2}(Fe)_{0.8}$, $(CuS)_{0.1}(Fe)_{0.9}$ were 305nm,300nm, 260nm, 245nm and 20nm while their grain sizes were 27, 20, 18, 17,15 .

From literature, the Copper Sulphide thin films have been reported as having thermal stability as observed in this study. The samples(doped and undoped) were annealed between temperatures of 293K and 493K and from the XRD, there were no diffractions or additional peaks observed up to 475K; This showed that the CuS poly crystallinenofilm was not oxidized. The change in the diffraction reflection intensities was attributed to the fact that the phase transition to cubic structure takes place in the CuS film at 375K (26).

The presence of oxygen atoms as shown by the EDS studies showed that the proportion ofiron to lead sulphide and iron to copper sulphide were not in equal proportion and also oxidation must have taken place because of their large surface area(26). The optical studies carried out showed that it had high absorbance and low transmittance in the ulra-violet and near infra red regions. These properties were advantageous in a poultry farm at Asa Road Ishiagu, Ebonyi state, Nigeria to warm chicken as the walls and roof of the place were glazed with the material.

III. Conclusions

A simple, cheap and convenient SILAR method was be employed to deposit good quality $(PbS)_x (Fe)_{1-x}$ composite thin films. The deposited films were uniform and adherent to the substrate. Their structural and morphological properties of those composite thin films were studied.The EDS Studies showed that in $(PbS)_x (Fe)_{1-x}$ composite thin films, the compositional ratio of iron was 21.8wt%. The XRD and morphological studies revealed that $PbS_x(Fe)_{(1-x)}$ thin films were nanocrystalline in nature depending on film composition. The average crystallite size was found to vary for the PbSFe thin films from 34 to 16 depending on film composition. The variation in thickness, strain and dislocation densities were also composition dependent. Similar observation has been reported by Wang et al (2009) and Udeajah (2020).(21-29) The samples annealed

at different temperatures (383K-500K) never showed any prominent peaks structurally and morphologically as confirmed by studies done by He *et al.*(2008) From literature, considerable changes can be seen for temperatures up to 700 ^{0}K (30). These properties can be well used in solar energy conversion devices and poultry farm warming in Ishiagu, Ebonyi State, Nigeria.

ACKNOWLEDGMENT
The authors are grateful to Nanoscience Research Group, University of Nigeria Nsukka

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