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Review on Chemical Bath Deposition Technique

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ABSTRACT: In recent year demands of semiconductor devices to use solar energy in different work has lead to study on chemical bath deposition method. As it is the simplest method to deposit uniform, stable and reproducible thin films and nanomaterials. This paper is a short review which tells us the scope of this technique in the field of photovoltaics.The growth of thin film depends mainly upon the time, temperature, and concentration of metal ion and the nature of the substrate used for study.

Keywords: Themical bath deposion; Thin layers; photovoltaics and Temperature.

INTRODUCTION: Thin film is layer of materials which can be made by chemical deposition method ranging from micrometers to nanometer scale. The first thin film of PbS was prepared in 1984.later various combination of chalocogenides and chalcopyrite were used. The pioneer of thin film was bode et al from Barbara research institute initially the films prepared used as a photodetector after decade they employed as energy applications [1-2].

Chemical bath deposition is a simple technique to prepare thin films as compared to other methods such as CVD, spray pyrolysis sol-gel etc.the first film deposited by this method is made up of PbS which was used as a photodetector [3] later this technique was used in solar absorber coatings[4].

In past few years this technique found their active role in solar cells applications for more than 11% energy conversion [5]. P K Nair group has done tremendous workin this technique [6].The photovoltaic laboratory at university science and technology has done lot of work for the prepration CIS/CdS thin film solar cells having both n-type and p-type materials[7].

PRINCIPLE OF CBD TECHNIQUE: In chemical bath deposition technique precipitation of solid phase occurs due to super saturation in the reaction bath. At given temperature when ionic product of reactant is more than solubility product precipitation occurs but if ionic product is less than solubility product then solid phase produced which dissolves back in solution

Resulting no net precipitate. Therefore it is necessary to control chemical reaction for better deposition. In this method mostly metal chalocogenides are used for thin films preparation.

METHODS OF DEPOSITION: There are mainly three ways to deposit thin films

i) ION-ION Process-in this process ion condense at the reacting surface to form film.
ii) Cluster by Cluster: In this process colloidal particles are formed in the solution due to homogeneous reaction which is absorbed at the surface of substrate to form thin layer.
iii) Combination/Mixed process : Here predominance is governed by heterogeneous and homogeneous nucleation

FACTORS AFFECTING DEPOSITION PROCESS: CBD technique is mainly governed by following process:

i) Nature of Reactant: if metal sulfate is used to deposit metal selenide film using selenosulfate the rate of deposition decreases and terminal thickness increases[8-9]
ii) Concentration of reactant: initially rate of deposition increases with concentration but later higher concentration may lead to precipitation which decreases the film thickness.
iii) Concentration of complexing agent:In general the concentration of metal decreases with increase in concentration of complexing agent can decrease the rate of deposition.
iv) Reaction Temperature: with increase in temperature dissociation of molecules increases this may increase or decrease terminal thickness depending upon super saturation of solution.
v) Reaction PH: When PH is higher the metal complex becomes more stable reducing metal ion availability hence decreases the rate of reaction and higher terminal thickness [10].

vi) Reaction Duration: growth of good quality of thin film proceeds at a slow rate
vii) Nature of Substrate: nature of substrate play a major role as adhesion depends upon nature of substrate .it was seen that during deposition of PbSe thin film higher rate of thickness have observed in on GC rather on Si[11] because of better matching lattice parameters.

ANALYSIS OF DEPOSITED FILMS: The deposited films can be investigated for:

X-Ray diffraction (XRD): To Analyze crystal structure.

Scanning Electron Microscopy (SEM): For analyzing Surface morphology.

Energy Dispersive Spectroscopy: for elemental analysis.

Optical studies are done by using UV-VIS spectroscopy

LITERATURE REVIEW: Extensive work is done in the field chemical bath deposition and there are many semiconducting materials prepared and find its applications in the field of photovoltaic. There are huge number of papers found in this technique and various thin films are prepared some of them are mentioned here.

CdS: This material has higher conversion efficiency and stability and proved to be a good window material in solar cells [12].

CdS/CdTe: Solar cells was reported by T.L Chu etal in 1992.they use SnO_2 glass substrate for preparing CdS film of thickness 600-1000A^0.Hai wing in 1996 chemically deposit CdS film which act as a window layer and CuInSe2 as absorber which show high efficiency [13].

Zinc oxide film was prepared to improve the light transmission by improving the band gap of 3.3 this can used as substitute in place cadmium sulfide thin layer to avoid the toxicity of cadmium[14]

P.K Nair group has used Sulfides and selenides of Bi in the field of photovoltaics [15, 16] they deposited film of 0.2 um thickness in 9hrs at room temperature with selenourea solution [17]. CulnfS is an alternative and attractive material for solar energy conversion with the band gap of 1.55eV about 7.3% energy conversion is possible with this material [18] also Padam etal has prepared this material using CBD[19].the XRD analysis shows that it crystalline structure with slight deviation with d-values.

Similarly Savadogo gropu has prepared Sb2S3 thin films which is used in schottky barrier solar cells (pt-Sb2S 3) [20] and in hetero junction solar cells (n-Sb2S3/p-Ge with conversion efficiencies of 5.5% and 7.3% respectively. Mondal and mandal used a solution containing potassium antimony tartarate, triethanol amine, aqueous ammonia and thioacetamidethey showed did the addition of silicotungstic acid in the bath yields films with enhanced photoconductivity with W03 incorporated in them[21,22].

Photovoltaic cells are prepared by Using indium have been reported from Photovoltaic laboratory, Dept. of Physics, Cochin University of Science and Technology [23].

It has been observed that till now PbS, CdS, CUxS, CuInSe2 etc. has been used as material of common interest for major thin film deposition by CBD method. This shows although efficiency was only around 3%, still it has opened the avenue for large area-low cost thin film solar cells. Recently the interest has been slowly shifting towards relatively new materials.

CONCLUSION: Chemical bath deposition is the simplest and cost effective technique to deposit thin films. It can simply carry out with a beaker containing reaction mixture and a simple glass slide dipped into it which is rotating at specific RPM. And deposition takes place at within atmospheric pressure and at room temperature. It is safe and environmental friendly method with minimum hazards to environment.

The semiconductors prepared by this method can be converted to n-type or p-type by easy and simple methods of CaD technique. Multicomponent chalocogenides thin films over a wide range of stoichiometry can be prepared by CBD. Large area deposition for commercial use is also possible with this method.

The major concern is with reproducibility but by this method reproducible thin layers can be deposited by keeping certain factor constant. Binary compound are easily reproducible by this method in CBD method Precipitates are unavoidable however it can be minimized by filtered out and reacted with acids or other suitable reagents to retrieve the starting materials for deposition. In many cases the precipitate may be rinsed well, dried and stored to serve as precursor for other deposition techniques.

Although this technique has various advantages still It is not easy to dope the intrinsic semiconductor thin films with external dopants at the time of film formation. Also it is difficult to control stoichiometry ternary and other multicomponent compounds to pro-

duce reproducible films precise knowledge of the effect of various parameters on the growth medium should be thoroughly known and understood This technique cannot be used to deposit very thick layer of materials if thickness is greater than few microns the chances of peeling off the film is high.

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