

**Final Report**

for

**UGC Sponsored Minor Research Project**

**“Characterization of Chemically deposited Nanocrystalline CdS  
and Ag<sub>2</sub>S Thin films for Photovoltaic application”**

Submitted to

**PSGVP Mandal’s ASC College,  
Shahada 425 409 Dist. Nandurbar**

*Submitted by*

**U.M.Jadhav**

**Associate Prof,**

**Department of Chemistry**

**PSGVP Mandal’s, SIP Arts, GBP Science and STSKVS  
Commerce College, Shahada, Dist. Nandurbar.**

**(2012)**

**Annexure -III**

**UNIVERSITY GRANTS COMMISSION**

**BAHADUR SHAH ZAFAR MARG**

**NEW DELHI – 110 002.**

**PROJECT COMPLETION REPORT/ FINAL REPORT**

**OF MINOR RESEARCH PROJECT**

1. Project report No. : **Final**
2. UGC Reference No. : **F. 47-829/09(WRO) dated 22-9-2009.**
3. Period of report : **1<sup>st</sup> Oct 2009 to 1<sup>st</sup> Oct 2012.**
4. Title of research project: **“Characterization of chemically deposited Nanocrystalline CdS and Ag<sub>2</sub>S Thin Films for Photovoltaic application”.**
5. (a) Name of the Principal Investigator: **U.M.Jadhav.**  
(b) Deptt. And University/ college where work has progressed:  
**Dept. of Chemistry, PSGVP Mandal’s, ASC**  
**College,Shahada,PIN-425409,Dist.Nandurbar Maharashtra).**
6. Effective date of starting of the project: **01.10.2009**
7. Grant approved and expenditure incurred during the period of the report:
  - a. Total amount approved : **Rs.1,20,000/-** (1<sup>st</sup> installment: Rs. **77,500/-** and 2<sup>nd</sup> installment : Rs. **34,000/-** )
  - b. Total expenditure Rs. **1,22,966/-**
  - c. Report of the work done: (Please attach a separate sheet)
    - (i) Brief objective of the project: **Annexure IIIa**
    - (ii) Work done so far and results achieved and publications, if any, resulting from the work (Give details of the papers and names of the journals in which it has been published or accepted for publication): **Annexure IIIb**
    - (iii) Has the progress been according to original plan of work and towards achieving the objective. If not, state reasons: **Yes, the progress has been according to original plan.**

- (iv) Please indicate the difficulties, if any, experienced in implementing the project: **No difficulties were experienced in implementing the project. The support extended by college has been satisfactory.**
- (v) If project has not been completed, please indicate the approximate time by which it is likely to be completed. A summary of the work done for the period (Annual basis) may please be sent to the Commission on a separate sheet: **The project is completed. Summary of the work done for the period is given in Annexure IIIc.**
- (vi) If the project has been completed, please enclose a summary of the findings of the study. Two bound copies of the final report of work done may also be sent to the Commission: **The project is completed. Final PCR report of the work done is submitted herewith as per the requirement.**
- (vii) Any other information which would help in evaluation of work done on the project. At the completion of the project, the first report should indicate the output, such as
- (a) Manpower trained: Nil
  - (b) Ph. D. awarded: Nil
  - (c) Publication of results: **1**
  - (d) other impact, if any: Nil

(U.M.Jadhav)  
PRINCIPAL INVESTIGATOR

(Dr. Vishwas K. Patil)  
PRINCIPAL

## **Annexure IIIa**

### **Brief objective of the project**

1. Deposition of CdS and Ag<sub>2</sub>S thin films onto corning glass substrates and fluorine doped tin oxide (FTO) coated glass substrates using chemical bath deposition (CBD) and modified chemical bath deposition (M-CBD) methods.
2. Optimization of preparative parameters for CBD such as concentration of anionic and cationic solutions, pH of the bath, deposition time and deposition temperature.
3. Optimization of preparative parameters for M-CBD such as concentration of anionic and cationic solutions, adsorption time, rinsing time, No. of deposition cycles etc.
4. Characterization of the thin films deposited onto glass substrate by X-ray diffraction (XRD), scanning electron microscopy (SEM), transmission electron microscopy (TEM), optical absorption, electrical resistivity.

## Annexure IIIb

### Work done so far and results achieved

1. Silver sulphide thin films are deposited using chemical bath deposition method (CBD) and modified chemical bath deposition method (M-CBD).
2. All the reagents used for the preparation of  $\text{Ag}_2\text{S}$  thin film were of analytical grade (Loba chemicals) and used as it is without further purification. Silver nitrate ( $\text{AgNO}_3$ ), thiourea  $\text{CS}(\text{NH}_2)_2$  and liq.ammonia (liq  $\text{NH}_3$ ) were used for the deposition of silver sulphide ( $\text{Ag}_2\text{S}$ ) thin films in an aqueous medium. Double distilled water was used throughout the experiment.
3. For depositing thin films of  $\text{Ag}_2\text{S}$  on a glass substrate by 0.1 M.  $\text{AgNO}_3$  solution was prepared in a beaker cationic precursor. In another beaker 0.1M.thiourea was prepared. The (1:1) volume ratio of Silver nitrate and thiourea solution is taken in a beaker with constant stirring at  $27^\circ\text{C}$ . The pH of solution 10.2 by liq. ammonia. was maintained at room temperature ( $27^\circ\text{C}$ ). The cleaned glass substrates were immersed in the mixture for two hours which was found as the optimum duration for obtaining uniform thin films. Then the substrate is manually taken out of mixture, washed with doubly distilled water and dried in air at room temp. Thickness of films was found to be 135 nm which was measured by using stylus method (Talystep) for the deposition.
4. For depositing thin films of  $\text{Ag}_2\text{S}$  on a glass substrate by MCBBD .a 0.1 M.  $\text{AgNO}_3$  solution was taken in one beaker and liq.  $\text{NH}_3$  is added to it to reach the PH 10.2. In another beaker 0.1 M. thiourea solution is taken .In order to deposit the thin film both are maintained at room temp. The cleaned glass substrate were immersed in silver nitrate solution for 20 sec., the  $\text{Ag}^{+2}$  ion ader to the substrate forming an ionic layer .then the substrate is manually transferred to the beaker containing 0.1 M. thiourea solution .Here again the immersion time was 20 sec. After each immersion of substrate into anionic and cationic precursor the substrate were rinsed in beaker

containing doubly distilled water for 10 sec. so that unadsorbed ions were removed from the substrate. This completes one M CBD cycle of the ion layer adsorption and reaction process.

The films were washed well with distilled water and dried in air at room temperature. Thickness of film were found to be 135 nm. by using stylus method for deposition of 20 cycle.

5. The  $\text{Ag}_2\text{S}$  films were characterized by means of X-ray diffraction (XRD), Scanning Electron Microscopy (SEM), UV-Vis-NIR, optical absorption spectroscopy and electrical resistivity measurement technique. X-ray diffraction patterns of the film were recorded on Model Bruker D8 advance AXS X-ray diffractometer with scanning angles in the range  $20 \text{ - } 80$  degree using  $\text{CuK}\alpha$  radiation ( $\lambda=1.5406\text{\AA}$ ). The surface morphology was studied by scanning electron microscopy (SEM) using a Model JOEL, JSM 6360A. Energy dispersive X-ray analyses, (EDAX) were recorded on Energy dispersive X-ray spectrometer attached to the SEM. The optical absorption spectrums of the films were recorded using an UV-Shimadzu scanning spectrophotometer. The electrical resistivity measurement was carried out using a DC two point probe method.
6. The photoconductivities of these films are tested by constructing electrochemical photovoltaic cells. These cells were used to calculate cell parameter such as junction ideality factor(n), fill factor(f), conversion efficiency, Shunt resistance and series resistance.

## **Results Achieved :**

### **A) Characterisation of CdS thin film**

#### **Optimization of preoperative parameters**

For the optimization of the deposition of CdS thin films a cationic precursor solution consist of 0.1M CdSO<sub>4</sub> solution and liquor ammonia in first beaker and 0.1M thiourea in a second beaker as a anionic precursor. For cationic solution initially 40 ml. CdSO<sub>4</sub> solution was taken in a 50 ml. capacity beaker and slowly ammonia as a complexing agent was added to it to maintain the pH of the solution 11.2. By taking several trials, adsorption reaction rinsing time period were optimized. Rinsing time was selected such that there is no formation of precipitate in the cationic and anionic solution. Also the dipping time is taken as 20 sec. as a optimum duration for obtaining uniform thin films. So by keeping no. of immersion cycle as 40, adsorption time 20 sec., reaction time 20 sec. and rinsing time 5 sec., the deposition was carried out for varying conc. of CdSO<sub>4</sub> and thiourea. The pH of solution was maintained to 11.2. The thickness of film was found to be 250 nm. The complete deposition was carried put at room temperature.

The variation of CdS thin film thickness with different concentration of CdSO<sub>4</sub> for 20 deposition cycle is as shown in fig 1(a). Initially the thickness of film increases with increasing concentration of CdSO<sub>4</sub> and reaches to maximum value 250 nm for 0.1ML<sup>-1</sup> concentration. Further increase in CdSO<sub>4</sub> conc. results in decrease in film thickness. This is attributed to the formation of powdery layer and peeling off results. Thus 0.1ML<sup>-1</sup> is taken as the optimized con. of CdSO<sub>4</sub>.

Fig 1(b) shows the variation of CdS thin film thickness with deposition time. Initially film thickness increases with deposition time. This CdS film had terminal thickness 250 nm for 2 hours after this film thickness starts to decrease.

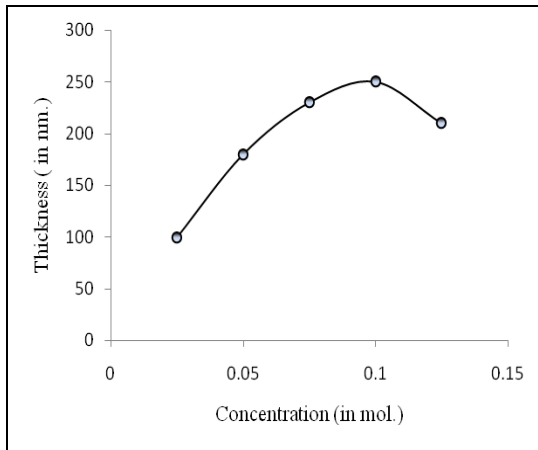


Fig.1(a)

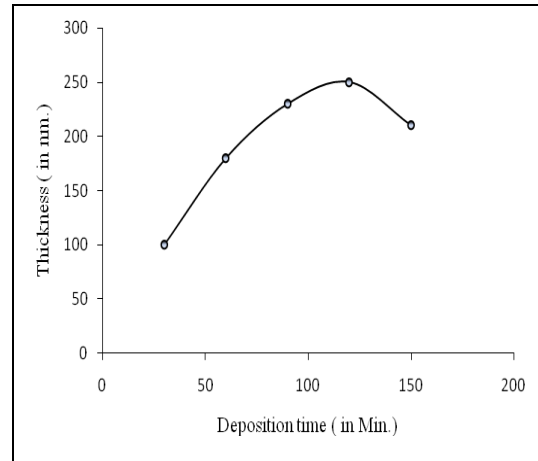


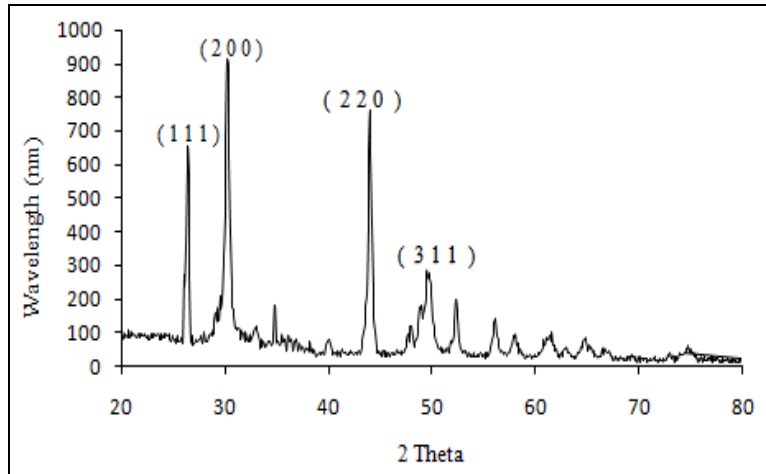
Fig.1(b)

**Fig 1 Variation of Thickness with (a) different conc. of CdSO<sub>4</sub> and(b) deposition time.**

X –ray diffraction pattern (XRD)

The crystallinity and phase purity of the products were determined by power X- ray diffraction as shown in fig 2, the detailed comparison in the range of  $25^{\circ}$  to  $80^{\circ}$  of four diffraction patterns are  $26.5^{\circ}$ ,  $30.7^{\circ}$ ,  $44.0^{\circ}$ ,  $52.1^{\circ}$  corresponding to (111), (200), (220), and (311) respectively, the reflection of nanocrystalline nature is shown in fig. 2.

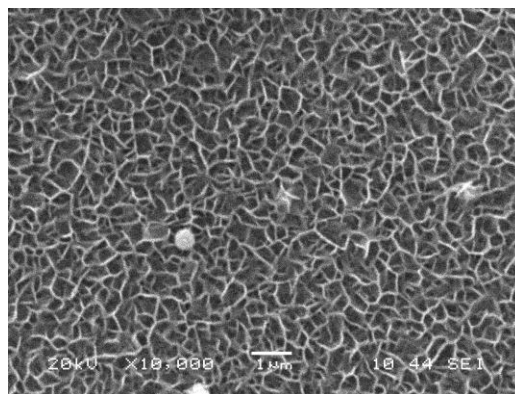




**Fig. 2. X-ray diffraction pattern of CdS thin film**

### **Scanning electron microscopy (SEM)**

The morphology of the material depend on the substrate, deposition time, method, temperature and method of substrate cleaning. In this method the film takes place by ion by ion adsorption and reaction. The CdS film deposited onto glass substrate with 250 nm thickness by this method was used for surface morphology using scanning electron microscopy. Fig.3 shows micrograph of CdS on glass surface at 10,000 X magnification. The scale bar length is 1  $\mu\text{m}$ . It was found that the film is well defined net like nanostructure, symmetric shape. The film is uniform, yellowish and well covered to substrate.



**Fig. 3: The surface morphology of as-deposited CdS on glass substrate at room temperature by scanning electron microscopy studies.**

## Atomic force microscopy (AFM)

The AFM images for CdS film deposited onto glass substrate were measured for an area of 1000 nm x 1000 nm. The atomic force microscopy images of the films prepared on glass substrate indicates spherical shaped grains that are uniformly distributed over the surface. The average size of smaller grains are observed to be 40 nm. The surface is relatively uniform. The average surface roughness and thickness is 48.30 and 65 nm respectively.

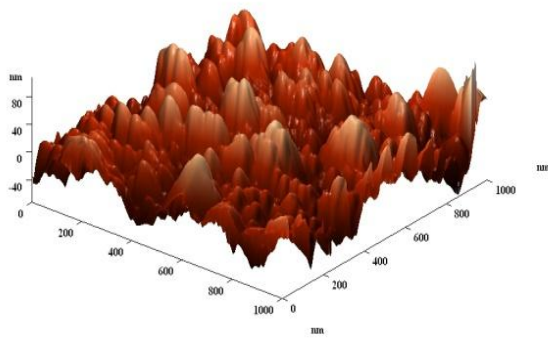


Fig (a)

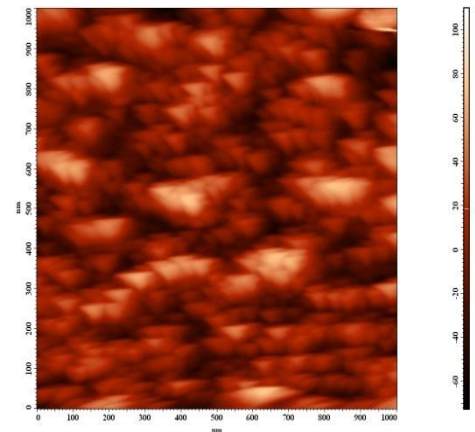


Fig (b)

**Fig. 4 (a) and Fig. 6 (b) show the three-dimensional and two-dimensional atomic force microscopy (AFM) images for CdS thin films deposited on glass substrate.**

## B) Characterisation of Ag<sub>2</sub>S thin film

### Optimization of preparative parameters

For the optimization of parameters for the deposition of Ag<sub>2</sub>S thin film 40 ml. of Ag<sub>2</sub>S solution is taken in 50 ml. beaker as a anionic precursor and liq. ammonia is added to maintain the pH of the solution. The variation of Ag<sub>2</sub>S thin film thickness with different conc. of AgNO<sub>3</sub> for 20 deposition cycle was studied. Initially the thickness of film increases. Further increase in AgNO<sub>3</sub> conc. decreases the film thickness. Thus 0.1 ML-1 is taken as the optimized value of AgNO<sub>3</sub> conc. The Ag<sub>2</sub>S film attained the maximum thickness of 135 nm. at 20 immersion cycles.

### X-ray diffraction (XRD)

The crystallinity and phase purity of products were examined by powder X-ray diffraction(XRD). The fig. 5 Shows the X-ray pattern of as deposited Ag<sub>2</sub>S thin film on glass substrate by M-CBD method. In the present diffraction pattern of XRD ,peak at  $2\theta = 36.82^\circ$ ,  $40.60^\circ$ ,  $43.49^\circ$ , and  $44.42^\circ$  corresponding to the (120), (031), (102) planes of Ag<sub>2</sub>S.

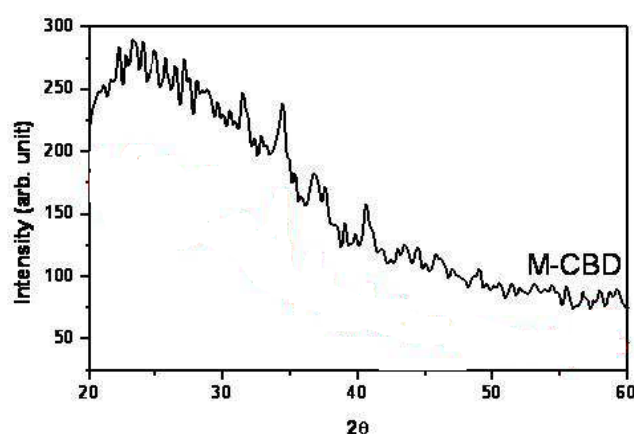


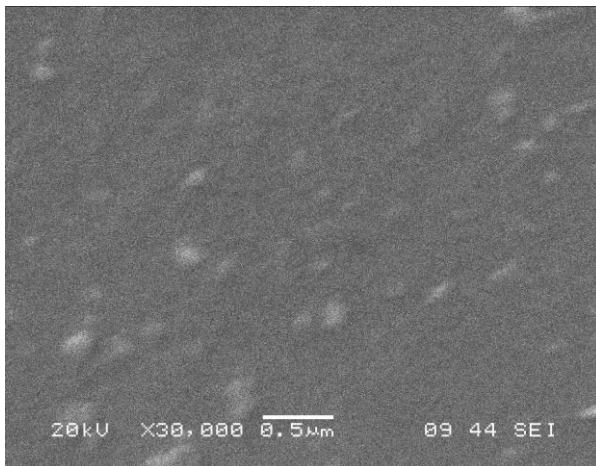
Fig. 5. X-ray diffraction pattern of Ag<sub>2</sub>S thin film

By comparison of observed interplaner distance 'd' and standard 'd' values, indicates that the formed compound is Ag<sub>2</sub>S with polycrystalline with monoclinic acantite structure which is in good agreement with JCPDS data. The as deposited Ag<sub>2</sub>S thin film resulted in an average crystallite size of approximately 25.61 nm indicates the film is nanocrystalline.

## Scanning electron microscopy (SEM)

The scanning electron microscopy is a method for studying the microstructure of thin films. The microstructure of Ag<sub>2</sub>S thin film on glass substrate at 30,000 X magnification is shown in fig 6. The scale bar length is 0.5  $\mu$ m. From the SEM image, uniform surface morphology was observed on glass substrate. The SEM micrograph reveals that the film is well adherent, homogeneous and well covered to the substrate surface without any crack or pinholes. Some of grains shows an agglomerated morphology.

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**Fig. 6: The surface morphology of as-deposited CdS on glass substrate**

## Atomic force microscopy(AFM)

The AFM images for Ag<sub>2</sub>S film deposited onto glass substrate were measured for an area of 1000nm x 1000 nm. The atomic force microscopy images of the films prepared on glass substrate indicates spherical shaped grains that are uniformly distributed over the surface. The average size of smaller grains are observed to be 25 nm. The surface is relatively uniform. The average surface roughness and thickness is 83.35 nm respectively.

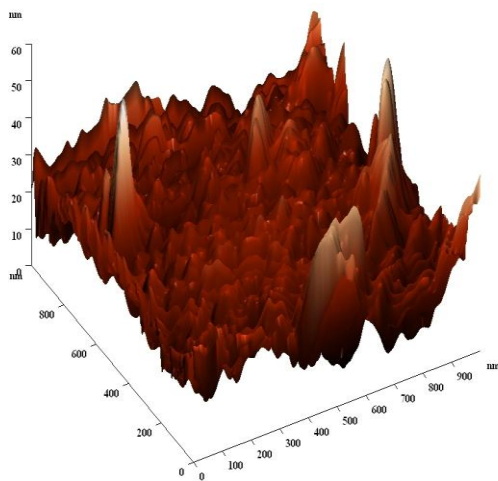


Fig (a)

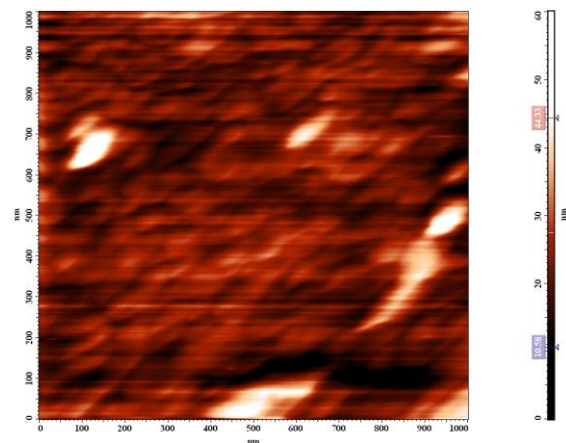


Fig (b)

**Fig.7 (a) and Fig. 6 (b) show the three-dimensional and two-dimensional Atomic force microscopy (AFM) images**

**Summary of Work done**

1. Modified chemical bath deposition (M-CBD) can be employed for deposition of CdS and Ag<sub>2</sub>S thin films.
2. The deposition of the CdS thin film was carried out at room temperature (300K). One M-CBD growth cycle consists of four steps, a) adsorption of cadmium ions from [Cd(NH<sub>3</sub>)<sub>4</sub>]<sup>2+</sup> complex solution, b) rinsing with double distilled water, c) reaction with copper iodide precursor solution and d) rinsing with double distilled water. This growth cycle was repeated to get the desired CdS thin film thickness.
3. The structural, surface morphological, compositional, optical and electrical properties of the films were studied. The XRD studies revealed that, the deposited films have cubic structure.
4. The XRD study indicates that nanocrystalline nature of Ag<sub>2</sub>S thin films that is also supported by SEM studies.
5. Thermoemf studies shows that Ag<sub>2</sub>S is n-type semiconductor.
6. By using CdS, and Ag<sub>2</sub>S thin films grown onto FTO coated glass substrate as photoelectrode (anode), the polysulphide as an electrolyte and Platinum (Pt.) as a counter electrode (cathode), the PEC cells were constructed. In short the fabrication of the complete device with structures is as shown below.
  - FTO/CdS/Electrolyte/Platinum,
  - FTO/Ag<sub>2</sub>S/Electrolyte/Platinum and
  - FTO/CdSCN/Electrolyte/Platinum.
7. From I-V characteristics studies, it is seen that the CdS deposited by M-CBD method gives very small negligible efficiency, Ag<sub>2</sub>S by M-CBD gives fewer efficiencies. That means, all the visible light falls on material CdS are directly transfer through it and there are no electron-hole pair generations, whereas in case of Ag<sub>2</sub>S, not all but maximum amount of visible light transfer through it and the film absorb the part of visible light from solar spectra, this part of visible light is utilized for generation of electron-hole pair, which is responsible for conversion of light into electricity.

**Annexure - IV**

**UNIVERSITY GRANTS COMMISSION**

**BAHADUR SHAH ZAFAR MARG**

**NEW DELHI – 110 002.**

**Utilization certificate**

Certified that the grant of Rs. 1,20,000/- (Rupees one lac twenty thousand only) sanctioned from the University Grants Commission under the scheme of support for Minor Research Project entitled “Characterization of Chemically deosited Nanocrystalline CdS and Ag<sub>2</sub>S Thin Films deposited for Photovoltaic application ” vide UGC letter No F. 47-829 / 09 dated 22-09-2009. During the two year amount of Rs. 1,22,966/- (Rs. One lac twenty two thousand nine hundred sixty six only) has been utilized for the purpose for which it was sanctioned and in accordance with the terms and conditions laid down by the University Grants Commission.

**(Prof. U.M. Jadhav)**

SIGNATURE OF PRINCIPAL      STATUTORY AUDITOR  
INVESTIGATOR

**( Dr .Viswas K.Patil)**

PRINCIPAL

**Annexure – V**

**UNIVERSITY GRANTS COMMISSION BAHADUR SHAH ZAFAR MARG  
NEW DELHI – 110 002.**

**STATEMENT OF EXPENDITURE IN RESPECT OF MINOR RESEARCH  
PROJECT**

1. Name of Principal Investigator: **U.M.Jadhav.**
2. Deptt. of University/College : **Department of Chemistry, P. S. G. V. P. Mandal's ASC College, Shahada, 425 409, Dist. Nandurbar, Maharashtra.**
3. UGC approval No. and Date : **No. F. 47 – 829 / 09 dated 22-9-2009.**
4. Title of the Research Project : **“Characterization of chemically deposited Nanocrystalline CdS and Ag<sub>2</sub>S Thin Films for Photovoltaic application”.**
5. Effective date of starting the project: **01-10-2009**  
(a) Period of Expenditure : From 1-10-2009 to 1-10-2012
6. Details of Expenditure

Sr. No.	Item	Amount Approved Rupees			Expenditure Incurred Rupees		
		Received I <sup>st</sup> year	Received II <sup>nd</sup> year	Awaited	I <sup>st</sup> year	II <sup>nd</sup> year	Total
i.	Books and Journals (for 2 years)	35,000=00	-	-	35,072=00	-	35,072=00
ii.	Equipments ( for 2 years)	-	-	-	-	-	-
iii.	Contingency & Special Needs	17,500=00	14,000=00	3,500=00	18,014=00	18,618=00	36,632=00
iv.	Field work / Travel	5,000=00	4,000=00	1,000=00	4,980=00	5,790=00	10,770=00
v.	Hiring Services	-	-	-	-	-	-
vi.	Chemicals	20,000=00	16,000=00	4,000=00	20,478=00	20,014=00	40,492=00
vii.	Overhead	-	-	-	-	-	-
viii.	Any Other Items	-	-	-	-	-	-
	<b>Total</b>	<b>77,500=00</b>	<b>34,000=00</b>	<b>8,500=00</b>	<b>78,544=00</b>	<b>44,422=00</b>	<b>1,22,966=00</b>

**(Prof. U.M. Jadhav)**

**( Dr .Viswas K.Patil )**

SIGNATURE OF PRINCIPAL

STATUTORY AUDITOR

PRINCIPAL

INVESTIGATOR



**Expenditure on Books and Journals :**

Amount approved (For 2 years): **Rs. 35000=00** /- (Rupees Thirty five thousand only)

Amount spend with details:

<b>Sr. No</b>	<b>Date</b>	<b>Name of Supplier</b>	<b>Amount</b>
1	28-8-10	Prashant Book House Jalgaon	<b>4318=00</b>
2	12-9-10	Deep Book House, Nashik	<b>20,634=00</b>
3	6-10-10	Manoj Pustkalaya, Dhule	<b>10,120=00</b>
<b>Total</b>			<b>35072=00</b>

(U.M.Jadhav)

PRINCIPAL INVESTIGATOR

## Expenditure on Contingency

### Ist year

Amount approved (for 1 year): Rs. 17, 500=00/- (Rupees Seventeen thousand Five hundred only)`

Amount spend with details:

<b>Sr.No</b>	<b>Item</b>	<b>Cost(Rs.)</b>
1	Xerox	350=00
2	Punjab Sci. Dhule	185=00
3	Xerox	150=00
4	Laxmi Store (Stationary)	1739=00
5	Swami Enterprises(Comp. bill)	3500=00
6	Laxmi Store	2020=00
7	Bhavsar Store.	650=00
8	Xerox	250=00
9	Joshi Sci. Mumbai	4725=00
10	Conf. registration	500=00
11	Conf. proceeding	500=00
12	Xerox	95=00
13	Laxmi Store	2110=00
14	Swami Enterprises Pen drive 4GB	540=00
15	Conference reg. Fee Jalgaon	700=00
<b>Total</b>		<b>18014=00</b>

## II<sup>nd</sup> year

Amount approved (for II year): Rs. 17, 500=00/- (Rupees Seventeen thousand Five hundred only)`

Amount received (for II year): Rs. 14, 000=00/- (Rupees fourteen thousand only)`

Amount spend with details:

<b>Sr.No</b>	<b>Item</b>	<b>Cost(Rs.)</b>
1	Audit Fee	400=00
2	Scholar Research Library-Publication charges	1000=00
3	Sharda Stores(Stationary)	93=00
4	ITO Glass	5175=00
5	AFM Characterisation charges	1800=00
6	Conf. registration 16-2-11	250=00
7	Conf. registration 18-2-11	500=00
8	Poster printing charges	200=00
9	Conf. registration 9-3-12	500=00
10	Poster printing charges	200=00
11	AFM Characterisation charges	3000=00
12	SEM EDAX Characterisation	5500=00
<b>Total</b>		<b>18,618=00</b>

(U.M.Jadhav)

PRINCIPAL INVESTIGATOR

## **Expenditure on Travel**

### **Ist year**

Amount approved (for 1 year): Rs. 5000=00/- (Rupees five thousand only)

Amounts spend with details:

<b>Sr.No.</b>	<b>Date</b>	<b>Amount (Rs)</b>
1	2 <sup>nd</sup> Dec. 2009	2060=00
2	8 <sup>th</sup> Mar 2010	940=00
3	22 <sup>nd</sup> Aug 2010	430=00
4	12 <sup>th</sup> Sept 2010	1000=00
5	3 <sup>rd</sup> Oct. 2010	250=00
6	21 <sup>st</sup> Nov 2010	300=00
<b>Total:</b>		<b>Rs. 4980=00</b>

### **IInd year**

Amount approved (for IInd year): Rs. 5000=00/- (Rupees five thousand only)

Amount received (for IInd year): Rs. 4000=00/- (Rupees four thousand only)

Amounts spend with details:

<b>Sr.No.</b>	<b>Date</b>	<b>Amount (Rs)</b>
1	19/2/2011	<b>1080=00</b>
2	15/9/2011	<b>430=00</b>
3	28/2/2011	<b>2160=00</b>
4	9/3/2011	<b>430=00</b>
5	19/5/2012	<b>1690=00</b>
<b>Total:</b>		<b>Rs. 5,790=00</b>

(U.M.Jadhav)

PRINCIPAL INVESTIGATOR

## Expenditure on Chemicals

### Ist year

Amount approved (for IInd year): **Rs. 20,000=00/-** (Rupees Twenty thousand only)

Amount received (for IInd year): **Rs. 20,000=00/-** (Rupees Twenty thousand only)

Sr.No.	Date	Name of Supplier	Amount
1	13-2-10	Joshi Scientific corporation	17,525=00
2	5-10-10	Joshi Scientific corporation	2953=00
<b>Total</b>			<b>20,478=00</b>

### IInd year

Amount approved (for IInd year): **Rs. 20,000=00/-** (Rupees Twenty thousand only)

Amount received (for IInd year): **Rs. 16,000=00/-** (Rupees sixteen thousand only)

Amount spend with details:

Sr.No.	Name of Supplier	Amount
1	Joshi Scientific Corporation, Mumbai	20,014=00
<b>Total</b>		<b>20,014=00</b>

(U.M.Jadhav)

PRINCIPAL INVESTIGATOR



Phone (02565) 229576, (R)225629 Fax No(02565)229576  
Mob.9767487483

UGC, New Delhi Awarded  
'College with Potential for Excellence'

PSGVP MANDAL'S

SHRI S.I.P. ARTS, G.B.P. SCIENCE & S.T.S.K.V.S. COMMERCE COLLEGE,  
SHAHADA - 425409, (DIST.NANDURBAR), (M.S.), INDIA.

Principal: Dr.Vishwas Kisan Patil, M.A., Ph.D. E-mail :  
principal.shahada@gmail.com

Outward No.

Date : / 0 / 2012

### Assets Certificate

This is to certify that **Shri. Uddhav Magan Jadhav** has purchased chemicals and glasswares worth Rs. **40,492/-** and the remaining chemicals and glasswares have been handed over to the Chemistry Department of our College. These chemicals and glasswares have been purchased from the amount sanctioned for UGC sponsored Minor Research Project entitled "**Characterization of chemically deposited Nanocrystalline CdS and Ag<sub>2</sub>S Thin Films for Photovoltaic application**". under the subject area – Chemistry No F. 47 – 829 / 09 dated 22-9 -2009.

Sr. No.	Year	Date	Bill No	Name of Supplier	Amount paid
1	I	13/02/10	108	Joshi Scientific Corporation, Mumbai	20,478=00
2	II	24/2/12	53	Joshi Scientific Corporation, Mumbai	20,014=00
<b>TOTAL – 40,492=00</b>					

**Shri U.M.Jadhav**

**Dr. Vishwas K. Patil**

Principal Investigator

Principal

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COLLEGE, SHAHADA - 425409, (DIST.NANDURBAR), (M.S.), INDIA.

Principal: Dr.Vishwas Kisan Patil, M.A., Ph.D. E-mail : principal.shahada@gmail.com

Outward No.

Date : 20 /10 /2012

### Accession Certificate

This is to certify that **Shri. Uddhav Magan Jadhav** has purchased **books** and journals worth Rs. **35072/-** and have been handed over to the departmental library of the college. The books have been purchased from the amount sanctioned for UGC sponsored Minor Research Project entitled "**Characterization of chemically deposited Nanocrystalline CdS and Ag<sub>2</sub>S Thin Films for Photovoltaic application**". under the subject area – Chemistry vide letter No.F. 47 – 829 / 09 dated 22-9 -2009.

The **Accession number** for books is noted in the **Accession Register** of the departmental library and is as follows-

<b>Sr.No.</b>	<b>Date</b>	<b>Bill No.</b>	<b>Accession No.</b>
1	28/8/10	5379	237-246, pageNo.14
2	12/9/10	126	301-333,page No.18-19
3	6/10/10	2193	293-300,page No.16-17

(Shri U.M.Jadhav)

(Shri. B. S. Patil)

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**Principal: Dr.Vishwas Kisan Patil, M.A., Ph.D. E-mail : principal.shahada@gmail.com**

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**Outward No. /2012-13**

**Date : / / 2012**

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To,

Joint Secretary, Western Regional Office

University Grants Commission,

Pune University Campus, PUNE - 7.

**Subject:** Submission of final report on Minor Research Project entitled “**Characterization of chemically deposited Nanocrystalline CdS and Ag<sub>2</sub>S Thin Films for Photovoltaic application**”.

**Reference:** No F 47 – 829 / 09 dated 22-9 -2009.

.Respected Sir / Madam,

Please find enclosed herewith final report of Minor Research Project entitled “**Characterization of chemically deposited Nanocrystalline CdS and Ag<sub>2</sub>S Thin Films for Photovoltaic application**”. undertaken by Shri. Uddhav Magan Jadhav. The financial assistance for the project is Rs. 1, 20, 000/- for a period of two years .Out of which an amount of Rs. 1,11,500 /- was released as the first and second installment .

The amount of Rs. 1,22,966/- has been utilized till the completion of the project. Major objectives of the project have been achieved.

We request you to release the remaining amount of Rs. 8,500/- as early as possible.

Thanking you.

Yours faithfully,

(Dr. Vishwas K. Patil )

Principal

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Make yourself necessary to somebody- Ralph Waldo Emerson



