



ज्ञान-विज्ञान विमुक्तये

**MAJOR RESEARCH PROJECT
FINAL REPORT
Year- 2017-2018**

**UGC MAJOR PROJECT
F.NO.42-799/2013(SR)
PERIOD 01-04-2013 TO 31-03-2017**

(Extended up to 31-03-2017 vide letter dated 26th march 2016)

**PRINCIPAL INVESTIGATOR
Dr. Sumanta Kumar Tripathy
Associate Professor,
Department of Physics,
GVP College of Engineering (A),
Madhurawada, Visakhapatnam-530048**



ज्ञान-विज्ञान विमुक्तये

UNIVERSITY GRANT COMMISSION
BAHADUR SHAH ZAFAR MARG
NEW DELHI-110002
Annexure – VIII

FINAL MAOR RESEARCH PROJECT REPORT

1. NAME AND ADDRESS OF THE PRINCIPAL INVESTIGATOR

Dr. Sumanta Kumar Trpathy
Department of Physics,
GVP College of Engineering (Autonomous),
Madhurawada, Visakhapatnam-530048,
Andhra Pradesh

2. NAME AND ADDRESS OF THE INSTITUTION

GVP College of Engineering (Autonomous),
Madhurawada, Visakhapatnam-530048,
Andhra Pradesh

3. UGC APPROVAL NO. AND DATE : F.No.-42-799/2013 (SR) dated 11-03-2014

4. DATE OF IMPLEMENTATION : 21-07-2014

5. TENURE OF THE PROJECT : 3 Years

6. TOTAL GRANT ALLOCATED : Rs.10,13,300/-

7. TOTAL GRANT RECEIVED: Rs. 6,56,800/-

8. FINAL EXPENDITURE: Rs. 9,65,492/-

9. TITLE OF THE PROJECT:

Synthesis of nanoparticle Tin Oxide thin film by Sol-Gel method and comparative study of its characteristics with thin film prepared by thermal evaporation technique for application to gas sensor.

10. OBJECTIVES OF THE PROJECT:

i. Objective of the Project:

The main objective of the Project was

1. To synthesis SnO₂ thin film on glass substrate by thermal evaporation and Dip Coating method.
2. To study the film structure, optical characteristics, electrical characteristics and morphology.
3. To co-relate these parameters in between the film prepared by Thermal Evaporation and Dip coating.
4. To measure the sensitivity of SnO₂ thin film to Carbon Monoxide gas at different concentration and at different temperature of the film .
5. To conclude which method of synthesis of tin oxide thin film is suitable for gas sensing and at what temperature the sensitivity is optimum..

ii. Work done

1st Year

1. Equipment, Books and required Chemicals were purchased.
2. Project Fellow was appointed.
3. Tin Oxide thin films of thickness 500nm were synthesized by Thermal Evaporation and Dip Coating Method.
4. Optical properties were studied.
5. Structural and Morphological study along with sensitivity towards CO gas were studied for two samples each.
6. The result thus obtained was demonstrated at UGC Sponsored National Conference on Advanced Technology Oriented Materials (ATOM-2014) Organized by Department of Physics, Government College (A), Rajahmundry, Andhra Pradesh and also published in Conference proceedings "International Journal of Science and Research" (IJSR), ATOM-2014, Paper ID- ATOM2014_29, pp-101-105

2nd Year

1. Tin Oxide thin film of thickness around 500nm were synthesized.
2. Films were annealed at 100^oC, 200^oC, 300^oC and 400^oC for 1hr., 2hr., 3hr.
3. Optical properties were studied.

4. Good films were identified.
5. XRD and SEM were done at Andhra University and the structural characterization was studied.

3rd Year

1. Comparative analysis is prepared.
2. Gas sensing property is carried outside the parent Institution.
3. Comparison of results with the results from thermal evaporation method was done.
4. The result thus obtained was demonstrated at
 - (a) International conference on Recent Advances In Material chemistry (RAMC), February 24-26, 2017, organized by P.G. Department of Chemistry, Utkal University, Bhubaneswar.
 - (b) National Conference on Advanced Materials Processing and Characterization (AMPC), February 27-28, 2017, Organized by Department of Physics, National Institute of Technology, Tiruchirappalli, Tamilnadu.
 - (c) National Seminar on Recent Trends in Chemical Speciation, Kinetics and Nanomaterials (RTCSKN-2017), March 3- 4, 2017, Organized by Department of Inorganic & Analytical Chemistry, Andhra University, Visakhapatnam.
5. Final Report was prepared for submission.

iii. Has the progress been according to original plan of work and towards achieving the objective.if not, state reasons:-

It was delayed due to non-release of 2nd Installment.

iv. Please indicate the difficulties, if any, experienced in implementing the project :
NO

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.

Not applicable

vi. If the project has been completed, please enclose a summary of the findings of the study.

Summary

Anhydrous tin(II) chloride was taken in a beaker and then methanol with glacial acetic acid was added to it and stirred by a magnetic stirrer to get a clear and homogeneous solution. Thin film was synthesized on glass substrate by dip coating method. The coated substrates were dried at 150°C in a muffle furnace for 1hr and then heat treated at 300°C for about 15 minutes. The procedure was repeated for four times to get the desired thickness of around 500nm. After getting the required thickness finally heat treatment was carried out on each substrate at 500°C for one and half hour in a furnace.

Tin oxide thin film was also synthesized by thermal evaporation technique from pure tin oxide (SnO_2) powder. Tin oxide powder was taken in a boat and connected to the electrodes. The pressure of the chamber was maintained at 2.5×10^{-5} torr and rate of deposition fixed at 6-8 $\text{\AA}/\text{sec}$ at substrate temperature 40°C . During the process the target and source was maintained at 10 cm apart.

Optical characterization was studied from transmission% vs wavelength curve which was plotted from the data obtained from transmission spectrum analysis of the film by ELICO UV/VIS spectrophotometer, Model, SL 159 in the wave-length range 300–1100 nm. From this data the refractive index and thickness of the film was calculated.

It was observed that transmittance is more in case of film prepared by thermal evaporation method than Sol-Gel Method. It may be due to high porosity and larger grain size and less absorption in the film deposited by thermalevaporation method. It was also clear that transmission values were more than 0.80 at wave length greater than 500nm in both the cases. From the Transmission Vs. wavelength graph average refractive index was calculated as 2.14 and 2.18 for films prepared by Sol-Gel and Thermal Evaporation respectively. From optical data band gap was also calculated and it was observed the band gap was 3.65eV and 3.52eV in case SnO_2 thin film deposited by Sol-Gel and Thermalevaporation technique respectively. The less band gap of the film deposited by thermal evaporation technique may be due to improvement of the degree of crystallization and growth of grain.

XRD measurement was carried out by Siemens Diffractometer Model-D 5000 using $\text{CuK}\alpha$ having wave-length $\lambda = 0.1540$ nm radiation with a diffraction angle 2θ – 65° . the average grain size of the deposited film was calculated as 45.24 and 40.18nm, for the film grown by

thermal evaporation and sol-gel technique respectively. This difference may be probably due to the presence of strains distributed unevenly in the film.

The sensitivity of the SnO₂ thin film for carbon monoxide gas was studied at concentration 50ppm. It was observed that maximum sensitivity occur at temperature of 220⁰C for Thermal Evaporation Technique and 235⁰C for Sol-Gel technique. which may be concluded that tin oxide film synthesized by thermal evaporation method is better for gas sensing than sol-gel method due to more surface area is available to expose.

The proposed investigations will contribute to an improved understanding and interpretation of characteristics of SnO₂ thin film by sol gel method. The result obtained from this investigation will lead to the application of SnO₂ thin film for gas sensors. It was observed that tin oxide film synthesized by thermal evaporation method is better for gas sensing than sol-gel method due to more surface area is available to expose.

11. WHETHER OBJECTIVES WERE ACHIEVED: YES

12. ACHIEVEMENTS FROM THE PROJECT

- a) It was observed that the sensing is better in film prepared by Sol-Gel method than the Thermal evaporation method.
- b) The proposed investigations will contribute to an improved understanding and interpretation of characteristics of SnO₂ thin film by sol gel method. The result obtained from this investigation will lead to the application of SnO₂ thin film for gas sensors
- c) The outcomes of the project is mainly useful for the sensing of CO gas effectively.
- d) One Technician Mr. M.V.S.N. Murty, Technician, department of ECE, GVP College of Engineering (A) was trained for the maintenance of the Thermal Evaporation Unit.
- e) The result was demonstrated at International and national Conferences.

15. WHETHER ANY PH.D. ENROLLED/PRODUCED : NO

16. NO. OF PUBLICATIONS OUT OF THE PROJECT

1. **Sumanta Kumar Tripathy**, T.N.V. Prabhakar Rao, " Study of structural and optical properties Tin Oxide Thin Film synthesized by Thermal Evaporation Method for gas sensing applications", Proceedings of National Conference on Advanced materials: Processing and Characterisation (AMPC-2017),pp-63-69, Excel India Publishers, ISBN-978-93-86724-04-5.
2. **Sumanta Kumar Tripathy**, T.N.V. Prabhakar Rao, "Thermally Evaporated Tin Oxide Thin Film for Gas Sensing Applications", Journal of Nano and Electronic Physics- Vol. 9 No 2, 02019(4pp),April-2017
3. **S. K. Tripathy**, T.N.V. Prabhakar rao "The Influence of Annealing Temperature on Optical Properties of Tin Oxide (SnO₂) Thin Films Prepared by Thermal Evaporation Process", International Journal of Science and Research, Vol-5, Issue-5, p.p. 591-596, 2016.
4. **Sumanta Kumar Tripathy**, R. Prabeena, V. Siva Jahnvi, N.V. Prabhakara Rao Thirumala, "Tin Oxide Thin Film Synthesized by Sol-Gel and Thermal Evaporation Techniques for Gas Sensors", International Journal of Science and Research, Paper ID: ATOM2014_29, December-2014,pp.101-105



(PRINCIPAL INVESTIGATOR)



(REGISTRAR/PRINCIPAL)

Principal
G.V.P. College of Engg (Autonomous)
Madhurawada
VISAKHAPATNAM - 530 048



(CO-INVESTIGATOR)



GAYATRI VIDYA PARISHAD COLLEGE OF ENGINEERING

(Autonomous)

Approved by AICTE & Affiliated to JNTU - Kakinada
Accredited by NAAC with 'A' Grade with a CGPA of 3.47/4.00



CERTIFICATE

This is to certify that the Final Report bearing File No.- 42-799/2013(SR) entitled "Synthesis of nanoparticle Tin Oxide thin film by Sol-Gel method and comparative study of its characteristics with thin film prepared by thermal evaporation technique for application to gas sensor", awarded to Dr. Sumanta Kumar Tripathy, Principal Investigator, Department of Physics, Gayatri Vidya Parishad College of Engineering (Autonomous), Visakhapatnam has been placed on Institution website ([http://www.gvpce.ac.in/UGC-MRP-42-7992013\(SR\)Final%20Report.pdf](http://www.gvpce.ac.in/UGC-MRP-42-7992013(SR)Final%20Report.pdf)) and kept in the Library.

Date: 3.4.2021

PRINCIPAL

Principal
G.V.P. College of Engg. (Autonomous)
Madhurawada,
VISAKHAPATNAM-530 048

UNIVERSITY GRANTS COMMISSION
BAHADUR SHAH ZAFAR MARG
NEW DELHI – 110002

ASSESSMENT CERTIFICATE

It is certified that the proposal entitled “Synthesis of nanoparticle Tin Oxide thin film by Sol-Gel method and comparative study of its characteristics with thin film prepared by thermal evaporation technique for application to gas sensor” by Dr. Sumanta Kumar Tripathy, Associate Professor, Department of Physics, Gayatri Vidya Parishad College of Engineering(Autonomous), Visakhapatnam has been assessed by the Assessment Committee consisting the following members for submission to the University Grants Commission, New Delhi for financial support under the scheme of Major Research Projects:

Details of Expert Committee:

1. Prof. K Chandra Mouli,
Professor of Physics,
College of Engineering,
Andhra University, Visakhapatnam
2. Prof. M Indira Devi,
Professor of Physics,
Andhra University, Visakhapatnam

K. Chandra Mouli
04/7/17
Dr. K. CHANDRA MOULI, M.Sc., Ph.D.
PROFESSOR
Department of Engineering Physics
Andhra University
VISAKHAPATNAM
Signature with Seal

M. Indira Devi
04/7/17
Dr. M. INDIRA DEVI
M.Sc., Ph.D.
Professor of Physics,
Andhra University,
Visakhapatnam-530 003.
Signature with Seal

The proposal is as per the guidelines.

Ashtor
(Registrar/ Principal)
Seal
G.V.P. College of Engg. (Autonomous)
Madhurawada,
VISAKHAPATNAM-530 048