To,

The Faculty in Charge,

SNFCE, MNNIT Allahabad

Prayagraj – 211004

Uttar Pradesh, India

Through Proper Channel

Subject: Submission of Internship Report and Documents

Respected Dr. Vimal Singh,

I am pleased to inform you that I have successfully completed my internship under your mentorship from 06/12/23 to 02/01/24, as indicated in Reference Letter No. 179/SNFCE/2023-2024 dated December 1st , 2023.

Enclosed, please find two copies of my internship report, along with the plagiarism report and attendance record, for your kind review. Your prompt attention to this matter is greatly appreciated, and I am grateful for your support throughout the internship.

Thank you for your guidance, and I look forward to your feedback.

With warm regards,

Rohan Joshi

Vellore Institute of Technology

January 17 ,2024

PRINTING AND DROP-CASTING BASED PROCESS AND SPROCESS TOOL

A Report submitted as a part of Project Work for

The Winter Internship Training Program 2023- 2024

By Rohan Joshi

(3rd Year, B Tech ECE

Spl. Biomedical Engineering

Vellore Institute of Technology)

Under The Supervision of

Dr. Vimal Singh

(Assistant Professor)

DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING

MOTILAL NEHRU NATIONAL INSTITUTE OF TECHNOLOGY ALLAHABAD

PRAYAGRAJ -211004, UTTAR PRADESH, INDIA

Dec23 – Jan24

DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING

MOTILAL NEHRU NATIONAL INSTITUTE OF TECHNOLOGY ALLAHABAD

PRAYAGRAJ -211004, UTTAR PRADESH, INDIA

CERTIFICATE

This certifies that Mr. Rohan Joshi, a student pursuing a B.Tech. in Electronics and Communication Engineering specialization in Biomedical Engineering at Vellore Institute of Technology in Vellore, Tamil Nadu, has successfully Completed his Internship in the Department of Electronics and Communication Engineering at this Institute from December 06, 2023 to January 02, 2024. He was supervised and guided by me during this time. While receiving effective instruction on " PRINTING AND DROP-CASTING BASED PROCESS AND SPROCESS TOOL "

January 02,2024

Dr. Vimal Singh
Assistant Professor

ECE Department

MNNIT Allahabad

UNDERTAKING

I hereby declare that the content presented in this report titled "PRINTING AND DROP-CASTING BASED PROCESS AND SPROCESS TOOL", submitted to the Department of Electronics and Communication Engineering, MNNIT Allahabad, Prayagraj, for the SNFCE Winter Internship training, is entirely my own work. I affirm that I have not plagiarized or submitted the same work for the fulfillment of any other degree.

Rohan Joshi

Vellore Institute of Technology

January 02 ,2024

PREFACE

It gives me great pleasure to share my internship report, which summarises the fascinating experiences I had while working as an intern at MNNIT Allahabad. This report summarises my professional growth, challenges, and practical insights from December 06, 2023 to January 02, 2024.

I had the honour of collaborating on a number of initiatives at MNNIT Allahabad, a prestigious institution in the field of VLSI. This report offers an overview of the tasks completed, illuminating the organisational culture and structure in addition to the priceless lessons discovered.

I would like to express my sincere appreciation to Dr. Vimal Singh for his leadership and assistance, as well as to the whole MNNIT Allahabad staff for creating a positive learning atmosphere. The transformational journey that was completed during this internship is attested to in this report.

Rohan Joshi
Vellore Institute of Technology

ACKNOWLEDGEMENT

I extend my heartfelt thanks to for their invaluable guidance and support during my internship at MNNIT Allahabad. Special appreciation goes to the faculty, staff, and fellow interns for fostering a collaborative learning environment.

I am grateful for the shared experiences and camaraderie with colleagues. My sincere thanks to my family and friends for their constant encouragement.

This internship has been a significant chapter in my professional journey, and I am thankful to everyone who contributed to this enriching experience.

Rohan Joshi
Vellore Institute of Technology

ABSTRACT

This report presents printing and drop-casting based process of ZnO and simulate the fabrication process using SPROCESS tool of Senaturus. Zinc oxide (ZnO), characterized by its unique optoelectronic properties, has emerged as a promising material for various electronic devices. In this report, we delve into the fabrication of ZnO thin films using advanced printing and drop-casting techniques, coupled with simulation methods, to tailor the properties of these films for specific applications. ZnO, a wide-bandgap semiconductor, exhibits excellent transparency, high electron mobility, and piezoelectric characteristics, making it ideal for applications ranging from sensors and transistors to solar cells and light-emitting diodes. The challenge lies in achieving controlled and scalable fabrication processes to harness the full potential of ZnO in electronic devices.

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INTRODUCTION

Zinc oxide (ZnO) has garnered significant attention in the realm of electronic materials due to its exceptional electrical, optical, and piezoelectric properties. In this section, we explore the fabrication of ZnO thin films through innovative and scalable techniques: printing and drop-casting. These methods not only offer cost-effective alternatives but also provide a means to tailor ZnO thin films for various electronic applications. The fabrication journey begins with the meticulous preparation of the ZnO ink. The ink composition, a critical determinant of film quality, typically includes ZnO nanoparticles, a suitable solvent, and additives for stability. The choice of precursor materials and their ratios influence the final properties of the thin film.

Printing Process:

Overview: Printing techniques, such as inkjet or screen printing, enable precise control over the deposition of ZnO ink onto substrates.

Substrate Preparation: Substrates, commonly glass or flexible materials, undergo thorough cleaning and, if necessary, surface modification to enhance adhesion.

Printing Parameters: Variables such as ink viscosity, drop size, and printing speed are optimized to achieve uniform coverage and desired film thickness.

Drop-Casting Process:

Principle: Drop-casting involves depositing ZnO ink onto a substrate by allowing droplets to fall under gravity, leading to a self-assembled thin film.

Substrate Conditions: Similar to printing, substrate preparation is crucial, ensuring proper wetting and adhesion of the droplets.

Drying Process: The controlled drying of the droplets influences the film's morphology and crystalline structure. Temperature and humidity conditions are carefully regulated.

Both printing and drop casting offer advantages in terms of cost, scalability, and versatility, making them attractive for various applications in electronic and optoelectronic devices. The selection of the appropriate technique depends on the specific requirements of the application and the desired characteristics of the ZnO thin film.

PROCEDURE

1. 5mg of ZnO nanowire powder is used to drop cast on a glass slide and then add a cover slip .
2. 5ul drop cast on coverslip almost 2 times for heating .
3. Put the coverslip on a hot plate to dry it out for the annealing process.
4. Annealing process was done for not more than 10 minutes.

In drop casting, a micropipette is commonly used for precise and controlled deposition of small liquid droplets onto a substrate. Drop casting is a technique often employed in material science and thin-film deposition processes. Here's how micropipettes are typically used in drop casting:

1. Selection of Micropipette and Tips:
   - Choose a micropipette with an appropriate volume range for the desired droplet size.
   - Select disposable plastic tips based on the volume needed and the substance being deposited.

2. Setting the Volume:
   - Adjust the micropipette to the desired volume using the volume adjustment knob or dial on the micropipette. Ensure that the volume setting matches the requirements of the experiment.

3. Preparation of Liquid Sample:
   - Load the liquid sample into the micropipette by immersing the tip into the liquid and depressing the plunger to aspirate the desired volume.

4. Positioning and Deposition:
   - Position the micropipette tip over the substrate where the droplet needs to be deposited.
   - Gently dispense the liquid by slowly releasing the plunger, causing a controlled droplet to form and fall onto the substrate.

5. Repetition and Precision:
   - Repeat the process for each desired deposition point on the substrate.
   - The precision of the micropipette allows for accurate control over the droplet size and placement.

6. Substrate Preparation:
   - Ensure that the substrate is clean and properly prepared to receive the liquid droplets.

- Substrate materials can include glass slides, silicon wafers, or other surfaces depending on the experiment.

7. Drying and Post-Processing:
   - Allow the deposited droplets to dry or undergo further processing steps based on the specific requirements of the experiment.

Micropipettes provide a level of precision that is crucial in applications where controlled deposition of small volumes is essential. This technique is commonly used in the fabrication of thin films, coatings, and other material science experiments where precise liquid placement is critical for the desired outcome.

NANOWIRE SPECIFICATION:

Diameter- 90nm

Length- 1um

Fm sigma Aldrich USA- 773989- 500mg

Equipment used for Drop casting

1. Micropipette - A micropipette is frequently used in drop casting to precisely and carefully deposit tiny liquid droplets onto a substrate. In thin-film deposition and material science, drop casting is a commonly used technique.

2. Micropipette dropping -Where the droplet needs to be deposited, place the micropipette tip over the substrate. Slowly release the plunger to create a regulated droplet that falls onto the substrate, then gently dispense the liquid.

3. Hot Plate- In drop casting procedures, a hot plate is frequently utilised to speed up the evaporation of solvents and encourage the deposition and creation of thin films or coatings. Little liquid droplets are deposited onto a substrate during the drop casting process, and the deposited material is then dried and solidified with the use of a heated plate.

4. Dehydration and Evaporation: The solvent's evaporation from the deposited droplets is accelerated by the hot plate. The substance remains behind and forms a thin coating or film on the substrate when the solvent evaporates.

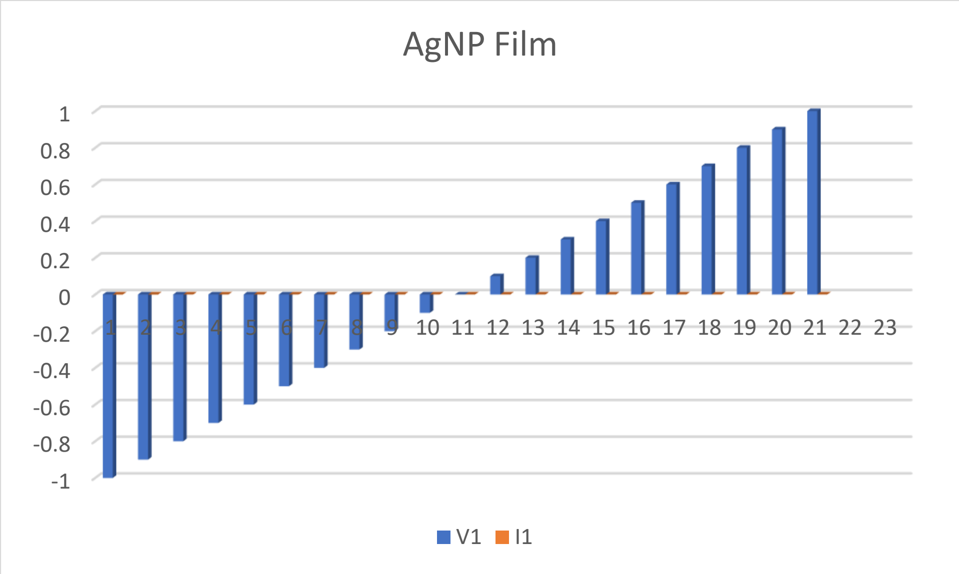
5. <u>500mg of ZnO nanowire powder</u>- 5ul of ZnO powder is used for drop casting in this process and IV curve is received .

6. <u>B1500A Keysight I-V Parametric Analysis</u>

GRAPHS AND VALUES

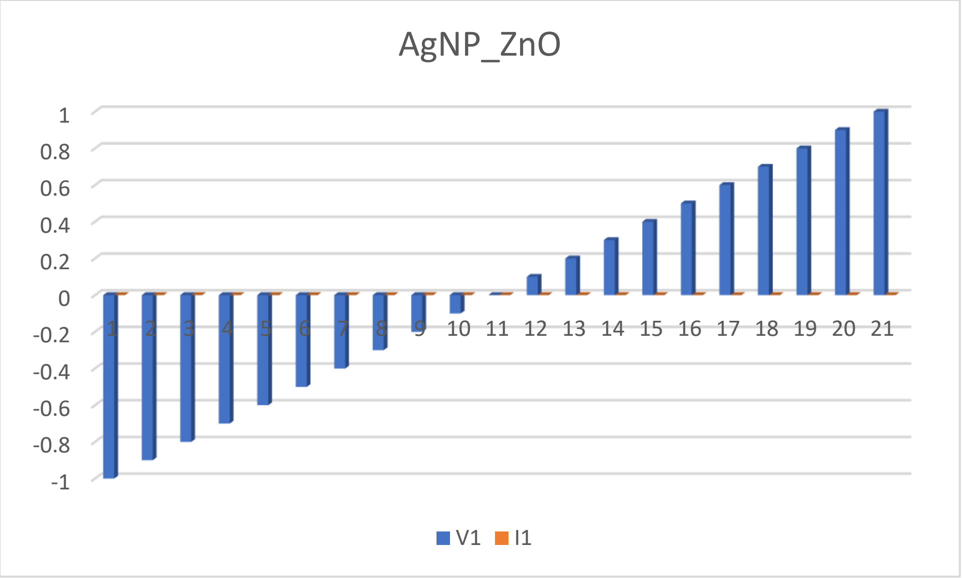
1. AgNP Film

V1	I1
-1	-0.0003201
-0.9	-0.00024576
-0.8	-0.00017552
-0.7	-0.00010904
-0.6	-5.08E-05
-0.5	-1.20E-05
-0.4	-2.14E-06
-0.3	-1.17E-06
-0.2	-8.01E-07
-0.1	-4.55E-07
0	-1.38E-07
0.1	4.63E-07
0.2	8.01E-07
0.3	1.17E-06
0.4	2.12E-06
0.5	1.18E-05
0.6	5.02E-05
0.7	0.000107412
0.8	0.00017404
0.9	0.00024482
1	0.00031868



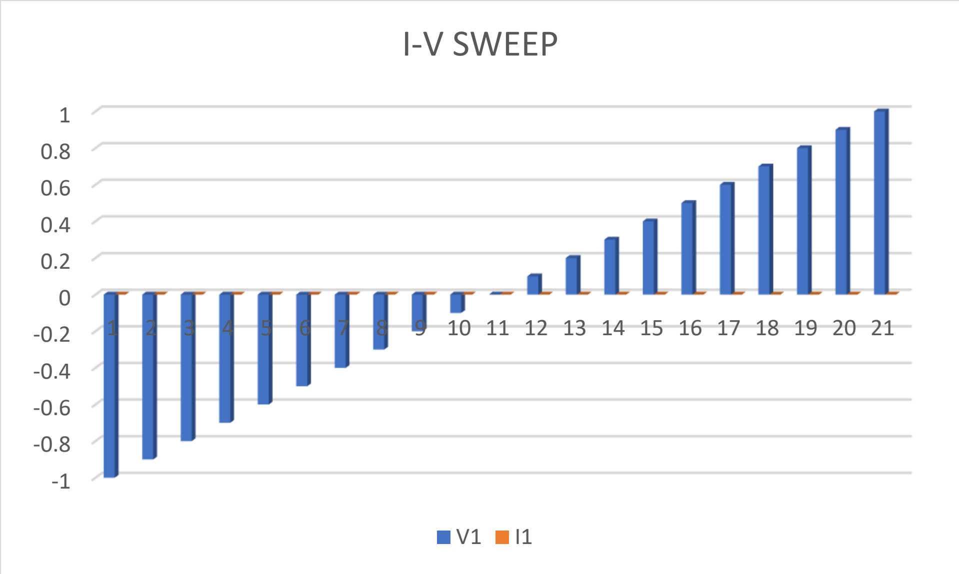
2. <u>AgNP_ZnO Film</u>

V1	I1
-1	5.22E-10
-0.9	5.75E-10
-0.8	5.45E-10
-0.7	5.51E-10
-0.6	5.02E-10
-0.5	5.61E-10
-0.4	5.61E-10
-0.3	5.85E-10
-0.2	5.73E-10
-0.1	5.67E-10
0	5.62E-10
0.1	5.55E-10
0.2	6.03E-10
0.3	5.56E-10
0.4	5.76E-10
0.5	5.87E-10
0.6	5.67E-10
0.7	5.09E-10
0.8	5.81E-10
0.9	5.75E-10
1	6.11E-10



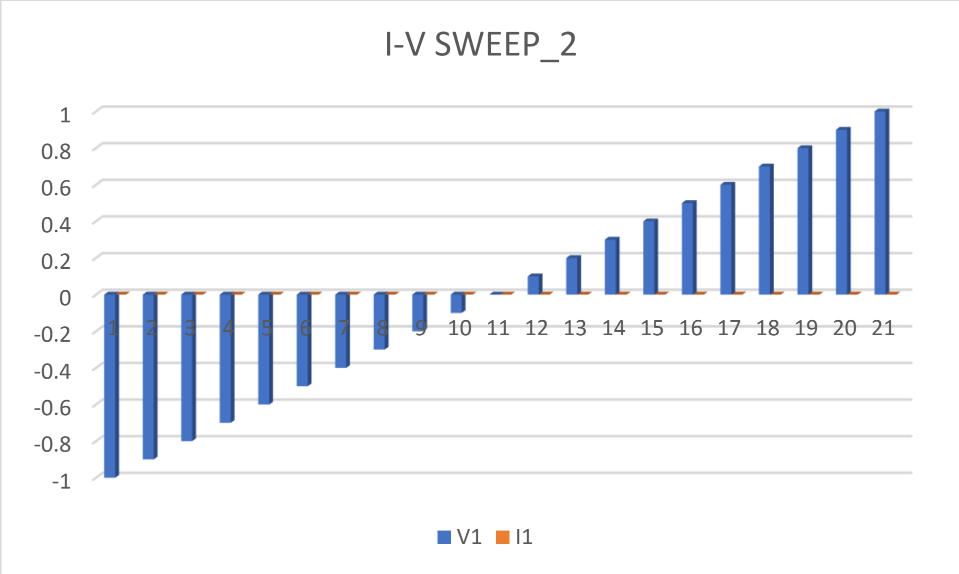
3. <u>I-V SWEEP</u>

V1	I1
-1	5.31E-10
-0.9	5.10E-10
-0.8	5.43E-10
-0.7	5.47E-10
-0.6	4.92E-10
-0.5	5.62E-10
-0.4	5.61E-10
-0.3	5.41E-10
-0.2	5.54E-10
-0.1	5.72E-10
0	5.51E-10
0.1	5.27E-10
0.2	5.74E-10
0.3	5.66E-10
0.4	5.03E-10
0.5	5.77E-10
0.6	5.72E-10
0.7	5.52E-10
0.8	5.69E-10
0.9	6.13E-10
1	5.70E-10



4. <u>I-V SWEEP_2</u>

V1	I1
-1	5.43E-10
-0.9	5.78E-10
-0.8	5.55E-10
-0.7	5.56E-10
-0.6	5.62E-10
-0.5	5.37E-10
-0.4	5.91E-10
-0.3	5.51E-10
-0.2	5.89E-10
-0.1	5.81E-10
0	5.60E-10
0.1	5.06E-10
0.2	5.76E-10
0.3	5.70E-10
0.4	5.51E-10
0.5	5.68E-10
0.6	5.80E-10
0.7	5.71E-10
0.8	5.60E-10
0.9	5.30E-10
1	5.68E-10



RESULTS AND DISCUSSIONS

The efficacy of the deposition technique is suggested by the drop-cast ZnO films' consistent morphology and good crystallinity.
These films may be suitable for applications involving transparent conductive electrodes, based on the reported optical characteristics.
The ZnO films appear to provide the necessary semiconducting qualities for a range of electronic and optoelectronic device applications, based on the observed electrical conductivity.

CONCLUSION

The technique of drop casting has shown to be effective in producing ZnO films with desired optical, structural, morphological, and electrical characteristics. These findings set the stage for more investigation and improvement of drop-cast ZnO films for use in light-emitting diodes, solar cells, and sensors.

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