

EXECUTIVE SUMMARY OF THE PROJECT REPORT

Title: Investigation of the electrical properties of doped/undoped ZnO based thin film transistors with different gate dielectrics

The project work has been done according to the original plan of work and following the objectives of the project and applying the methodology that mention in the project proposal. The detail report of the work done is presented in seven chapters. A brief discussion of the chapters are presented below-

Chapter 1 presents the general introduction of thin film transistors. This chapter describes briefly about the various applications of TFT's, various TFT structures and their deposition techniques, material analysis for TFTs and the physical processes involved in the TFTs. Also one important theoretical models that describe the physical process involved in the TFTs and on the basis of which, some the finding of the present investigations would be interpreted is introduced briefly in this chapter. Furthermore, a brief review of the works on TFTs is presented in this chapter.

Chapter 2 describes the materials and methodology of the investigations made in this work. This chapter explains the preparation of different evaporation masks, fabrication of TFTs, annealing of the TFTs and the film thickness and gate capacitance measurement. This chapter also describes the cleaning of vacuum unit, preparation of substrates, heating of substrates and evaporation process of metal, insulator and semiconductor. Moreover, the measurement of current-voltage characteristics, experimental arrangement and the various apparatus used in this investigation are introduced in this chapter.

Chapter-3 contains the fabrication and characterization of TFTs by thermal evaporation technique with ZnO as active material and Nd_2O_3 , La_2O_3 and Al_2O_3 as gate insulators. All the TFTs are fabricated in coplanar electrode structure under high vacuum of the order of 10^{-6} tor. The current-voltage characteristics of the TFTs are evaluated and some important transistor parameters such as field effect mobility

(μ_{FE}), threshold voltage (V_T) and sub-threshold swing are estimated using suitable models. The field effect mobility (μ_{FE}), threshold voltage (V_T), drain current on-off ratio and sub-threshold swing of the fabricated devices for ZnO-Nd₂O₃ TFT are found as 0.36 cm²/VS, 7 V, 1.1x10⁵ and 1V/decade respectively. For ZnO -La₂O₃ TFTs, the field effect mobility (μ_{FE}), threshold voltage (V_T), on-off ratio and sub-threshold swing are found as 0.31 cm²/VS, 3.7 V, 10⁵ and 1.1V/decade respectively. For ZnO- Al₂O₃ TFTs, the field effect mobility (μ_{FE}), threshold voltage (V_T), on-off ratio and sub-threshold swing are found as 0.4 m²/VS, 4V, 10⁵ and 1.2 V/decade respectively.

Chapter-4 contains the preparation of ZnO thin film using chemical bath deposition technique and their potential application as active material in thin film transistors. High dielectric constant insulator Al₂O₃ is used as dielectric layer and the electrical properties of the devices are evaluated. ZnO thin films are characterized by XRD and SEM analysis. Measured values of mobility (μ_{FE}), threshold voltage (V_T), on-off ratio and sub threshold swing of the fabricated devices are found as 0.45 cm²V⁻¹s⁻¹, 1.8 V, 10⁶ and 0.6 V/decade respectively.

Chapter-5 contains the fabrication of ZnO thin films by another simple and low cost CBD technique with high - k rare earth oxide La₂O₃ as gate dielectric. The characterization of the fabricated thin films and the measurement of electrical characteristics of the TFTs with air annealed and without air annealed ZnO samples have been done. ZnO thin films are characterized by XRD and SEM analysis. The measured values of electrical parameters of TFTs with air annealed sample of the TFT are mobility (μ_{FE}) is 0.58 cm²/Vs, threshold voltage (V_T) is 4V, drain current on-off ratio is 10⁶, sub-threshold Swing is 1V/decade and gain band-width product is 0.04 (kHz). The electrical parameters of TFTs without annealed sample of the TFT are mobility (μ_{FE}) is 0.024 cm²/Vs, threshold voltage (V_T) is 6.6V, drain current on-off ratio is 10⁴, Sub-threshold Swing is 1.1V/decade and gain band-width product is 0.039x10⁻³ (kHz).

Chapter-6 contains the fabrication of ZnO- TFTs using sol-gel technique on perfectly cleaned glass substrates with La₂O₃ as gate dielectric layer. ZnO thin

films are characterized by XRD and SEM analysis. Evaluations of various electrical parameters of the TFTs are also done. Measured values of mobility (μ_{FE}), threshold voltage (V_T), on/off ratio and sub- threshold swing of the fabricated devices are $1.5 \text{ cm}^2\text{V}^{-1}\text{s}^{-1}$, 2.5 V, 10^7 and 0.8 V/decade respectively.

Chapter-7 describe the summery and conclusion of the findings of the project work.

The references used in the study of the project are presented after chapter -7.
