INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

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Thesis Title: "**Growth Dynamics, Fabrication and Operational Stability of Organic Field-Effect Transistors Based on $SnCl_2Pc$, VOPc and CuPc Molecules.**"

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SHORT ABSTRACT

This thesis presents a systematic study on the growth mechanism, growth dynamics of organic thin films and device performances of organic unipolar and ambipolar field-effect transistors based on phthacyanine molecules. The complete thesis work has been organized into eight chapters. The present chapter, i.e., *Chapter 1* introduced a brief account of the organic semiconductors, particularly small molecule based $SnCl_2Pc$, VOPc, CuPc molecules. This chapter also included brief discussion on the study of growth kinetics of thin films, charge transport, electrical parameters of OFETs, and its bias stress stability. *Chapter 2* provides a brief description of the experimental techniques used for the present work along with the working principles of some characterization tools. In *Chapter 3*, we present the results the evolution of surface morphology and scaling behavior of non-planar $SnCl_2Pc$ thin films grown on Si(100) and glass substrates. Our results imply the superiority of glass substrate over the Si substrate for the growth of device quality $SnCl_2Pc$ thin film. The systematic study of substrate dependent growth behavior and possible growth model is described elaborately in this chapter. In *Chapter 4*, we present the systematic study of the surface evolution and growth dynamics of non-planar VOPc molecular thin film on SiO_2 and ITO-glass substrate, substrate temperature dependent growth behavior and particularly provide some insights on the role of molecular-substrate interface. It includes discussion on the substrate induced growth scenario from the AFM, height-height correlation function (HHCF) and two dimensional fast Fourier transform (2D FFT) analyses. *Chapter 5* provides a quantitative analysis of the electrical performances and stability of vacuum-deposited thin film based n-channel organic field-effect transistors with $SnCl_2Pc$ in top contact bottom gate configuration using Ag source/drain electrodes and $PMMA/Al_2O_3$ as a bilayer gate dielectric as well as SiO_2 gate dielectric. Furthermore, we demonstrate the effect of contact electrodes Al and Ag on the performance and stability of $SnCl_2Pc$ based n-channel OFET. In *Chapter 6*, we address the VOPc based p-channel OFET performance in an ambient condition

and its operational stability using HMDS treated SiO_2 and non-treated SiO_2 gate dielectric layer. We demonstrate that HMDS treated devices shows high performances and better air stability than the devices with non-treated SiO_2 layer. In *Chapter 7*, we explore a bilayer ambipolar OFET based on the heterojunction of low band gap $SnCl_2Pc$ and CuPc small molecules and Ag top contact, which exhibit ambipolar conduction in heterostructure configuration. The change in the active layer thickness resulted in the evolution of the field-effect mobility values and it is also found that the optimized thickness of $SnCl_2Pc$/CuPc heterostructure yielded balanced carrier mobility. We also study the device stability for optimized thickness of the $SnCl_2Pc$/CuPc layers. Finally, in *Chapter 8*, we provide a summary and outlook of the present thesis. In particular, the highlights of the major contributions of the thesis, important conclusions of the present work and scope for future studies on phthalocyanine based organic molecules and its application as organic field - effect transistors are presented.

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