DECLARATION

I hereby declare that the thesis entitled "***Investigations on Dye Sensitized Solar Cells to Optimize its Performance***" has been prepared by me under the guidance of Dr. Suman Chatterjee, Professor, Department of Physics, University of North Bengal. The work is original and no part of this thesis has previously formed the basis for the award of any degree or fellowship.

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CERTIFICATE FROM THE SUPERVISOR

I certify that Mr. **RAJAT BISWAS** has prepared the thesis entitled, ***Investigations on Dye Sensitized Solar Cells to Optimize its Performance*** for the award of Ph.D. degree of the University of North Bengal, under my supervision. He has carried out the work at the Department of Physics, University of North Bengal. No part of this thesis has previously formed the basis for the award of any degree or fellowship.

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Dedicated to my family,

especially to my mother, wife

and loving daughter

Arohi

Preface

Photovoltaic technologies represent one of the leading research areas of solar energy. It is one of the most potent renewable alternatives to fossil fuels. Direct conversion of solar radiation into electricity is a renewable, abundant and clean method for producing energy. Though conventional photovoltaic devices (silicon-based solar cells) are promising for the direct conversion of photons into electrons, the prohibitive cost of these cells is uncompetitive with conventional power generating methods. On the contrary, dye-sensitized solar cells (DSSCs) are a non-conventional photovoltaic technology that has attracted significant attention because of their high conversion efficiencies, low cost, non-toxic and recyclable materials and suitability for wide variety of end-user products. This thesis work entitled *"**Investigations on Dye Sensitized Solar Cells to Optimize its Performance**"* is the outcome of the experimental investigations performed on the fabrication and characterization of DSSCs based on various dyes, photoanode and electrolyte materials.

This thesis focuses on optimizing the different components of a DSSC and studying the influence of various parameters of these component materials on the overall performance of the cell in terms of efficiency and stability. The thesis is broadly divided into seven chapters. **Chapter 1** briefly introduces the world's present energy scenario and an overview of the need for renewable energy sources. This chapter also discusses different generations of photovoltaic technology along with a brief introduction to different components and working principles of dye sensitized solar cells. **Chapter 2** describes the basic theory of the experimental techniques used for characterizing the different components of DSSCs. **Chapter 3** illustrates the charge transfer kinetics and effect of the shape of ZnO nanostructure on the performance of DSSCs based on two natural dyes. **Chapter 4** investigates the impact of surface modification via sol-gel spin coating of ZnO nanoparticles on the performance of WO_3 photoanode-based DSSCs by varying the

concentration of ZnO precursor solution. In **Chapter 5**, the role of chenodeoxycholic acid (CDCA) as dye co-adsorbent and blocking layer in improving the performance of dye sensitized solar cells has been presented. **Chapter 6** deals with investigating the use of gel electrolyte on the stability enhancement of DSSCs. Finally, the critical findings arising from the present work have been summarized in **Chapter 7**.

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Rajat Biswas

List of Abbreviations

ACN	Acetonitrile
CB	Conduction band
CDCA	Chenodeoxycholic acid
DSSC	Dye sensitized solar cell
EDS	Energy-dispersive X-ray spectroscopy
E_g	Energy band-gap
EIS	Electrochemical Impedance Spectroscopy
FF	Fill Factor
FTO	Fluorine doped Tin oxide
FWHM	Full width at half maximum
HOMO	Highest occupied molecular orbital
I_{max}	Maximum current
I_{sc}	Short-circuit current
ITO	Indium tin oxide
JCPDS	Joint committee on powder diffractionstandards
J_{sc}	Short-circuit current density
LUMO	Lowest unoccupied molecular orbital
MEA	Monoethanolamine
MPN	3-methoxypropionitrile
NP	Nanoparticle
NR	Nanorod
PC	Polyvinyl carbonate
PEDOT	[poly(3,4-ethylenedioxythiophene)]
P_{max}	Maximum power
PV	Photovoltaic
Pt	Platinum

RB	Rose Bengal
R_s	Series resistance
R_{sh}	Shunt resistance
SEM	Scanning electron microscopy
TCO	Transparent conducting oxide
V_{max}	Maximum voltage
V_{oc}	Open circuit voltage
XRD	X-ray diffraction
η	Power conversion efficiency
λ_{max}	Maximum absorption wavelength.

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