

Table of Contents

Chapter 1	Page No
Introduction	
1.1. Organic solar cell	1-10
1.1.1. The era of organic photovoltaic (OPV) solar cell	2-3
1.1.2. Mechanism of organic solar cell	3-9
1.1.2.1. Incoupling of the photon	4
1.1.2.2. Photon absorption	4-5
1.1.2.3. Exciton generation	5-6
1.1.2.4. Exciton diffusion	6-7
1.1.2.5. Exciton dissociation	7-8
1.1.2.6. Charge transport	8
1.1.2.7. Carrier collection of the electrode	9
1.1.3. Concepts for improvement	9-10
1.1.3.1. Increasing the absorption range	9
1.1.3.2. Device engineering and improved charge transport	10
1.2. Carbon nanotubes (CNT) and Improvement of charge transport	10-26
1.2.1. Carbon nanotubes (CNT) and its application in energy	11
1.2.2. Structure	11-13
1.2.3. Synthesis of carbon nanotubes	13-14
1.2.4. Issues related to CNT synthesis	14-15
1.2.4.1. Use of non-renewable precursors	14
1.2.4.2. High energy intensive process	15
1.2.5. Properties of CNT's	15-18
1.2.5.1. Strength and elasticity	15-16
1.2.5.2. Electrical conductivity	16
1.2.5.3. Thermal conductivity and expansion	17
1.2.5.4. Field emission	17-18
1.2.5.5. High aspect ratio	18

1.2.6. Energy application of CNT	18-22
1.2.6.1. Energy Storage	19
1.2.6.2. Thermal conductivity	19-20
1.2.6.3. Conductive, Adhesives and connectors	20
1.2.6.4. Thermal materials	20
1.2.6.5. Structural composites	20
1.2.6.6. Catalytic supports	20
1.2.6.7. Ceramic applications	20-21
1.2.6.8. CNT incorporated organic solar cell	21-22
1.2.7. Use of CNT in organic solar cell	22-25
1.2.8. Challenges in using CNT and recent development	25-26
1.3. Objectives and research plan	27-29
1.3.1. Objective	27
1.3.2. Research plan	28-29

Chapter 2

Synthesis and characterization of carbon nanotubes (CNT)	30-42
2.1. Introduction	30
2.2. Synthesis of CNT by CVD method and characterization	30-31
2.3. Characterization of CNT	31-35
2.3.1. Scanning electron microscopy (SEM)	31-32
2.3.2. X-ray diffraction	32-33
2.3.3. Transmission electron microscopy (TEM)	33-34

2.3.4. Energy dispersive X-ray spectroscopy (EDX)	34-35
2.4. Materials and method	36-37
2.4.1. Material used	36
2.4.2. Synthesis of catalyst	36
2.4.3. Synthesis of CNT using Ricinus communis Lin. (Castor oil)	37
2.5. Results and discussion	38-42
2.6. Conclusion	42

Chapter 3

Development and Testing of thin film based organic solar cell	43-64
3.1. Introduction	43
3.2. Fabrication of organic solar cell	44-46
3.2.1. Spin coating method	45-46
3.3. Characterization of thin film	47
3.3.1. UV-Vis spectra study	47
3.4. Testing of solar cell	47-49
3.5. Methods and materials	50-54
3.5.1. Materials for active layer	51-52
3.5.2. Material for electrode	
3.5.3. The structure of the organic solar cell	53-54
3.6. Experimental	54
3.7. Result and discussions	54-63

3.8. Conclusion

64

Chapter 4

Conclusion and Future scope

65-66

References

APPENDICES

LIST OF FIGURES

Fig. No	Title	Page No
Fig.1.1.	Different architecture of organic solar cell	3
Fig.1.2.	Mechanism of organic solar cell	4
Fig.1.3.	Description of nanotubes by chiral vectors	12
Fig.1.4.	Sketches of three different SWNT structure	12
Fig.1.5.	Mechanism of CNT polymers blend solar cell	23
Fig.1.6.	Flow chart of the plane of research	28
Fig.1.7.	Schematic representation of the plan of work using PERT diagram	29
Fig.2.1.	Diffraction of the X-ray from consecutive layer of atoms in a crystal	33
Fig.2.2.	Schematic diagram of chemical vapor deposition set up	37
Fig.2.3.	SEM micrograph of Iron oxide particle	38
Fig.2.4.	TEM micrograph of Iron oxide particle	39
Fig.2.5.	XRD pattern of Iron oxide	40
Fig.2.6.	SEM micrograph of CNTs	41
Fig.2.7.	EDX spectrum of CNT (Castor oil)	41
Fig.2.8.	TEM micrograph of CNT (Castor oil)	42
Fig.3.1.	Different techniques of thin film preparation	43
Fig.3.2.	Different fabrication techniques of organic solar cell	44
Fig.3.3.	Schematic representation of spin coating process	45
Fig.3.4.	Dependence of properties of thin film on some factors	46
Fig.3.5.	I-V curve of organic solar cell	48
Fig.3.6.	Structure of PCBM	51

Fig.3.7.	Structure of P3OT	52
Fig.3.8.	Designed organic solar cell	53
Fig.3.9.	Mechanism of the solar cell	53
Fig.3.10.	Absorption spectrum of materials used for solar cell	55
Fig.3.11.	Absorption spectra of the active layer material in chlorobenzene as solvent	55
Fig.3.11.	Transmittance spectrum of ITO glass	56
Fig.3.13.	I-V characteristic of ITO/P3OT-PCBM/LiF-Al solar cell	57
Fig.3.14.	ITO/P3OT-PCBM/LiF-Al, with Al-foil as electrode 2 min UV	58
Fig.3.15.	ITO/P3OT-PCBM-MWNT/LiF-Al, with Al-foil as electrode	58
Fig.3.16.	ITO/P3OT-PCBM/LiF-Al, with spray deposition	59
Fig. 3.17	ITO/P3OT-PCBM-MWNT/LiF-Al, with spray deposition	59
Fig.3.18.	ITO/P3OT-PCBM-MWNT/LiF-Al, with 2 min UV	60
Fig.3.19.	ITO/P3OT-PCBM-MWNT/LiF-Al, 3 min UV	60
Fig.3.20.	ITO/P3OT-PCBM-MWNT/LiF-Al with spray deposition, 5 min UV	61
Fig.3.21.	ITO/P3OT-PCBM-MWNT/LiF-Al using PVD	62

LIST OF TABLES

Table. No.	Title	Page No
Table.3.1.	List of characterization of ITO/P3OT-PCBM-MWNT /LiF-Al solar cell	63
Table.3.2.	The performance comparison between ITO/P3OT- PCBM/LiF-Al and ITO/P3OT- PCBM-MWNT/LiF-Al solar cell	63