SCIENTIFIC REPORT

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Visit Period: 14.01.2007-19.01.2007

Host: Prof. Dr. N. Serdar SARICIFTCI

Johannes Kepler University

Linz Institute for Organic Solar Cells

Linz/ Austria

Extensive studies has been conducted on the construction organic solar cell systems by the use of dyes brought from Solar Energy Institute at Ege University. Molecular Structures which used to fabricate organic solar cell and bilayer heterojunction solar cell and the detailed analysis figures are shown below.

In addition following two seminars are given by myself at Johannes Kepler University, Linz Institute:

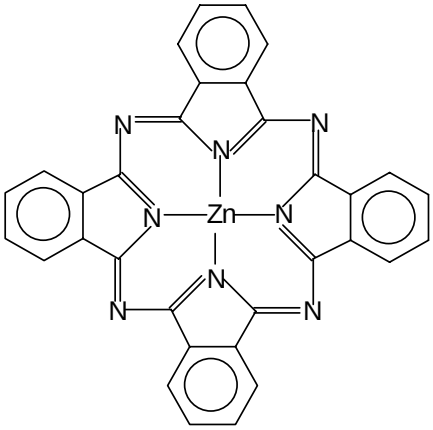
***Seminar in Linz, date: 19.02.07, Topic: Research activities at Solar Energy Institute on solar cells**

***Seminar in Linz, date: 26.02.2007 Topic: The work plan of Dr. Sule Erten in Linz.**

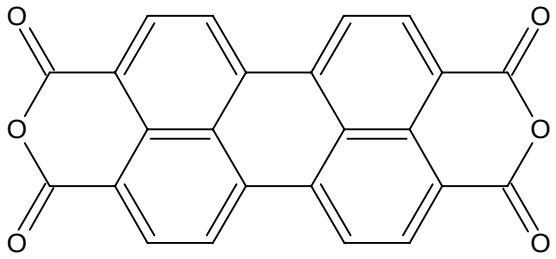
***Also I gave a lecture in winterschool on Organic Electronics- Interface Controlled and Functionalised Organic Films, 27 January-2 February 2007, Planneralm-Austria, National Research Network (NFN), "S. Erten, Th. B. Singh, N.S. Sariciftci, S. Icli-Air stable and soluble derivatives of perylene and naphthalene dimide for n-channel organic semiconductors",**

1. Molecular structures of used materials

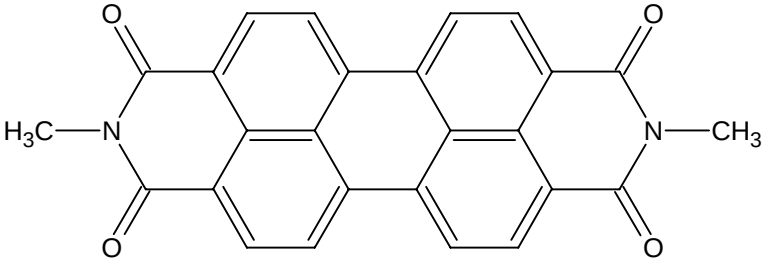
Dye sensitised solar cell and bilayer heterojunction solar cell were fabricated by using some molecular structures; Perylene tetracarboxylic dianhydride, Perylene dimide, Perylene bisbenzimidazole, Perylene monoimide monoanhydride, Perylene amidine imide, Naphthalene bisbenzimidazole, 7H-Benzimidazo[2,1-a]benz[de]isoquinoline-7-one-10-carboxylic acid, Naphthalene benzimidazole. Molecular structures of used materials are shown below.



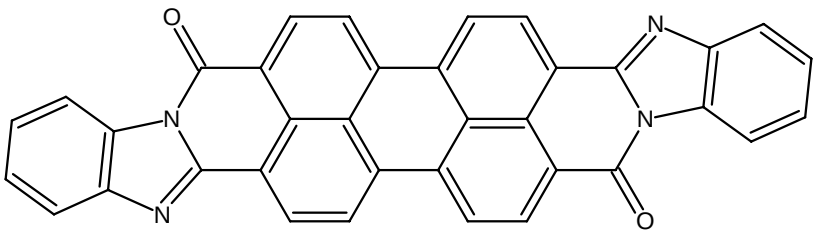
Zinc Phthalocynanine



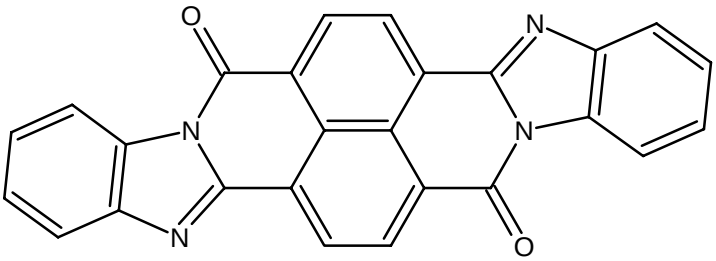
3,4,9,10-perylene tetracarboxylic dianhydride, PDA



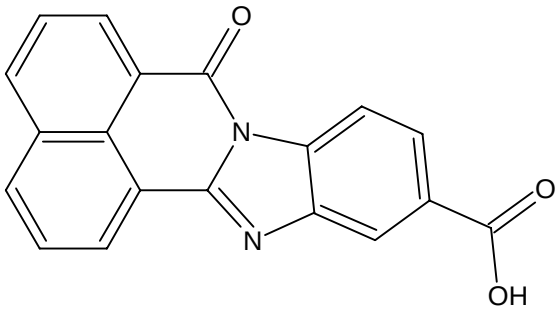
N,N'-bis-methyl-3,4,9,10-perylene dimide, PDI



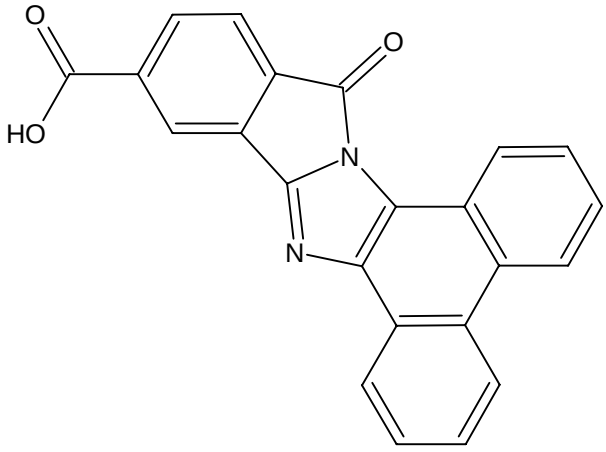
Perylene bis benzimidazole, BPP



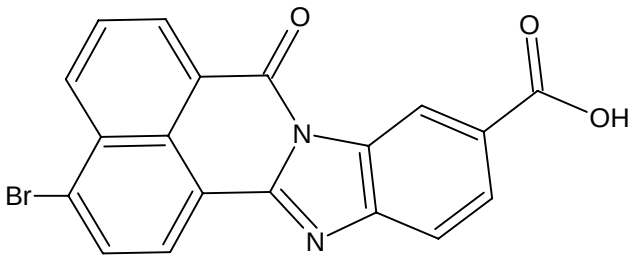
Naphthalene bisbenzimidazole, NBI



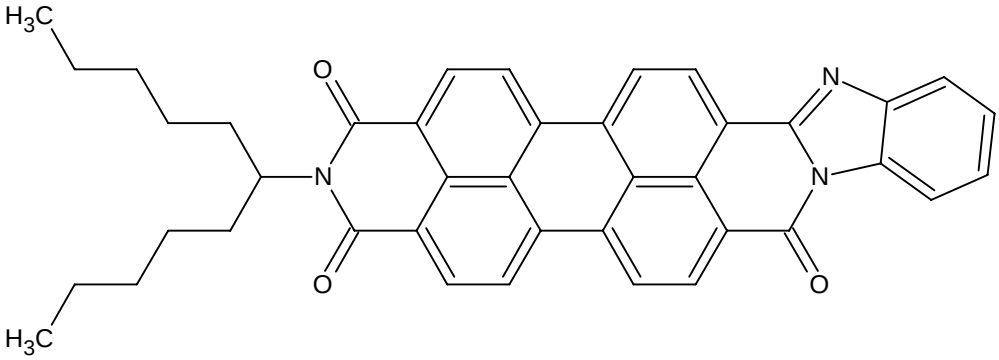
7H-Benzimidazo[2,1-a]benz[de]isoquinoline-7-one-10-carboxylic acid, NBI_I



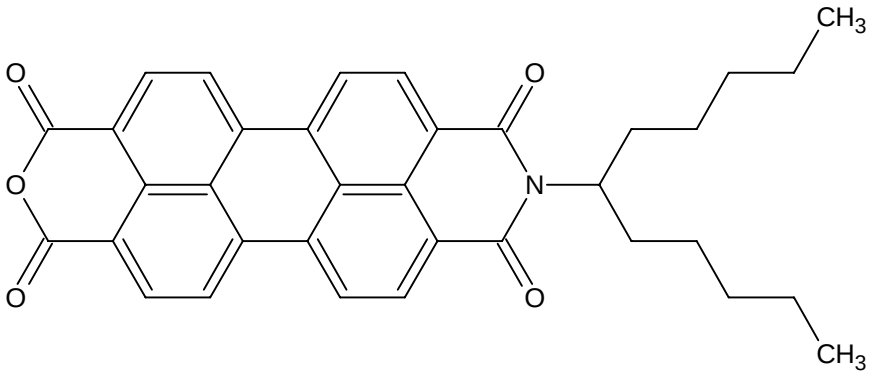
Phenanthrene benzimidazole comprising carboxyl group, PBI



4-bromo Naphthalene benzimidazole comprising carboxyl group, Br_NBI



Perylene imide amidine, PBI_2



Perylene monoimide monoanhydride, PMI

2. Absorption Spectra of used materials,

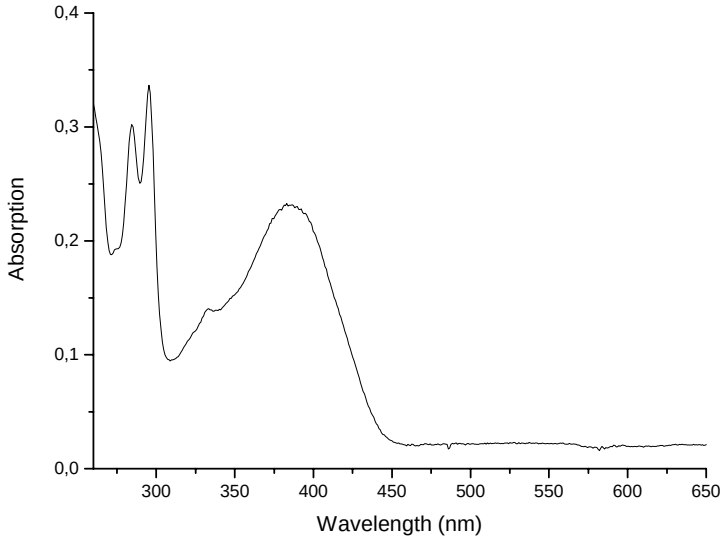


Figure 1. Absorption Spectrum of Naphthalene benzimidazole comprising carboxyl group, NBI_I (7H-Benzimidazo[2,1-a]benz[de]isoquinoline-7-one-10-carboxylic acid)

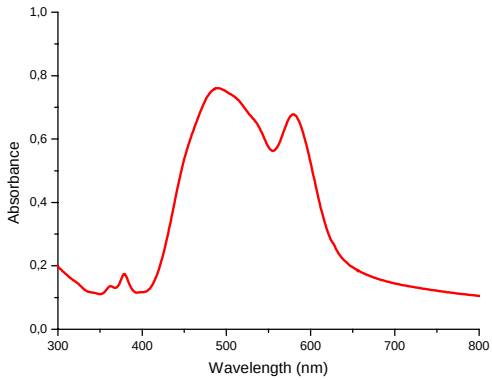


Figure 2. Absorption Spectrum of 3,4,9,10-perylene tetracarboxylic dianhydride (PDA)

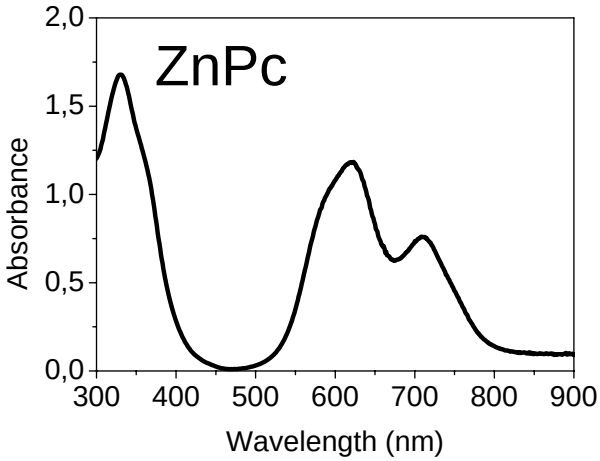


Figure 3. Absorption Spectrum of Zinc Phthalocynanine

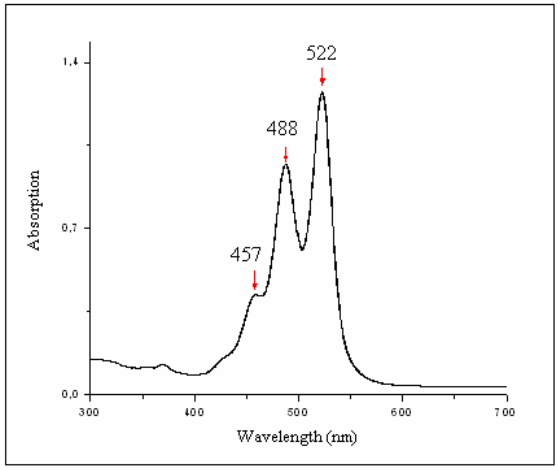


Figure 4. Absorption Spectrum of Perylene Dimide in $CHCl_3$

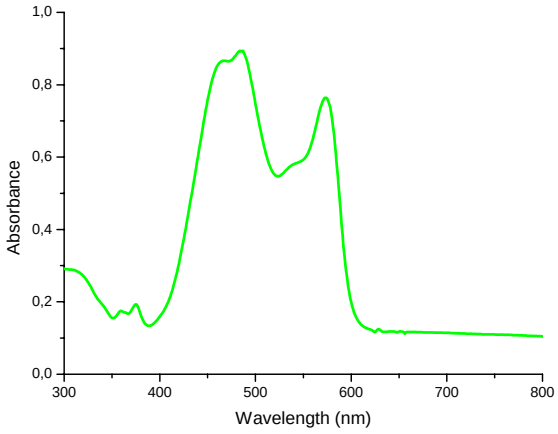


Figure 5. Absorption Spectrum of Perylene Dimide on film

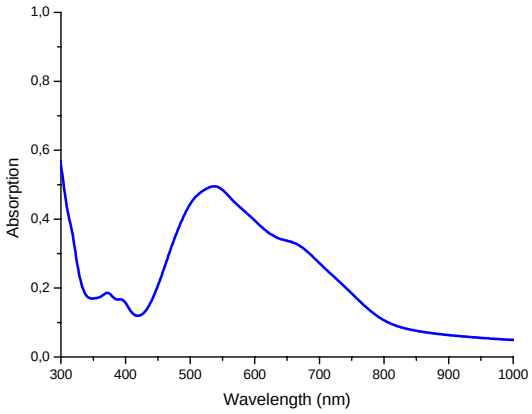


Figure 6. Absorption Spectra of Perylene bisbenzimidazole

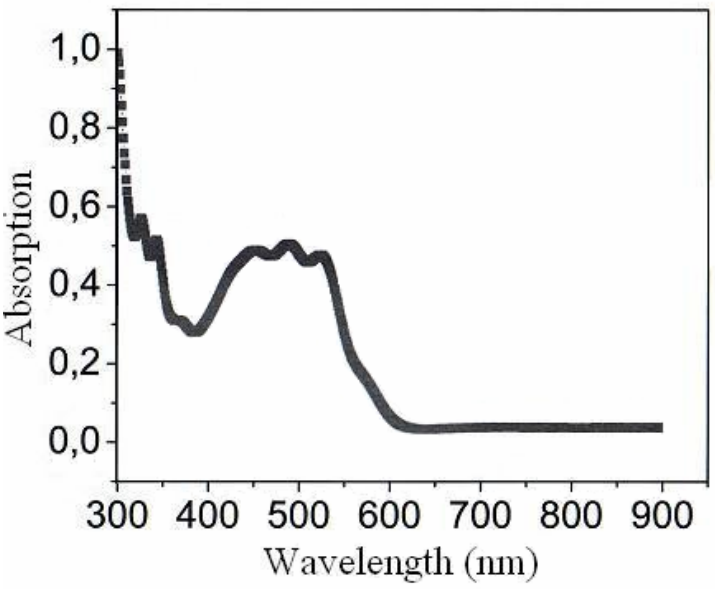


Figure 7. Absorption Spectrum of Naphthalene bisbenzimidazole

3. The results of the AFM studies are shown below,

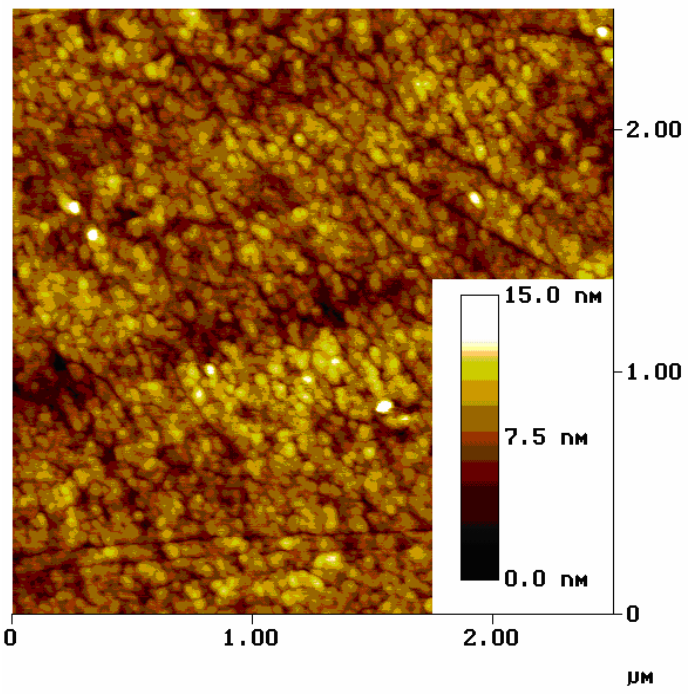


Figure 8. AFM Picture of 3,4,9,10-perylene tetracarboxylic dianhydride, PDA

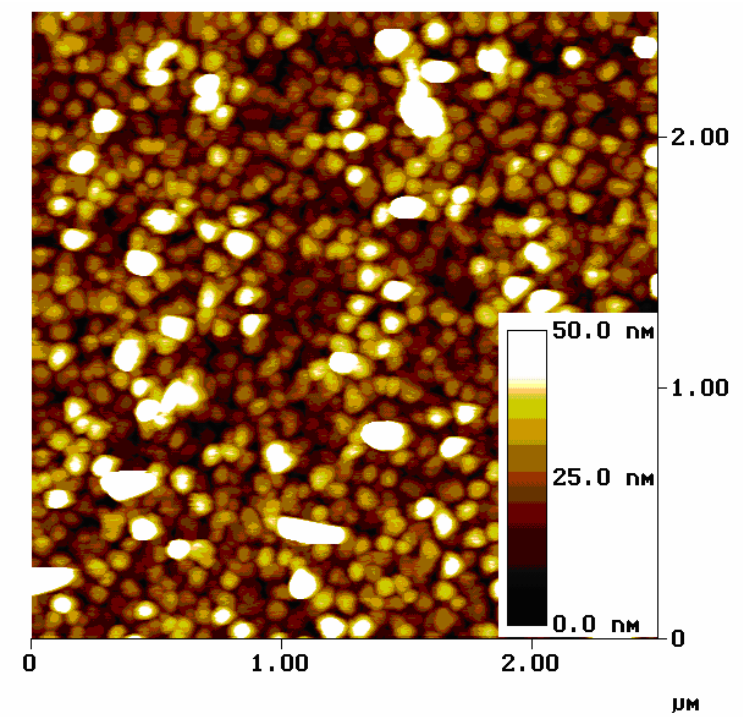


Figure 9. AFM Picture of PDI

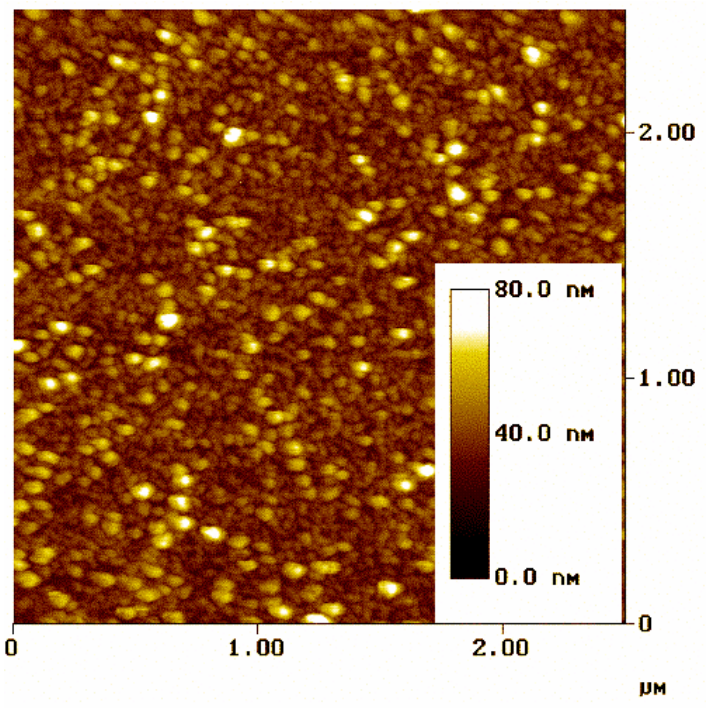


Figure 10. AFM Picture of perylene bisbenzimidazole, BPP

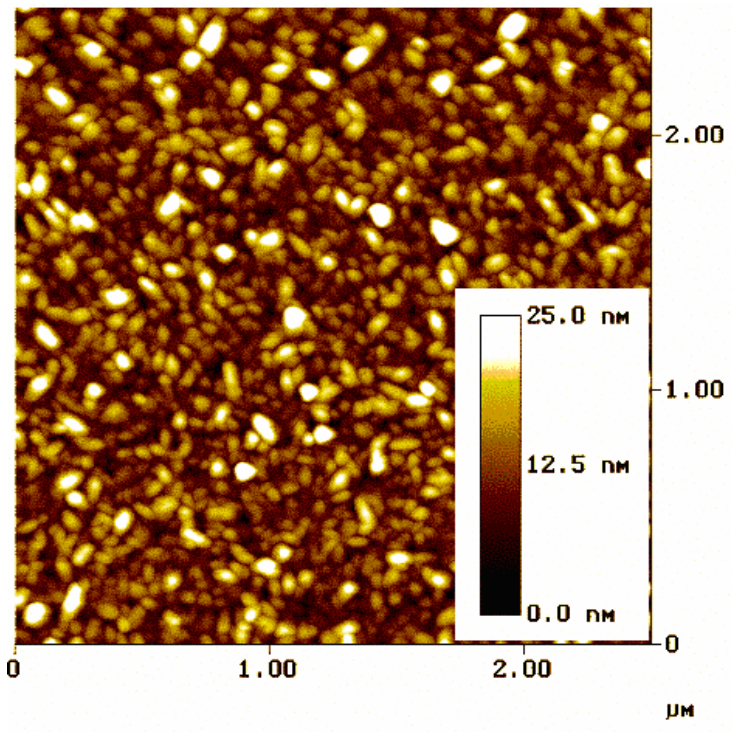


Figure 11. AFM Picture of Naphthalene bisbenzimidazole, NBI

4. **Device Structures fabricated are shown below,**

The device structure of bilayer heterojunction solar cell are shown below. PDA, PDI, NBI, PB_2 were used as electron acceptors in bilayer heterojunction solar cell device.

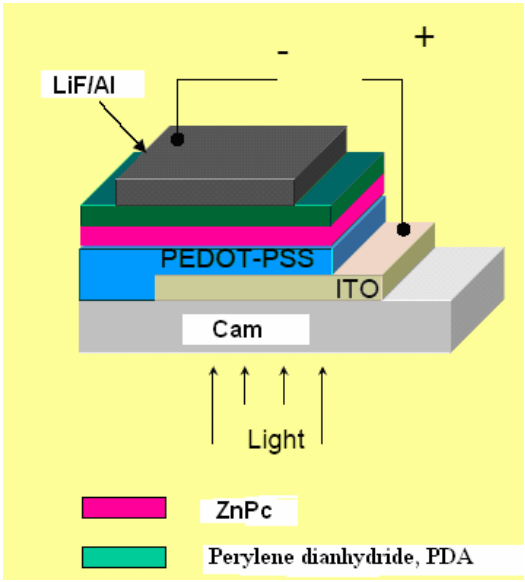


Figure 12. Device Structure of ITO/PEDOT/ZnPc(60nm)/PDA(40nm)/Al

Dye sensitised solar cell fabrication was also tried for NBI_I, PBI, Br_NBI

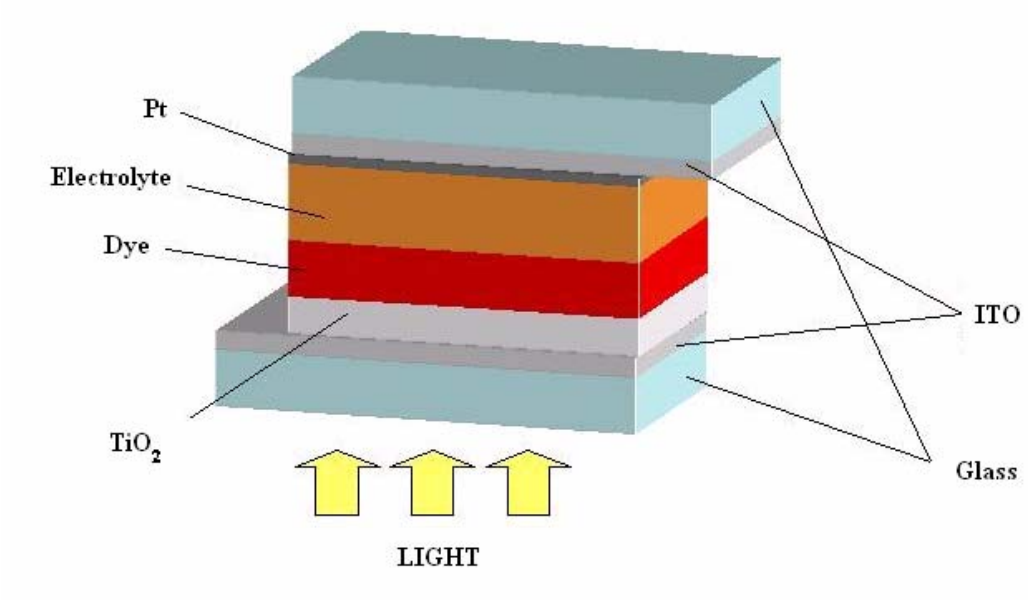


Figure 13. Device structure of ITO/ nc-TiO_2/ Dye(NBI)/ I^-/ I_3^-/ Pt/ ITO

Another device structure which I have studied is ITO/nc-TiO_2/ Dye(Perylene monoimide monoanhydride)/P3HT/Au

5. Device Results, I-V and IPCE Curves

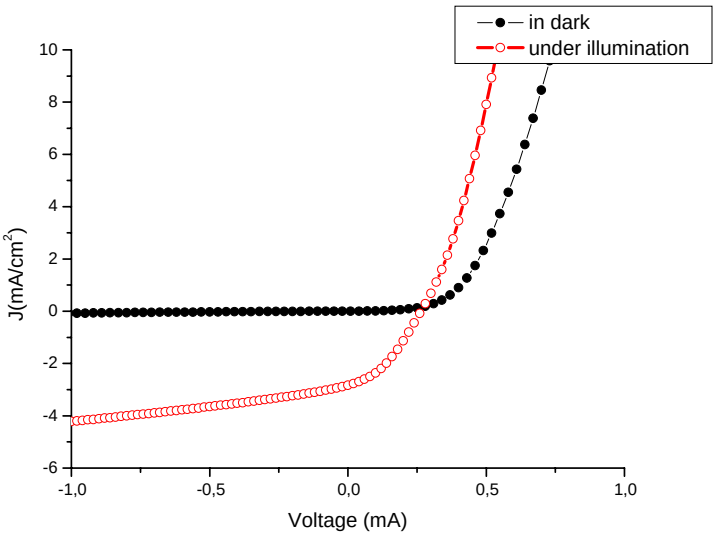


Figure 14. I-V Curve of ITO/PEDOT/ZnPc(60nm)/PDA(40nm)/Al, **V_{oc}= 0.26 V, I_{sc}= 4.2 mA cm^{-2}, FF= 0.30, η= 0.3 %, Device I**

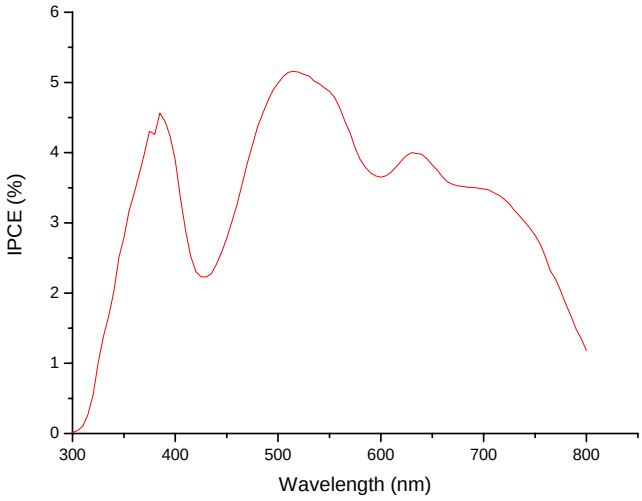


Figure 15. IPCE spectrum for the device of ITO/PEDOT/ZnPc(60nm)/PDA(40nm)/Al

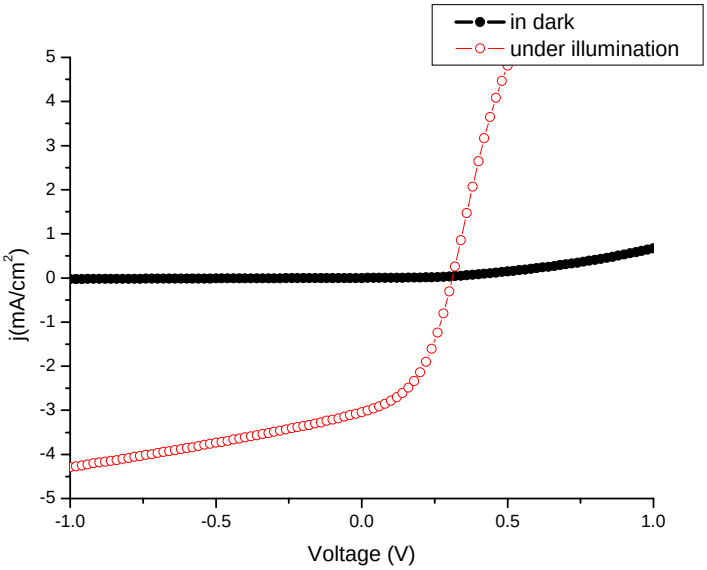


Figure 16. I-V Curve of ITO/PEDOT/ZnPc(60nm)/PDI(40nm)/Al, **Isc= 4.3 mA cm^{-2}, Voc= 0.309 V, FF= 0.32, η= 0.43 %, Device II**

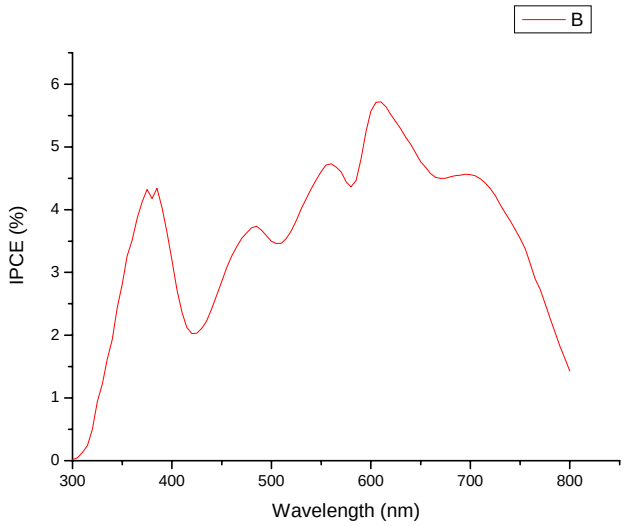


Figure 17. IPCE Curve for the device of ITO/PEDOT/ZnPc(60nm)/PDI(40nm)/Al

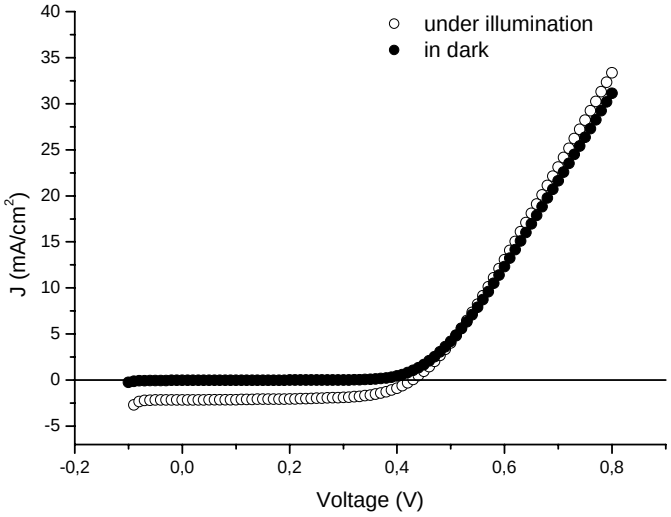


Figure 18. I-V Curve of ITO/PEDOT/ZnPc(40nm)/ NBI (60 nm)/ /Al

Isc [mA/cm^2] : 2.16, Voc [mV] : 430, FF : 0.62, Efficiency [%] : 0,58, Device III

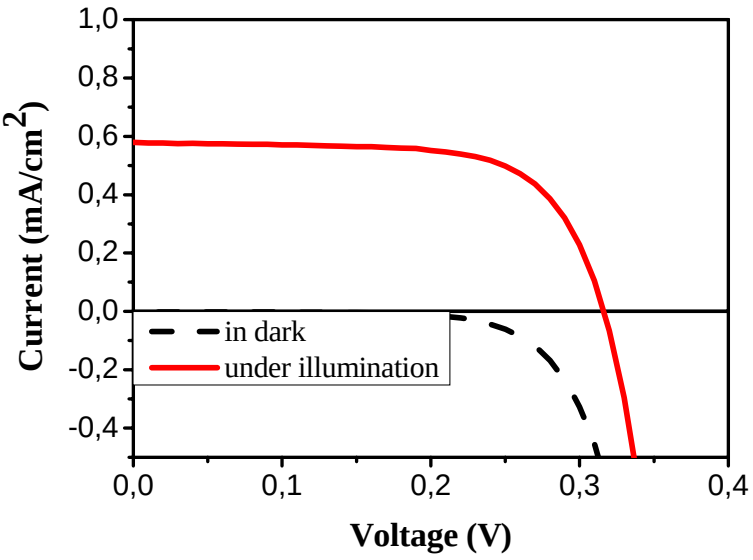


Figure 19. I-V curve of ITO/ nc-TiO_2/ Dye(PBI)/ I^-/ I_3^-/ Pt/ ITO , **Isc= 0.59 mA/cm^2, Voc= 0.316 V, FF= 0.67, η= 0.12 %, Device IV**

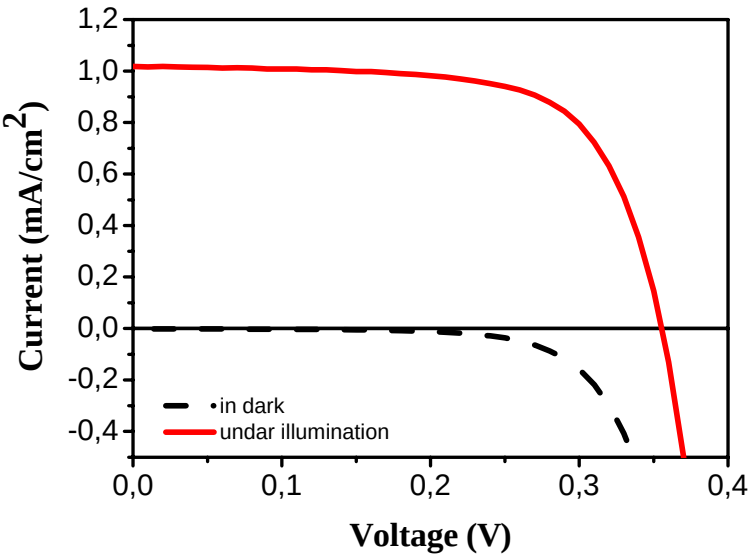


Figure 20. I-V Curve of ITO/ nc-TiO_2/ Dye(Br_NBI)/ I^-/ I_3^-/ Pt/ ITO, **Isc= 1.02 mA/cm^2, Voc= 0.35 V, FF= 0.67, η= 0.24 %, Device V**

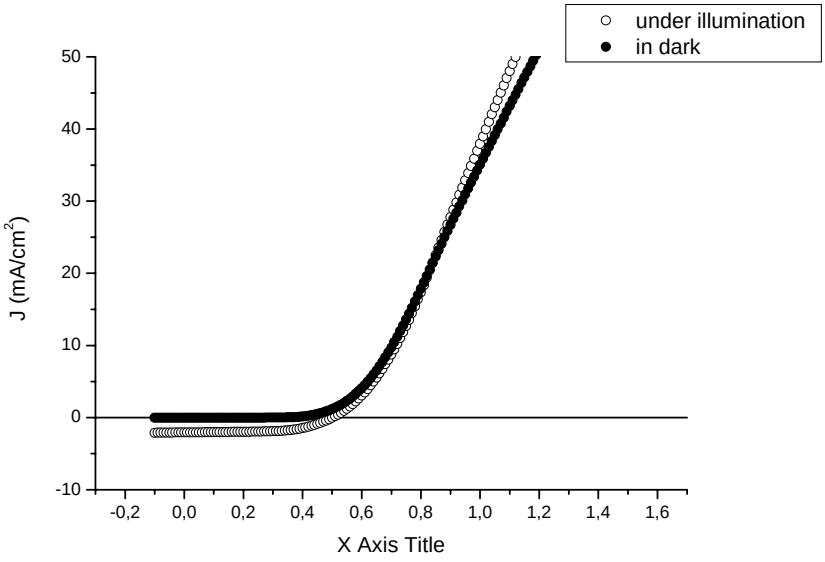


Figure 21. I-V Curve of ITO/PEDOT/ZnPc(60nm)/ PBI_2(40 nm)/ /Al, **Isc [mA/cm^2] : 2.05, Voc [mV] : 500 , FF : 0.60, Efficiency [%] : 0.62, Device VI**

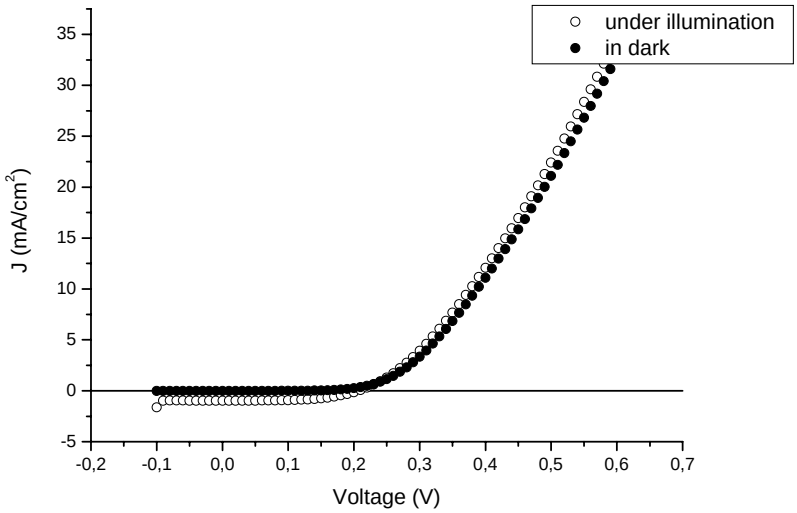
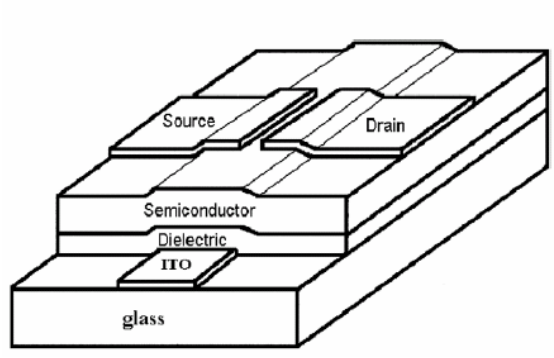


Figure 22. I-V Curve of ITO/nc-TiO_2/ Dye(Perylene monoimide monoanhydride, PMI)/P3HT/Au **Isc [mA/cm^2] : 1, Voc [mV] : 200, FF : 0,56, Efficiency [%] : 0,11, Device VII**

6. Table of summary of results

	Molecular structures	**Isc [mA/cm^2]**	**Voc [mV]**	**FF**	**Efficiency [%]**
Device I	**PDA**	4.2	260	0.30	0.30
Device II	**PDI**	4.3	309	0.32	0.43
Device III	**NBI**	2.16	430	0.62	0.58
Device IV	**PBI**	0.59	316	0.67	0.12
Device V	**Br_NBI**	1.02	350	0.67	0.24
Device VI	**PBI_2**	2.05	500	0.60	0.62
Device VII	**PMI**	1.00	200	0.56	0.11

7. Mobility measurements of perylene and naphthalene dimide on PVA dielectric



N,N'-bis-butyl-1,4,5,8-naphthalene dimide; μ_e= 0.012 $cm^2V^{-1}s^{-1}$

N,N'-bis-undecyl-3,4,9,10-perylene dimide; μ_e= 5.10^{-4} $cm^2V^{-1}s^{-1}$

N,N'-bis-nonyl-3,4,9,10-perylene dimide; μ_e= 3.10^{-5} $cm^2V^{-1}s^{-1}$

N,N'-bis-dehydroabietyl-3,4,9,10-perylene dimide; μ_e= 7.10^{-5} $cm^2V^{-1}s^{-1}$, μ_h= 8.10^{-5} $cm^2V^{-1}s^{-1}$

This study was supported by European Science Foundation.

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