Novel Organic Solar Cell Design towards an Optical Control of the Exciton Diffusion Length

Jordi Martorell
ICFO - The Institute of Photonic Sciences
Barcelona
OSC Brief History

The graph shows the efficiency of organic solar cells (OSC) over time, with specific reference to various materials and architectures such as P3HT/PCBM, Bi-layer(CuPc/C60), and PCDTBT. The x-axis represents the year, starting from 1976 to 2010, while the y-axis shows the efficiency in percent (%). The chart illustrates significant improvements and changes in efficiency over the years, highlighting key advancements in technology and materials used in OSCs.
OSC Brief History
OSC Brief History

The diagram illustrates the efficiency of OSCs (Organic Solar Cells) over time, with key events marked on the horizontal axis and corresponding efficiency changes on the vertical axis. The efficiency is measured in percent. Key events include the introduction of different materials and architectures, such as PCDTBT, P3HT/PCBM, Bi-layer(CuPc/C60), and MC. The diagram shows a significant increase in efficiency from the early 1970s to the early 2000s, with several notable peaks and plateaus.
OSC Brief History

![Graph showing the brief history of OSCs (Organic Solar Cells)](image)

- Efficiency (in %)
- Percentage change (in %)
- Year

Key Events:
- 1976: OSC
- 1982: ITO/MC
- 1989: BT-layer(C60)
- 1996: Hetero-junction
- 2003: P3HT/PCBM, PCDTBT
- 2010: PBDTTT-CF, Tandem

Inset Image: Microscopic view of OSC material.
OSC Brief History

Average efficiency increase per year ~ 16 %
OSC Brief History

Average efficiency increase per year ~ 16 %

By 2017 OSC will match SUNPOWER Si modules
Photonics and OSC

Concentration

Fluorescent guiding

Nanoantennas

Fluorescent control
OSC: Concept
OSC: Concept
Exciton Diffusion length & Recombination
Exciton Decay: Fluorescence
Inhibition of the Exciton Fluorescence
Spontaneous Emission in an Asymmetric Optical Cavity
Diffusion Current

$L_{\text{diff}} = 5 \text{ nm}$

$L_{\text{Abs}} = 50 \text{ nm}$
Realistic Optical Cavity OSC

L. Vuong et al., APL 95, 233106 (2009)
High Quantum Yield Fluorescence

Laser Dyes: Rhodamines,...

(High QY in liquid but low in Solid)
Absorption

Transmission (%)

Wavelength (nm)

Rh 6G

Rh 6G-PMMA

PMMA

Rh 6G

Rh 6G

Rh 6G

Rh 6G
Fluorescence

Rh 6G

Rh 6G-PMMA

PMMA

550  600  650  700  750
Wavelength (nm)
Quantum Yield Fluorescence

<table>
<thead>
<tr>
<th></th>
<th>Int. Fluorec. (norm. u.)</th>
<th>Max. Trans (%)</th>
<th>Conc. (norm. u.)</th>
<th>QY Fluores. (%)</th>
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<tbody>
<tr>
<td>Rh6G</td>
<td>23.7</td>
<td>67.8</td>
<td>1</td>
<td>0.04</td>
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<tr>
<td>Rh6G-PMMA</td>
<td>73</td>
<td>68</td>
<td>0.42</td>
<td>0.3</td>
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[Graph showing fluorescence spectra for Rh6G and Rh6G-PMMA]
Fluorescent Bi-layer Cell

PEDOT

ITO

SUBSTRATE

Al

Rh6G-PMMA

PPV
I-V curve Rh6G-PMMA

Rh6G-PMMA

20-30 nm

10-15 nm

50 nm

mA/cm²

(V)
OSC within an Optical Cavity

PEDOT

Al

PCBM

ITO/Thin Metal

PEDOT

Al
OSC within an Optical Cavity

Graph showing current (mA) versus voltage (V) for ITO and Thin Metal layers.
Photonics and OSC

- Fluorescence inhibition to enhance OSC efficiency
- Path to obtain fluorescent solid state materials
- Path to fabricate OSC within optical cavities
To acknowledge