Moving Towards a Sustainable Future with Scalable Organic Solar Cells

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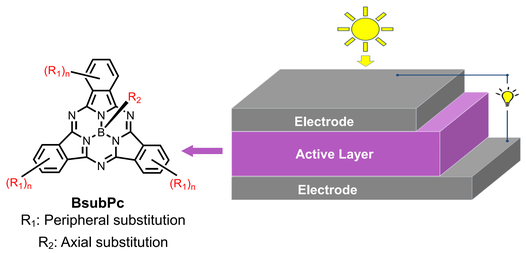
Introduction

Organic solar cells (OSCs) convert sunlight into electricity using organic molecules.



BsubPc
R_1: Peripheral substitution
R_2: Axial substitution

Advantages[1]:
- Lightweight
- Flexible
- Inexpensive
- Ease of manufacture

How do slight changes in BsubPc structure affect device performance?

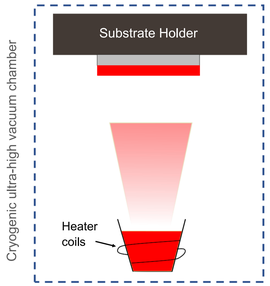
Can we move towards increasingly scalable OSC fabrication techniques?

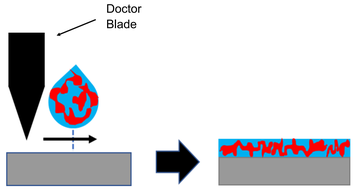
Methods

Two OSC fabrication methods are explored.

1. Thermal Evaporation

- Even and reproducible films with minimal impurities and defects
- Linear planar deposition of electron donor and acceptor films



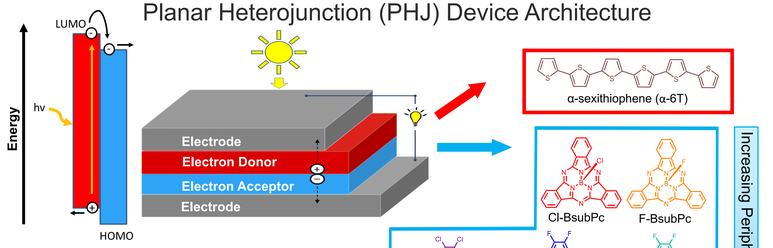


2. Doctor Blade Coating

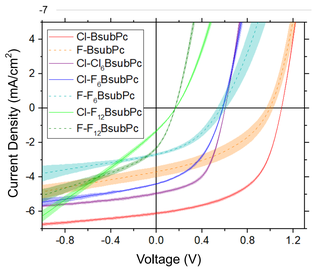
- Reduced material and energy consumption
- Mixed deposition of donor and acceptor film
- Will OSC efficiency or reproducibility suffer?

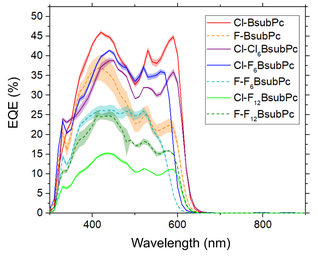
Thermal Evaporation

Planar Heterojunction (PHJ) Device Architecture



In-lab synthesized BsubPc electron acceptors paired with a standard electron donor[2].



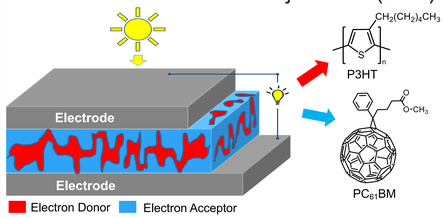


Electron Acceptor	Voltage (V)	Current Density (mA/cm^2)	Fill Factor	Efficiency (%)
Cl-BsubPc	1.098	-6.10	0.54	3.62
F-BsubPc	0.992	-3.70	0.41	1.53
Cl-Cl$_6$BsubPc	0.603	-4.95	0.54	1.60
Cl-F$_6$BsubPc	0.581	-4.39	0.44	1.12
F-F$_6$BsubPc	0.571	-2.68	0.39	0.60
Cl-F$_{12}$BsubPc	0.168	-1.31	0.28	0.06
F-F$_{12}$BsubPc	0.163	-2.30	0.32	0.12

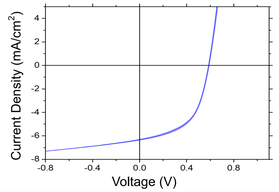
- Proportional change in voltage with peripheral substitution
- Higher currents for chlorinated BsubPcs than fluorinated BsubPcs

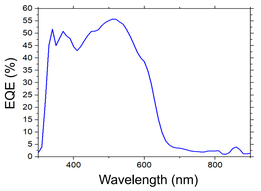
Doctor Blade Coating

Bulk Heterojunction (BHJ) Device Architecture



- Doctor blade coating baseline established using P3HT:PCBM[3]
- Six Sigma analysis for process optimization
- Research in progress: chlorinated and fluorinated BsubPc acceptors





Efficiency = 2.0%

Conclusion and Future Work

- Small changes in BsubPc structure = large changes in OSC performance
- Proportional trends in voltage and current due to BsubPc axial and peripheral substitution
  → **We can customize BsubPcs to tune OSC performance**

What's next?
- Doctor blade coated BHJ devices using chlorinated and fluorinated BsubPcs

Acknowledgements

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