EFFICIENCY IMPROVEMENT OF ORGANIC BULK HETEROJUNCTION SOLAR CELLS BY FUNCTIONALIZED POLYTHIOPHENE ADDITIVES

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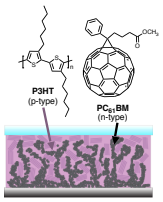
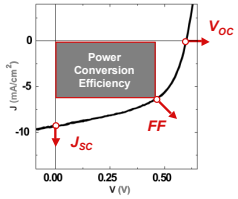
ORGANIC PHOTOVOLTAICS - MOTIVATION

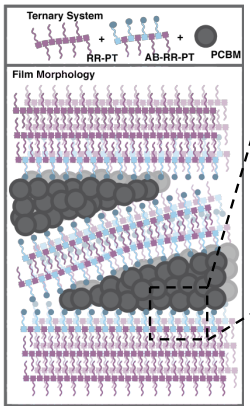
Si based	-PCE: ~ 25% -heavy -rigid, flat
Dye-sensitized (DSSC)	-PCE: ~ 15% **-lighter than Si** -rigid, flat
Organic based (OPVs)	-PCE: ~ 9% **-flexible, light** **-can be printed**

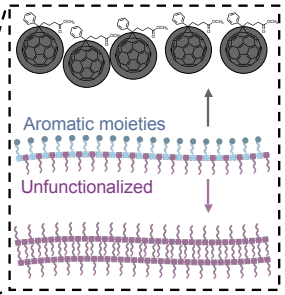




Modify the interface > increase J_{SC} > increase PCE

PROPOSED STRATEGY



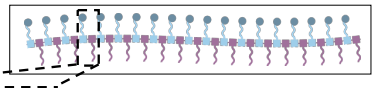


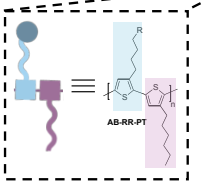
1. **Use only small amounts of an additive**
2. **Improve existing systems**
   Locate itself at the interface (surfactant)
   Generate a dipole at the interface

Surfactant Additive → Decrease charge recombination rate, Increase carrier lifetimes, Improve charge collection → Increase J_{SC} → Increase PCE

SURFACTANT ADDITIVE DESIGN AND SYNTHESIS

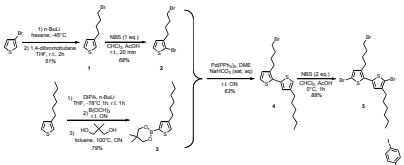
Polymer Additive

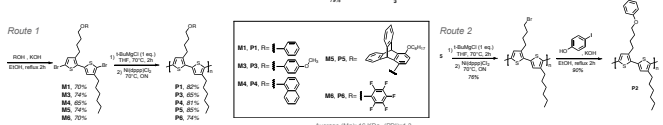


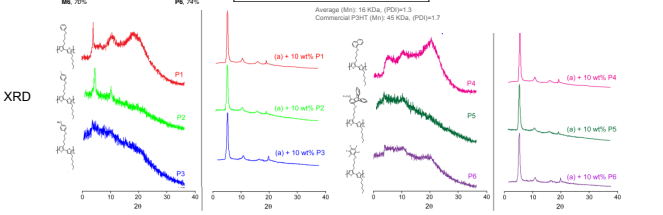


Regioregular polythiophene
AB alternating (functionalized-*alt*-unfunctionalized)
- Functionalized side-chains interact with PCBM (dipole)
- Unfunctionalized side-chains interact with P3HT

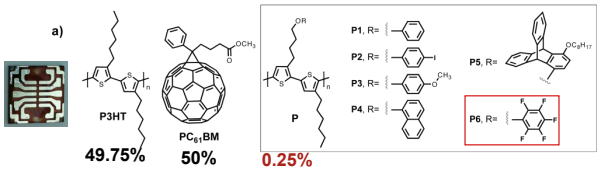
Parent monomer (5)
Combinatorial approach
Test different functional groups
Easy optimization

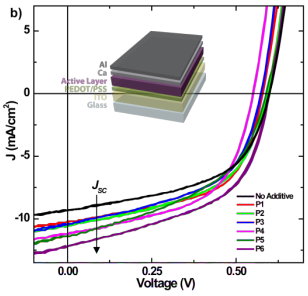


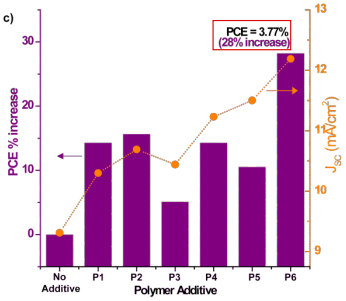




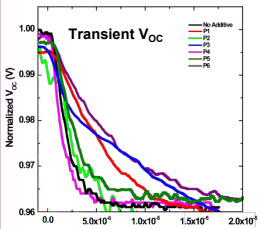
SOLAR CELL PERFORMANCE





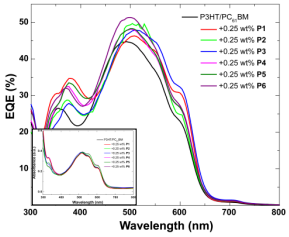


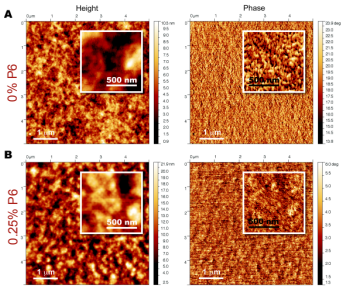
Just 0.25 % weight of additive > 28% increase in efficiency



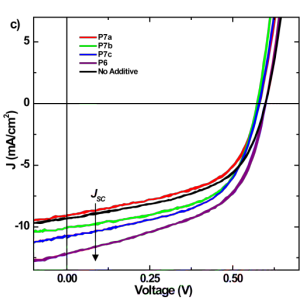
Additive increases PCE by increasing J_{SC}

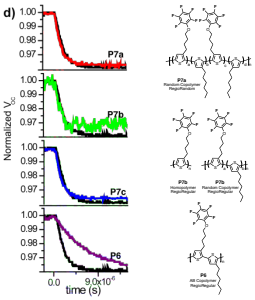
1. EQE increases, no increase in light absorption
2. Higher injection currents, rectification values
3. Higher J_{ph} (J_{ph} vs effective applied voltage)
4. Higher charge carrier lifetime (Transient V_{OC})
5. Higher hole mobility and lifetime





ADDITIVE MODIFICATION





CONCLUSIONS

Additives boost solar cell performance
- Additive: 0.25 % wt > 28% increase PCE
- Regioregularity, alternation play a crucial role

Chemical Tuning of the side-chain
- Functional group affects performance
- Can tune short-circuit current

Lobez, J. M.; Andrew, T. L.; Bulovic, V.; Swager, T. M. *in preparation*
Swager, T. M.; **Lobez, J. M.**; Wang, Fei *US. Pat. Apl. No. 61/387,851* **2011**