Polymorphic control of Zinc Phthalocyanine for Organic Photovoltaic Cell

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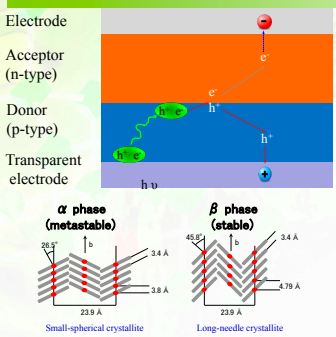
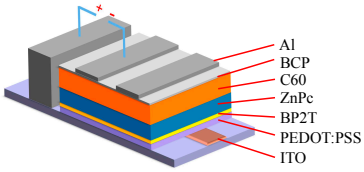
INTRODUCTION



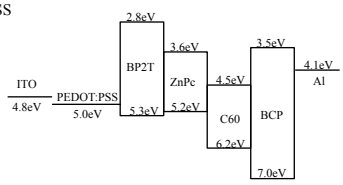
Crystal control

- π-stacking orientation
  - Direction of charge transport
  - Light absorption
- Crystallinity
  - Exciton diffusion length
  - Charge transport (CT)
- Morphology (domain, boundary)
  - CT &Charge separation
- Polymorphism (crystal phase)
- Impact on OPV cell is limited.

EXPERIMENTS



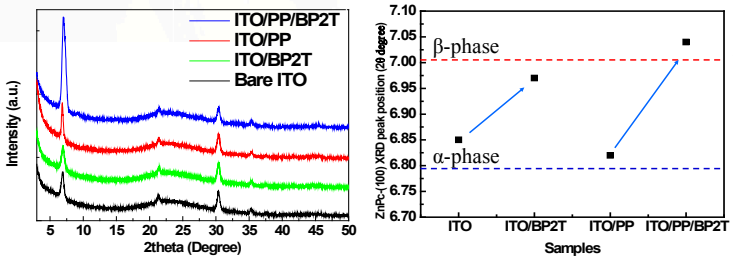
BP2T ZnPc



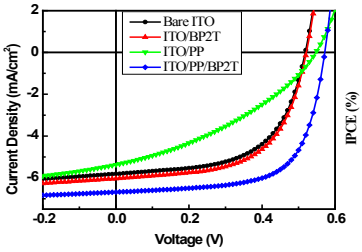
Why BP2T?
- Self-organization (rod-like molecule);
- Excellent crystallization under R.T.;
- Suitable energy level;
- High carrier mobility: 10^{-2} cm^2Vs^{-1} [1].

RESULTS&DISCUSSION

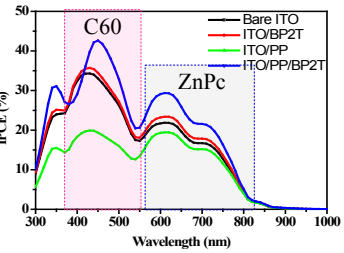
X-ray diffraction (XRD)



J - V characteristics



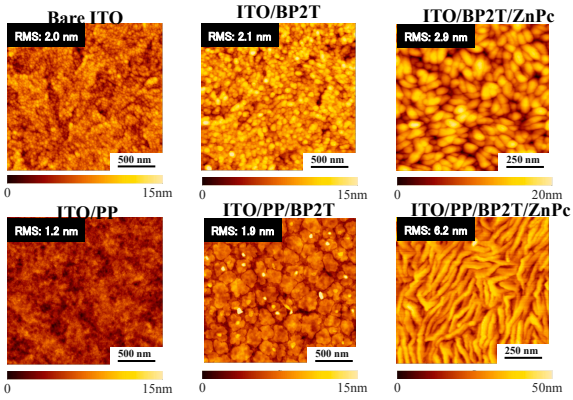
IPCE

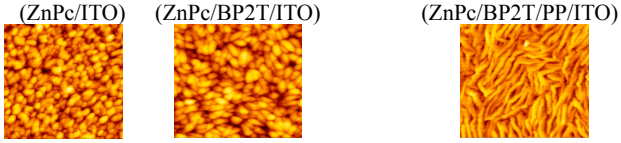


Cells	PCE (%)	Jsc (mA/cm²)	Voc (V)	FF
Bare ITO	1.73	5.81	0.52	0.57
ITO/BP2T	1.82	6.03	0.52	0.58
ITO/PP	1.07	5.37	0.55	0.36
ITO/PP/BP2T	**2.44**	**6.68**	**0.57**	**0.64**

- Peaks shift from α to β-phase with BP2T buffer layer.
- Better crystallinity with both BP2T and PEDOT:PSS.

Atomic force mocroscopy





Beyond critical size[2]

Metastable → Stable

- Poor crystallinity (disorder)
- Small-round-crystallites
- Low roughness

- High crystallinity (high order)
- Long-needle-crystallites
- High roughness

Stable β -phase allows:
- Better exciton transport (Longer exciton diffusion length)
- Better charge transport (higher carrier mobility with less traps and recombination);
- larger ZnPc/C60 interface area (higher exciton dissociation rate).

CONCLUSION

- Stable β-phase ZnPc was realized on BP2T under R.T.;
- Rough ITO surface hinders BP2T crystal growth resulting metastable β-phase ZnPc;
- Stable β-phase ZnPc is favorable for efficient OPV cells;
- Metastable α-phase PCE 1.07% → (150% increased) → stable β-phase ZnPc 2.44%

REFERENCES

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[2] F. Iwatsu, J. Phys. Chem. **92**, 1678 (1988).

Acknowledgment

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