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Charge transport properties of BO-chelated azadipyrromethenes

Tingrui Ma, Muyuan Zhao, Geneviève Sauvé*

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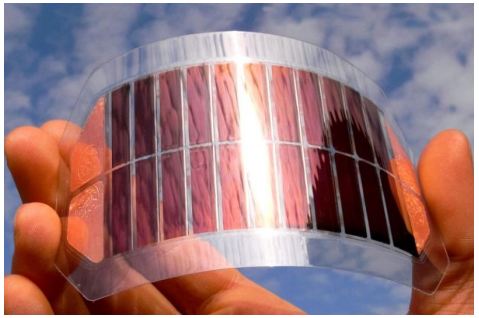
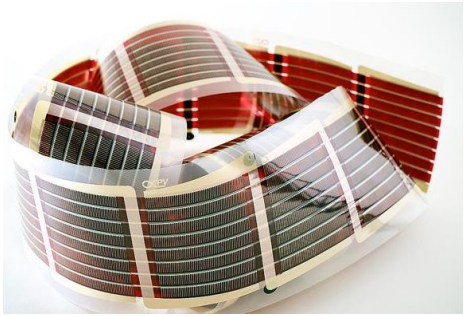
Outline

1. **Introduction**
2. **Device Fabrication and Thickness Measurement**
3. **Mobility Results**
4. **Summary and Future Plans**

Organic Solar Cells

- **Flexible and light-weight**
- **Low cost**
- **Large scale fabrication**



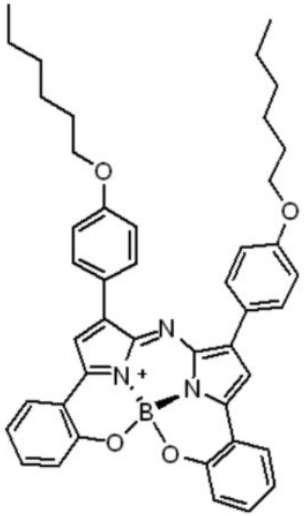


1.https://www.ecofriendlylink.com/blog/organic-solar-cells/

2. Solar Cells of the Future: System for Increasing the Efficiency of Organic Solar Cells https://scitechdaily.com/solar-cells-of-the-future-system-for-increasing-the-efficiency-of-organic-solar-cells/

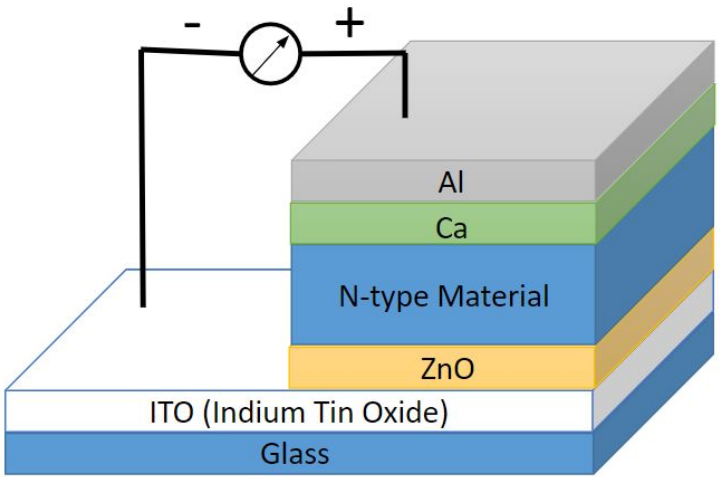
3.https://infinitypv.com/technology/opv

BO-chelated azadipyrromethenes Structure

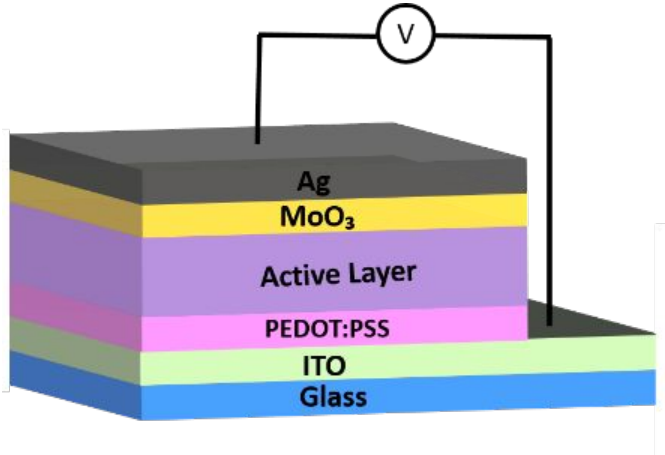


dOhexADP-BO

Mobility Device Structure



Electron Mobility Test



Hole Mobility Test

Mobility Calculation

Mott-Gurney Law

$$J = \frac{9}{8} \mu \epsilon \epsilon_0 \frac{V^2}{L^3}$$

μ	mobility
ε	dielectric constant
ε_o	permittivity of free space
d	film thickness
m	slope

$\mu = (8m^2d^3) / (9\varepsilon\varepsilon_0)$

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Space charge-limited current behavior

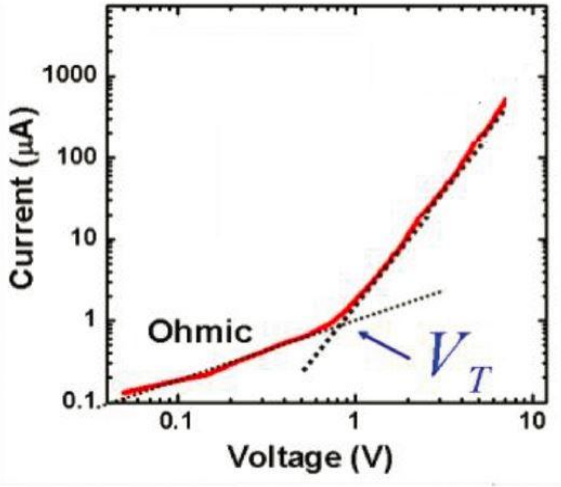
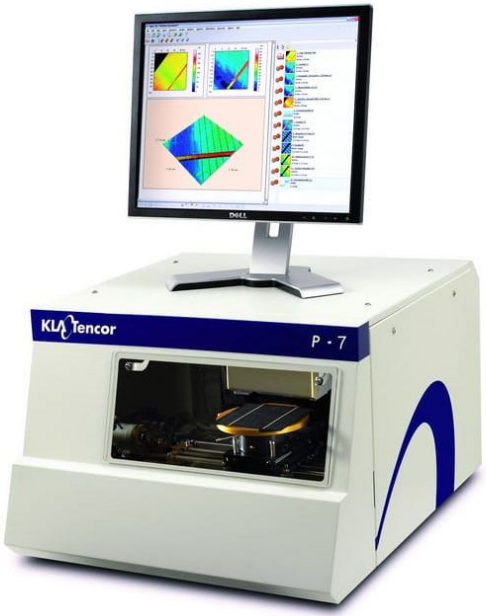


Figure 4. Space charge–limited current behavior for polymer semiconductor with only ohmic and trap-free space charge–limited current regions.

Device Fabrication (MORE Center)

- 1. Check the conductivity of ITOs.
- 2. Clean the ITOs.
- 3. Spin-coat a ZnO layer and anneal.
- 4. In glove box, spin-coat a solution of the **dOhexADP-BO** and anneal.
- 5. Thermally deposit 30nm Ca and 100nm Al for e-mobility or
  10nm MoO_3 layer and 80nm Ag were thermally deposited for h-mobility

Thickness measurement



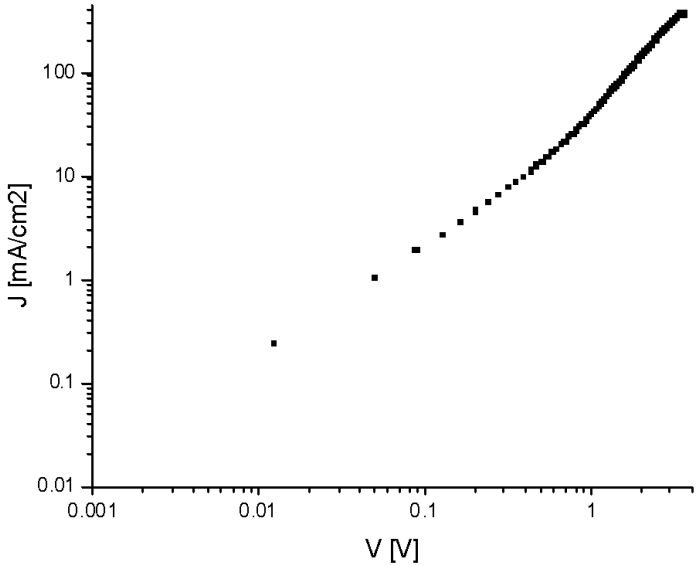
Stylus profilometer

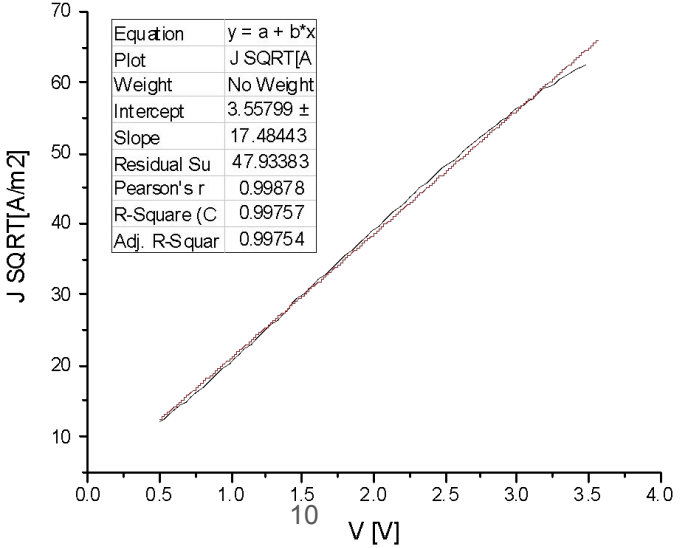
-Use probe to detect the surface
- Moving along the surface to acquire the surface height.
-Test the difference in heights of the surfaces
-Fit the slope and thickness to calculate the mobility.

SCLC Mobility Calculations 4-2

Equation	Units		
$J = (9/8)\,\mu\varepsilon\varepsilon_0(V^2/d^3)$			Denominatc 0.00000002
$\mu = (8m^2d^3) / (9\varepsilon\varepsilon_0)$	$cm^2/V{\cdot}s$		
Definitions		**Value**	**Units**
μ	mobility	0.0026277671	$cm^2/V{\cdot}s$
ε	dielectric constant	3	-
ε_0	permittivity of free space	0	F/m
d	film thickness	270	nm
		2.70E-05	cm
m	slope	19.969	

Hole Mobility Test (dOhexADP-BO)





Mobility: $7.4*10^{-4}$ $cm^2/V*s$

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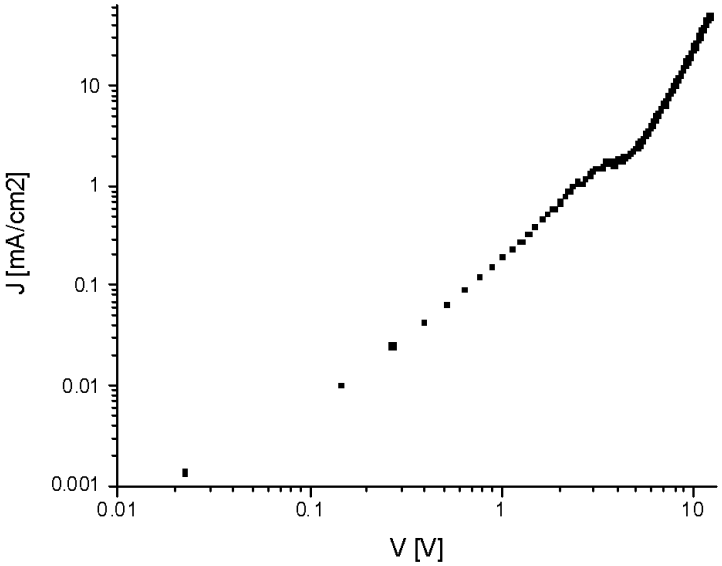
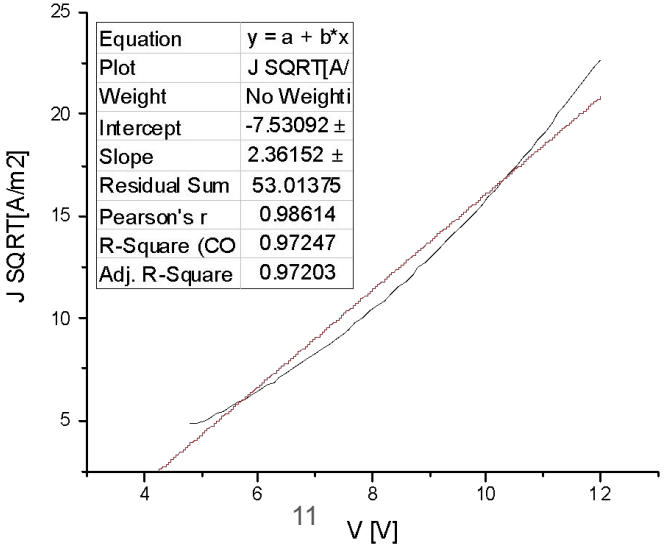
Electron Mobility Test (dOhexADP-BO)





Mobility: $4.6*10^{-6}$ $cm^2/V*s$

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Conclusions

N-type Materials	Neat μ_h ($cm^2\ V^{-1}s^{-1}$)	Neat μ_e ($cm^2\ V^{-1}s^{-1}$)
dOhexADP-BO	7.4×10^{-4}	4.6×10^{-6}

Summary and Future Plan

- BO-chelated materials are promising p-type semiconductors for electronic applications.
- More electron mobility tests of BO materials will be conducted.
- Continue both electron and hole mobility tests of different materials.

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