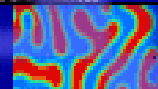
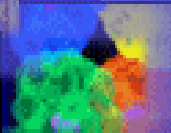


Improving mobility by contact treating Organic Thin Film Transistors (OTFTs)

K. Dillard-Crawford

07/24/07



K. Dillard-Crawford

- Society of Physics Students Internship
 - NIST, Semiconductor Electronics Division

- Dr. John Suehle, Group Leader, CMOS and Novel Devices
- Dr. David Gundlach, Project Leader, Macroelectronics
- Dr. Oana Jurchescu

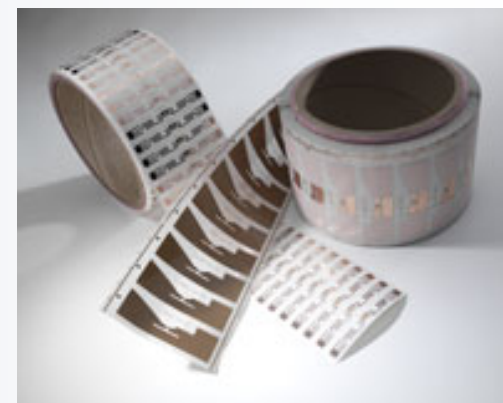
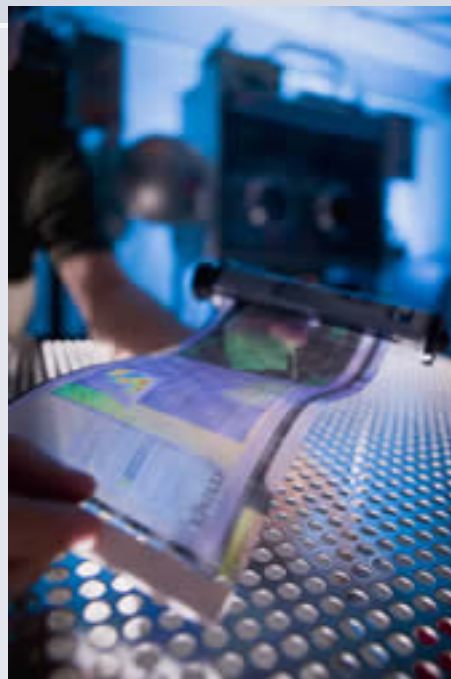
- B.S. Physics, Mesa State College



Organic Transistor Applications



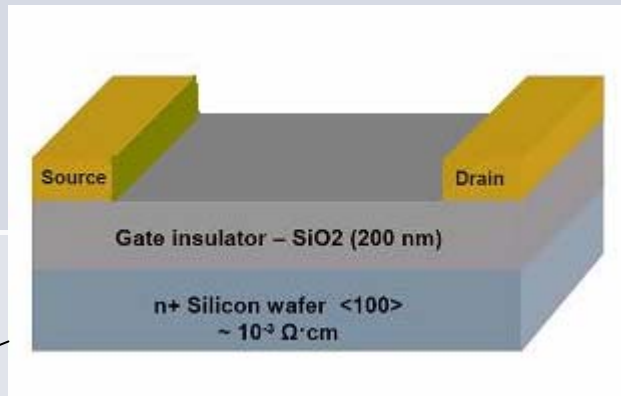
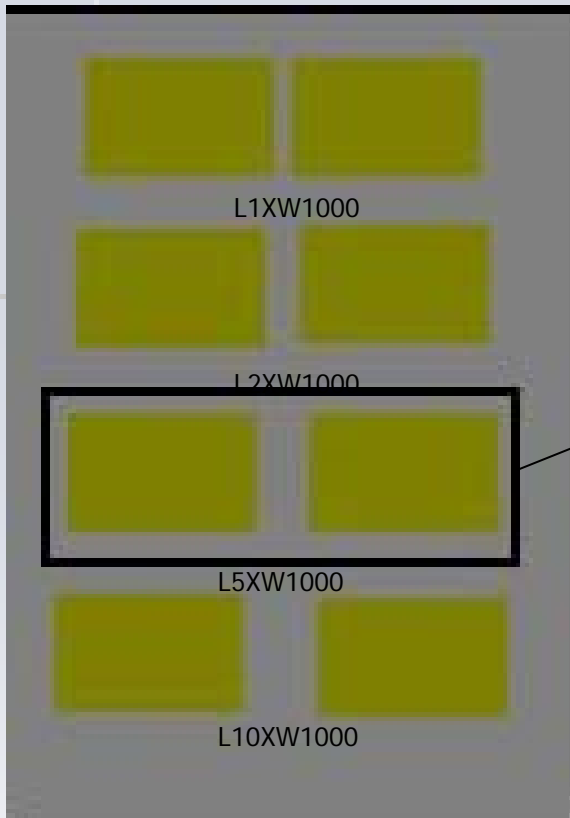
Flexible Displays



RFID Tags

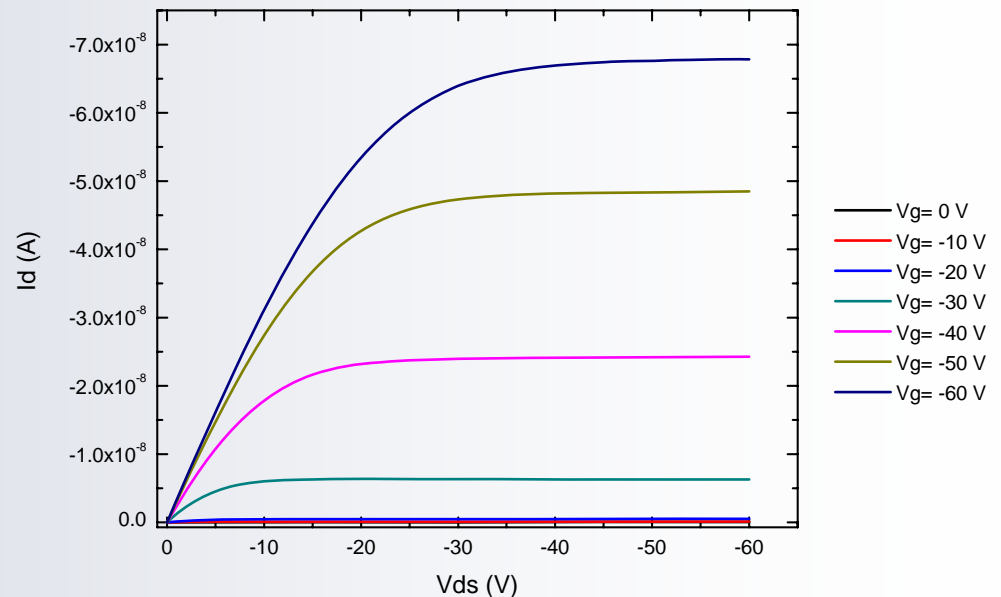
Outline

- Thin Film Transistors
- Organic Semiconductors
- Contact Treatments
- Measurements and Data



Cross-section of a TFT structure used in this research.

Device Test Beds Thin Film Transistors

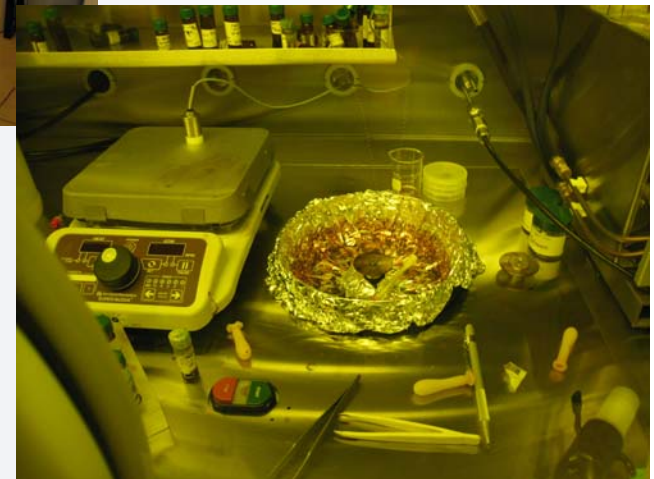


Fabrication Facilities

Cleaning Hood



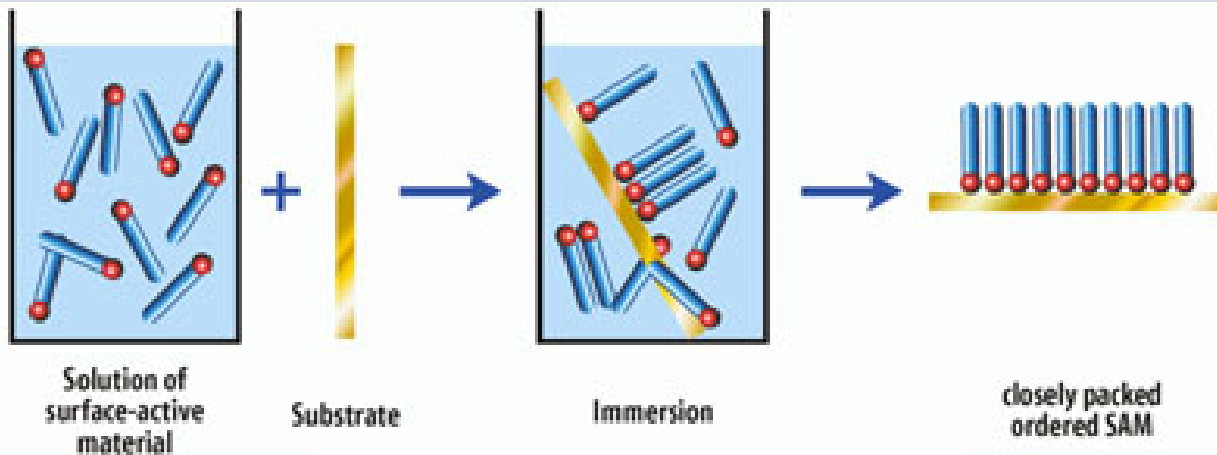
Spin-casting station



Glove Box

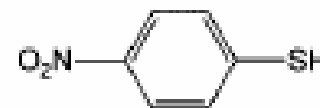
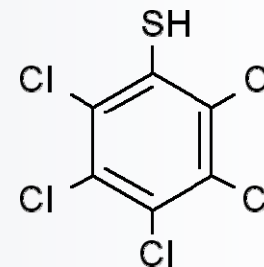
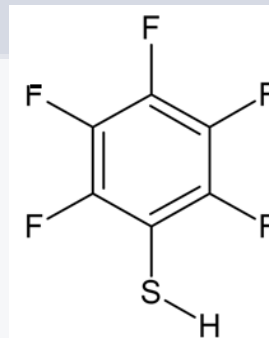


Self-Assembled Monolayer (SAM)



Contact Treatments

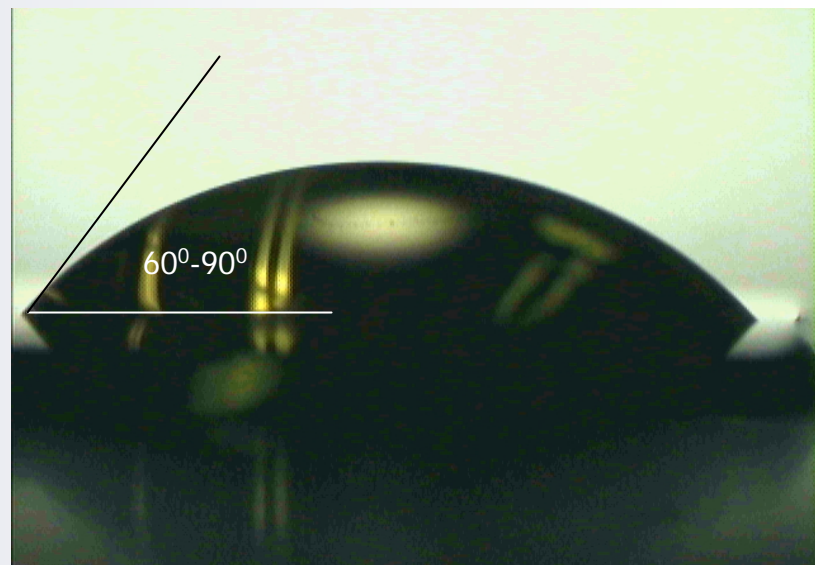
- Pentafluorobenzenethiol (PFBT)
 - Solvent: Ethanol
- Pentachlorobenzenethiol (PCIBT)
 - Solvent: Chloroform
- Nitrothiophenol (NTP)
 - Solvent: Acetone



Contact Angles

Sessile Drop Method

- Qualitative measurements of the contact angle on treated Au.
- Looking for hydrophobic behavior and contact angles from 60° and 90° .
- Important correlation between high contact angles and increased mobility.

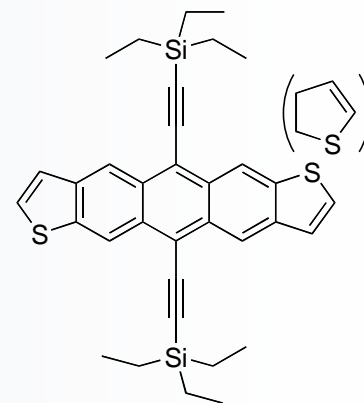


Organic Semiconductors

Dr. John Anthony, U. Kentucky

Soluble small molecules

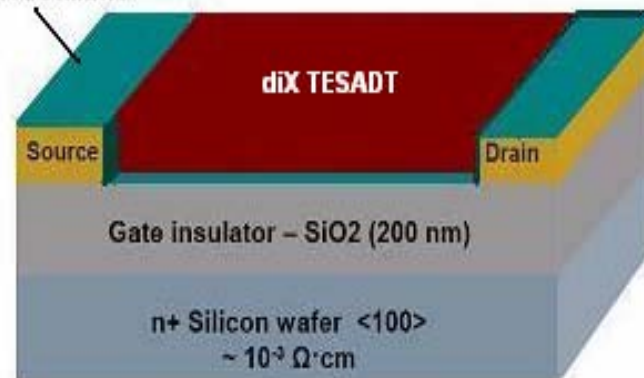
- fluorinated 5,11-bis(triethylsilylethynyl) anthradithiophene (diF-TESADT)
- chlorinated 5,11-bis(triethylsilylethynyl) anthradithiophene (diCl-TESADT)
- brominated 5,11-bis(triethylsilylethynyl) anthradithiophene (diBr-TESADT)
- Solvents: Chlorobenzene, Toluene



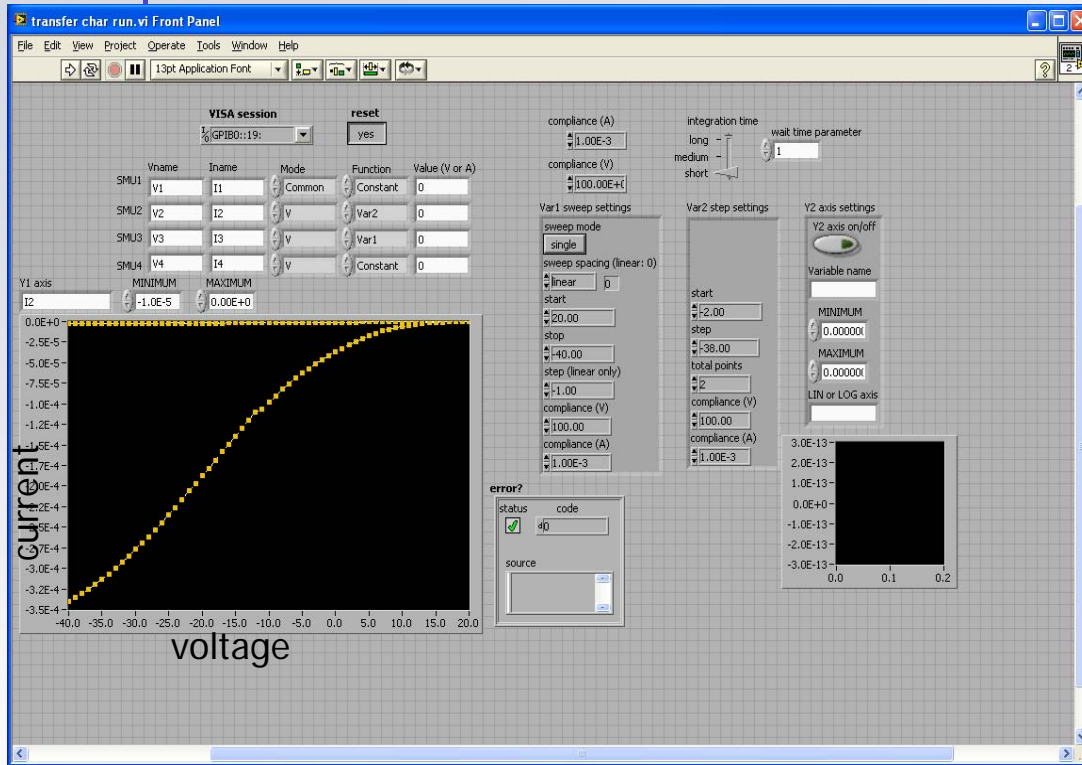
Organic Semiconductors Cont'd



Contact Treatment



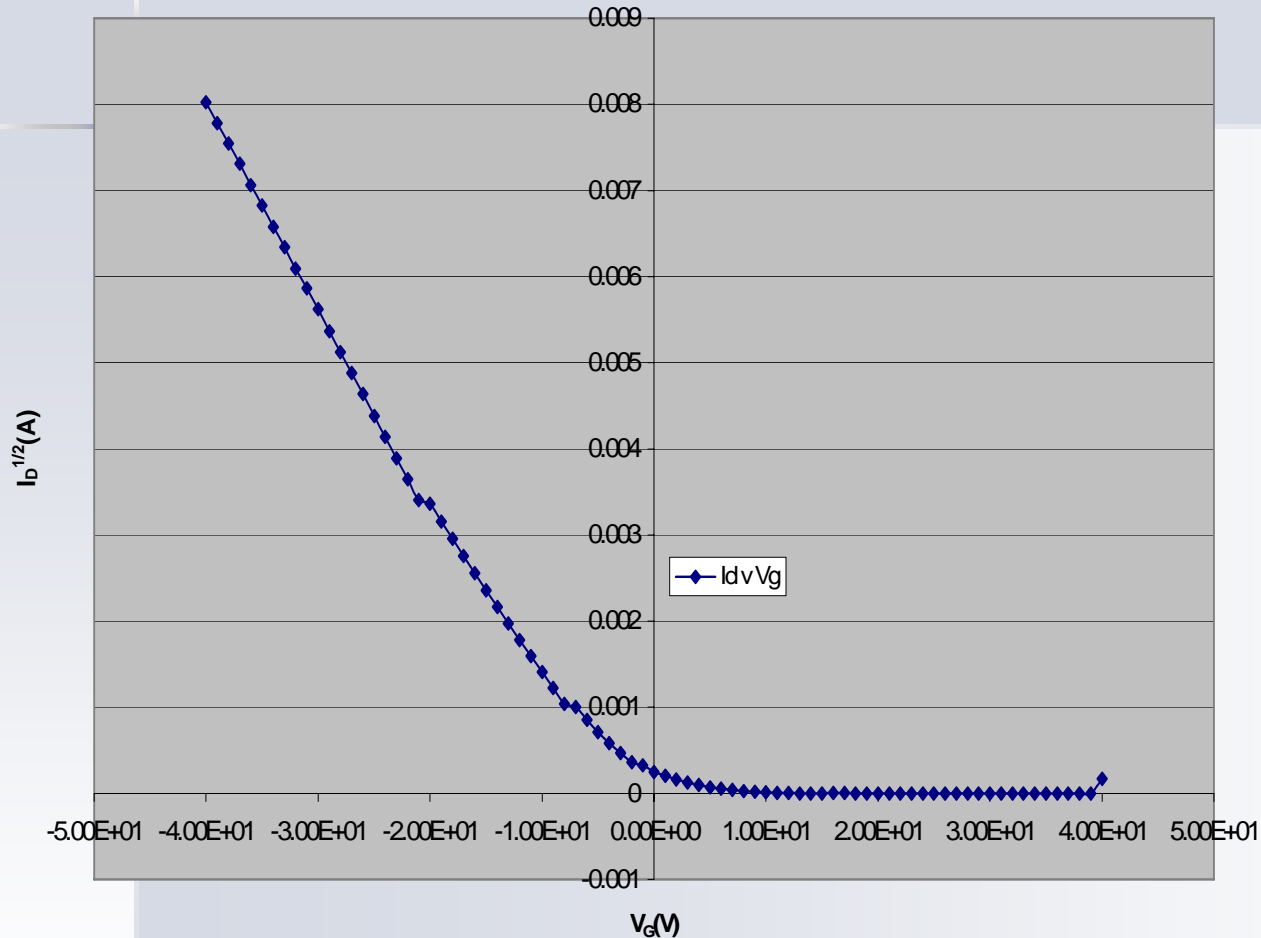
User Interface: LabVIEW



Probe Station



I_D v. V_G Graph, diF
L=10, W=1000
Chlorobenzene, V=500RPM



$$\mu = \frac{2L}{C_i W} \left(\frac{\partial \sqrt{I_D}}{\partial V_G} \right)^2$$

I_D Drain Current

C_i Capacitance of Insulator

W Channel Width

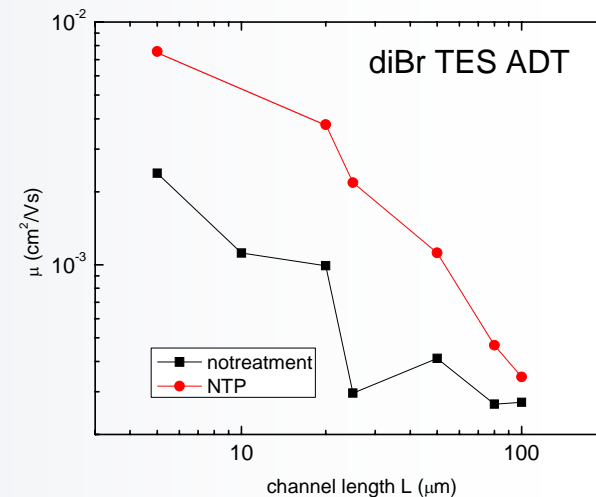
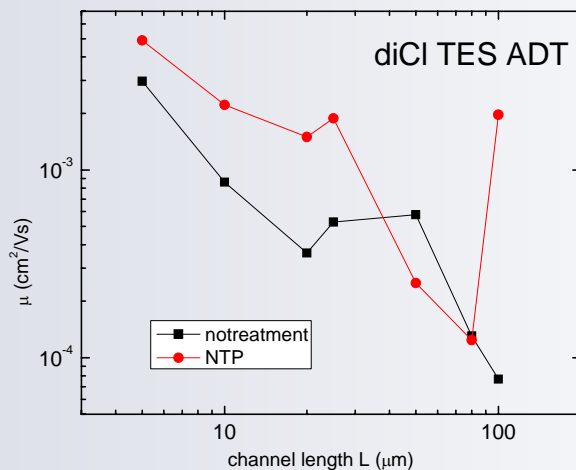
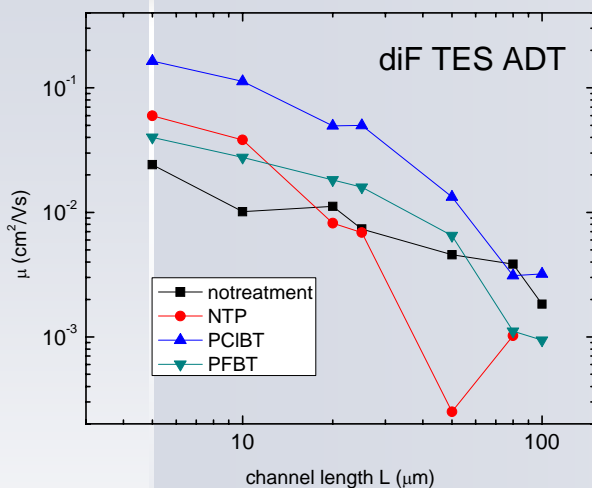
L Channel Length

V_G Gate Voltage

Mobilities for contact treated devices

Organic Solvent: Toluene

Deposition Speed: 1KRPM

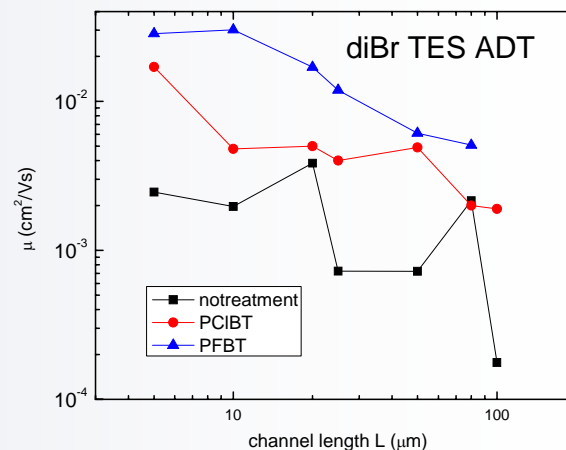
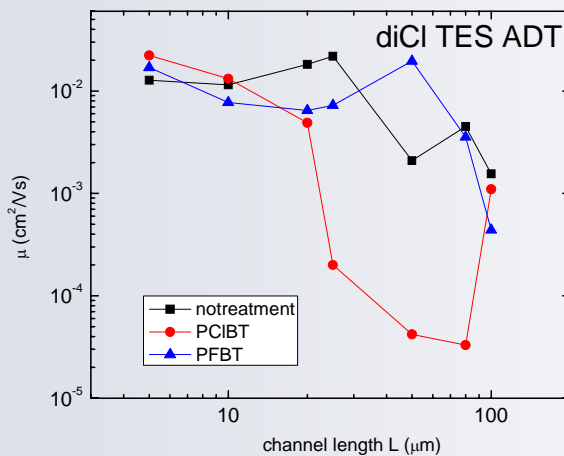
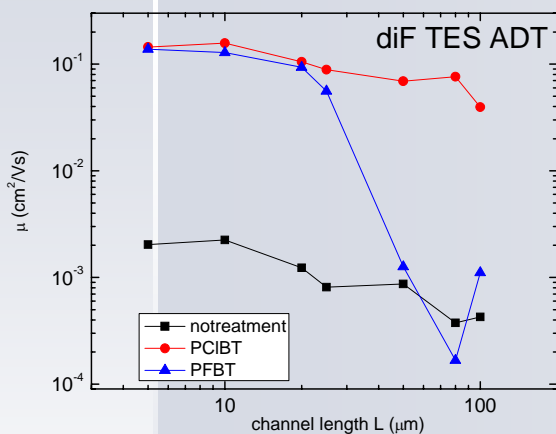


Mobility v. Channel Length

Mobilities for contact treated devices

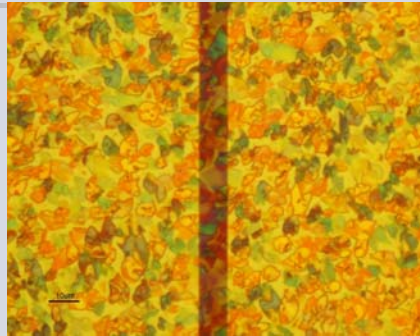
Organic Solvent: Chlorobenzene

Deposition Speed: 1KRPM

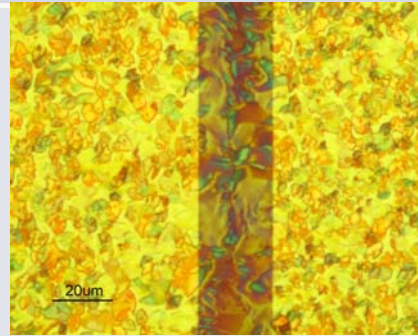


Mobility v. Channel Length

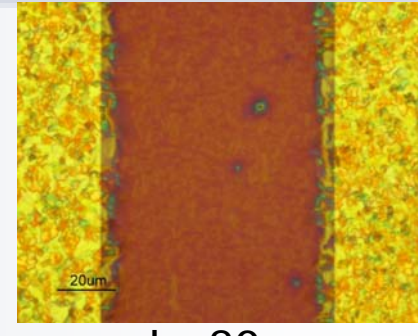
Crystallization of diF with PFBT contact treatment



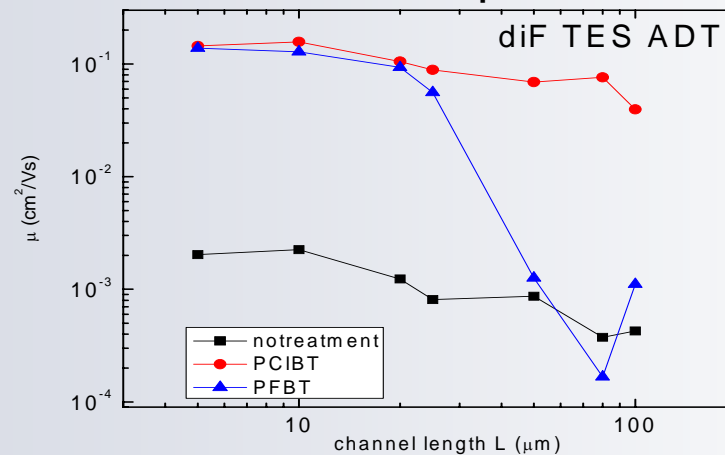
L=10µm



L=25µm

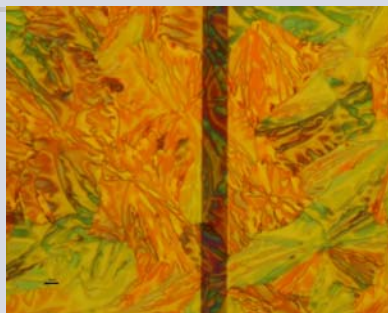


L=80µm

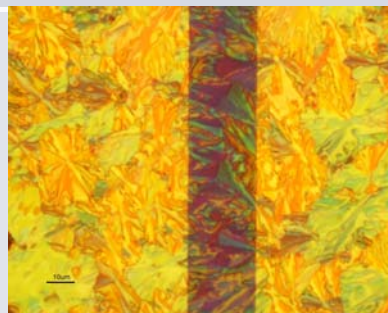


Mobility v. Channel Length

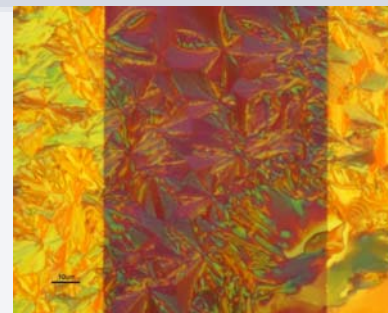
Crystallization of diF with PCIBT contact treatment



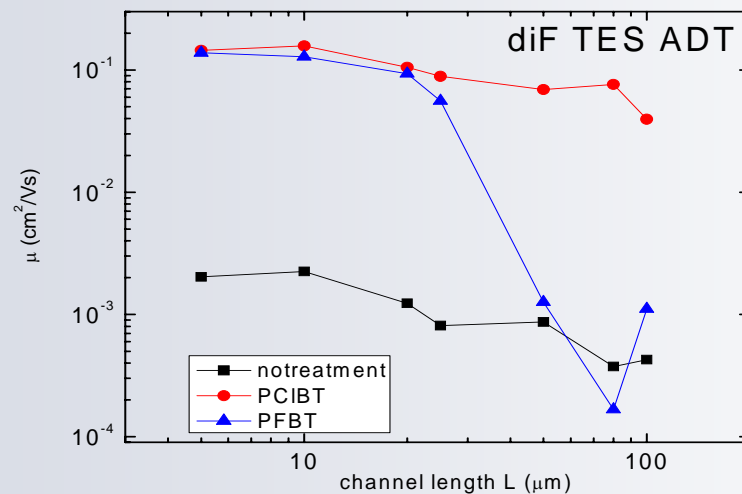
L=10 μm



L=25 μm

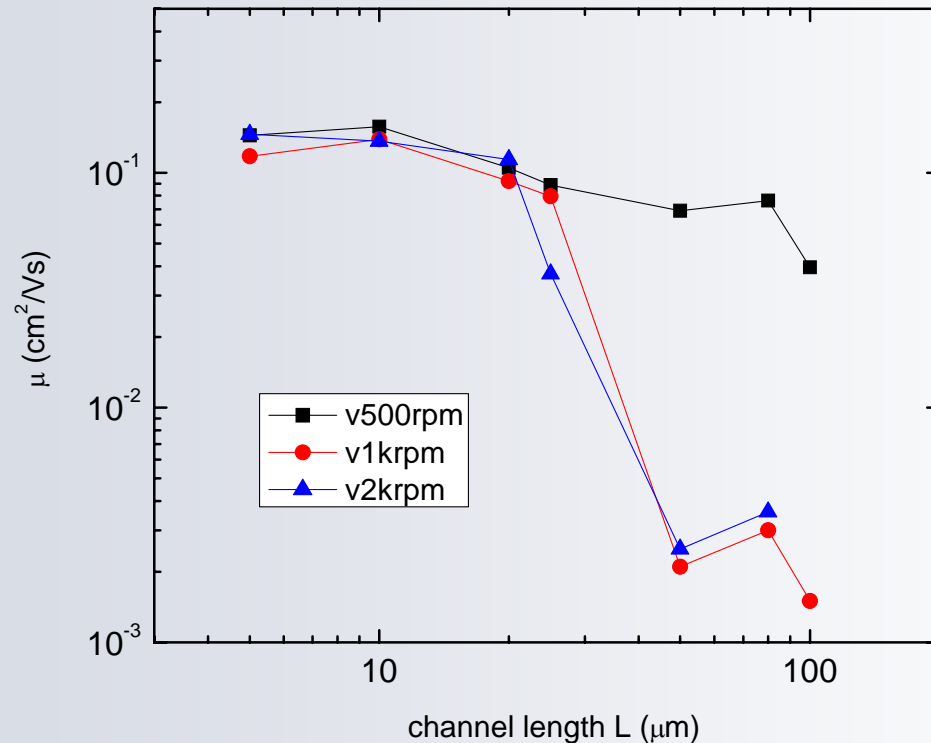


L=80 μm



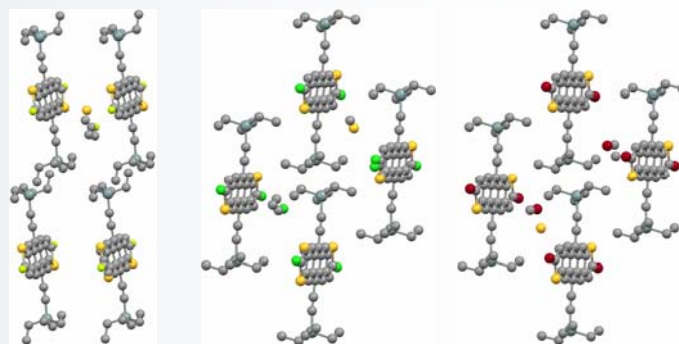
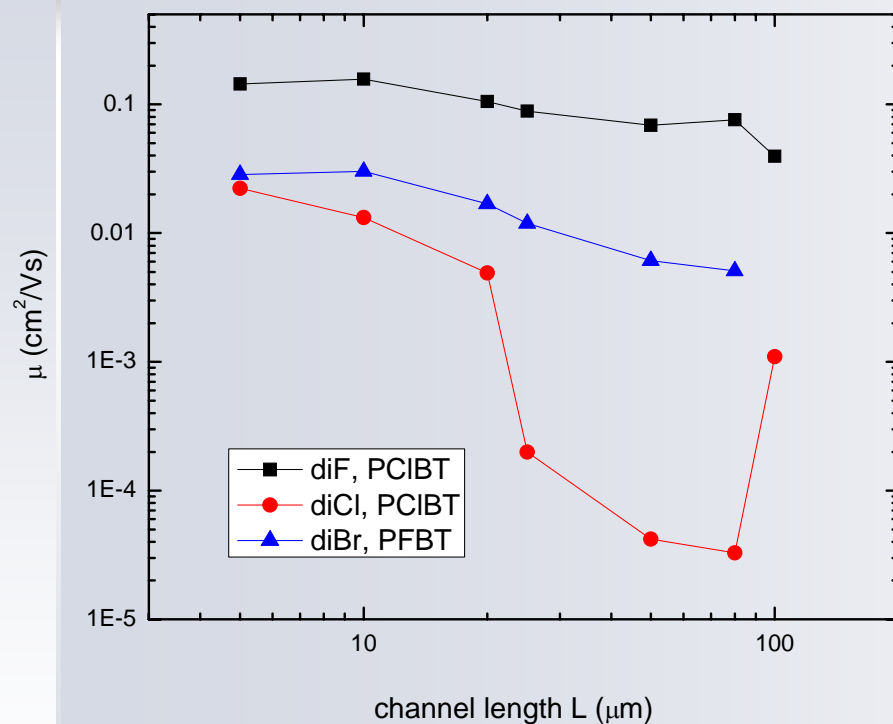
Mobility v. Channel Length

Mobilities for diF with PCIBT contact treatment and varying deposition speeds

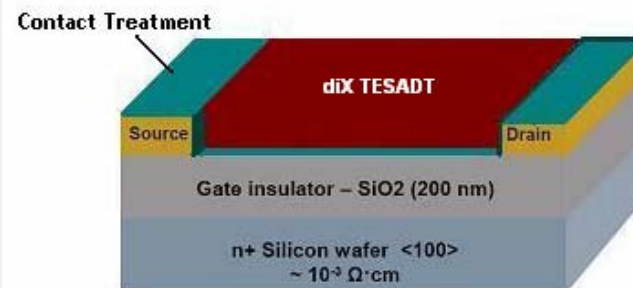


Mobilities for diF, diCl, and diBr

Organic Solvent: Chlorobenzene
Deposition Speed: 1KRPM



diF-TESADT diCl-TESADT diBr-TESADT



Special Thanks:

- **NIST:**  National Institute of Standards and Technology
– Dr. Oana Jurchescu
– Dr. David Gundlach
– Dr. John Suehle
– Dr. Behrang Hamadani

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– Dr. Gary White
– Dr. Jack Hehn



- **Mesa State College:**



- Dr. William Tiernan
- Dr. Chad Middleton
- Dr. David Collins
- Ms. Julie Fredlund