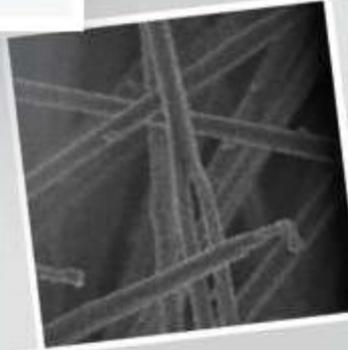


Electrospinning Polymer Fibers:

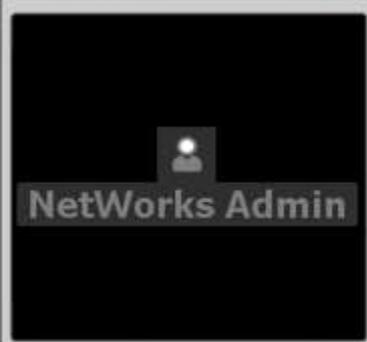
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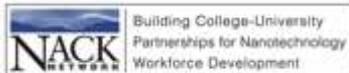
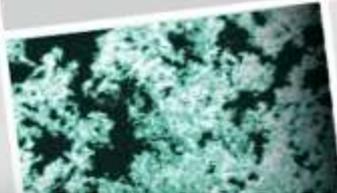
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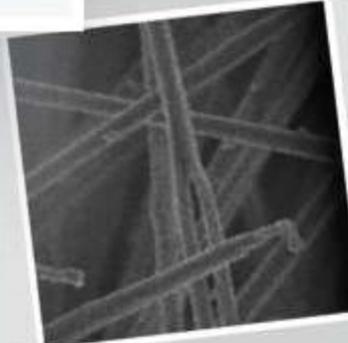
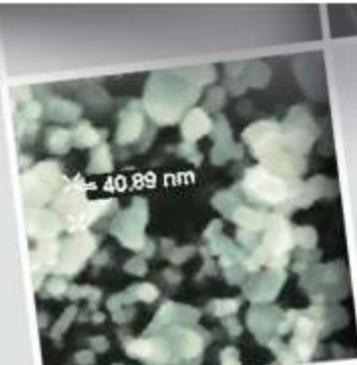


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A Simple Technique of Introducing Nanoscience to Undergraduates

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Today's Presenter



Dr. Nicholas Pinto

Professor in the Department of Physics and Electronics at the University of Puerto Rico, Humacao Campus.

- His research is in the field of conducting polymers for use as gas sensors, devices and in organic electronics at the nanoscale.
- He is also engaged in efforts to integrate undergraduate research into the Senior Lab course

Moderator: Mike Lesiecki
MATEC





Electrospinning polymer fibers: A simple technique of introducing nanoscience to undergraduates

Nicholas J. Pinto

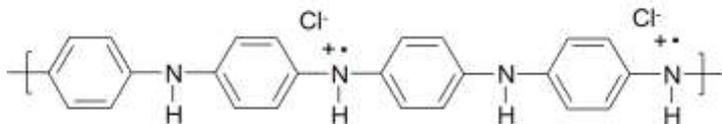
Dept. of Physics and Electronics

University of Puerto Rico-Humacao

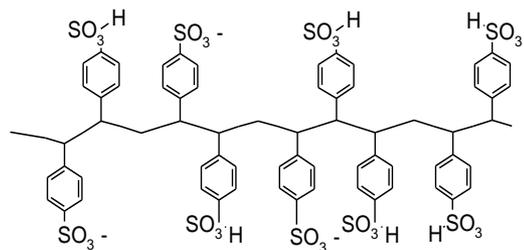


<http://www.freeworldmaps.net/centralamerica/puertorico/location.html>

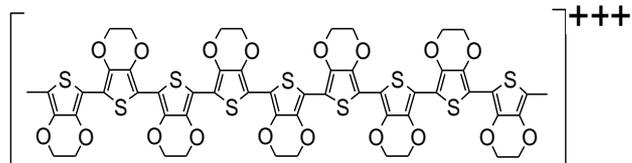
Conducting polymers/Metal oxides



Polyaniline



PSS



PEDOT

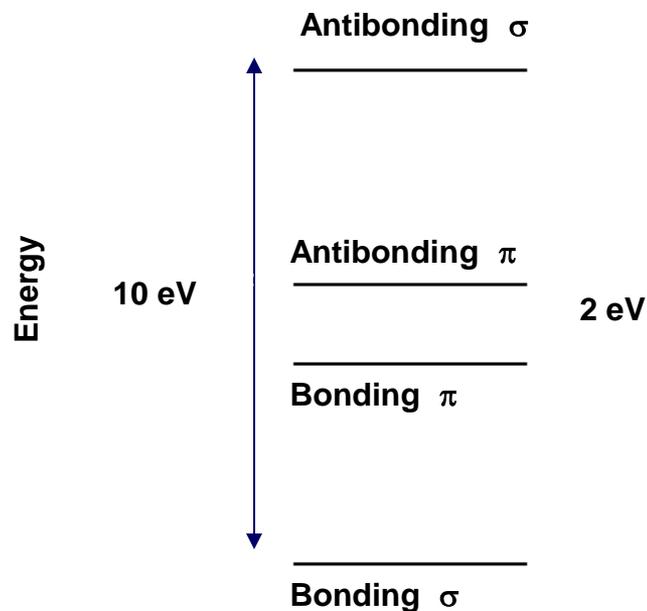
Poly(3-hexylthiophene)

[P(ND12OD-T2)]_n - ActivInk™

SnO₂

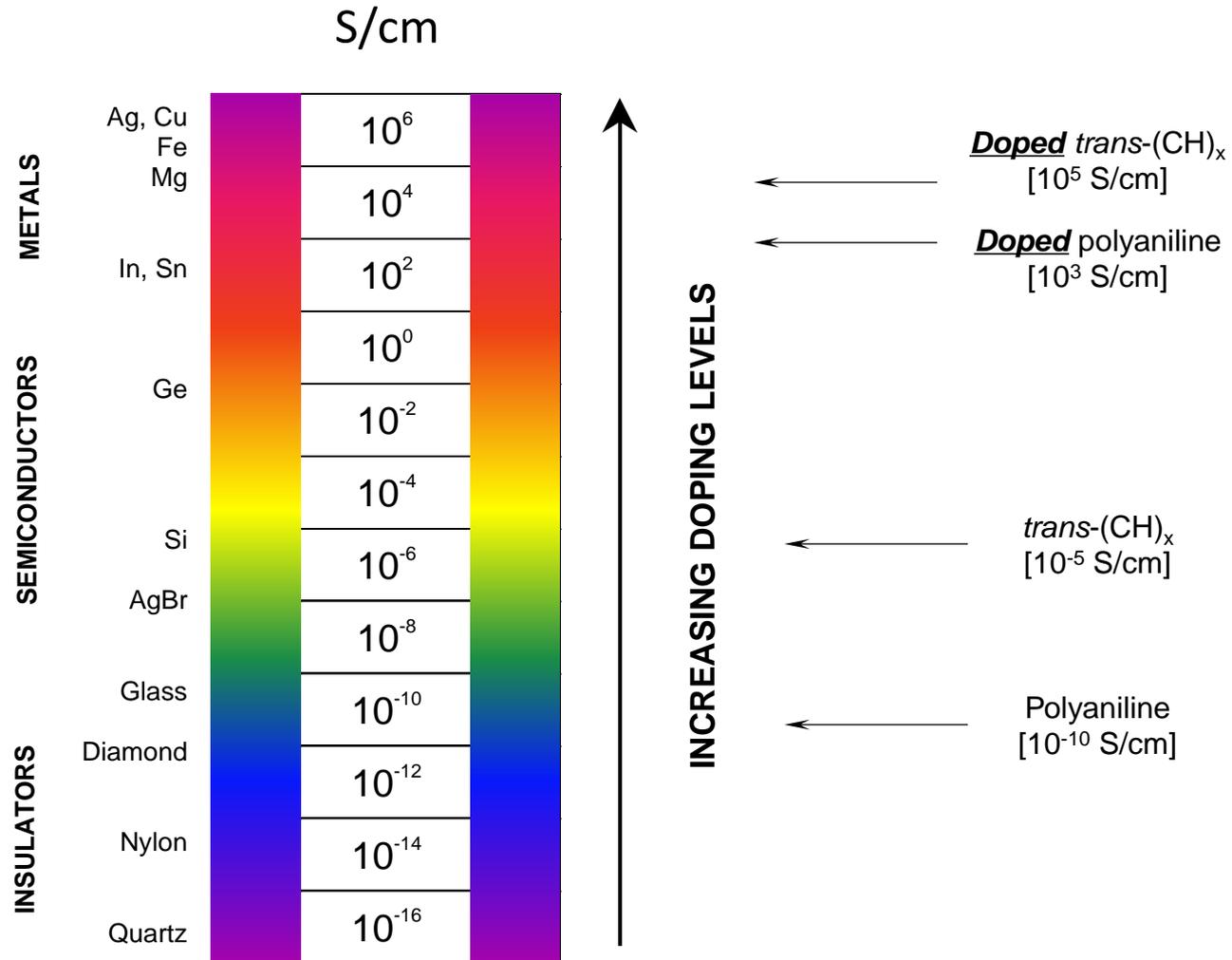
ZnO

Electronic structure

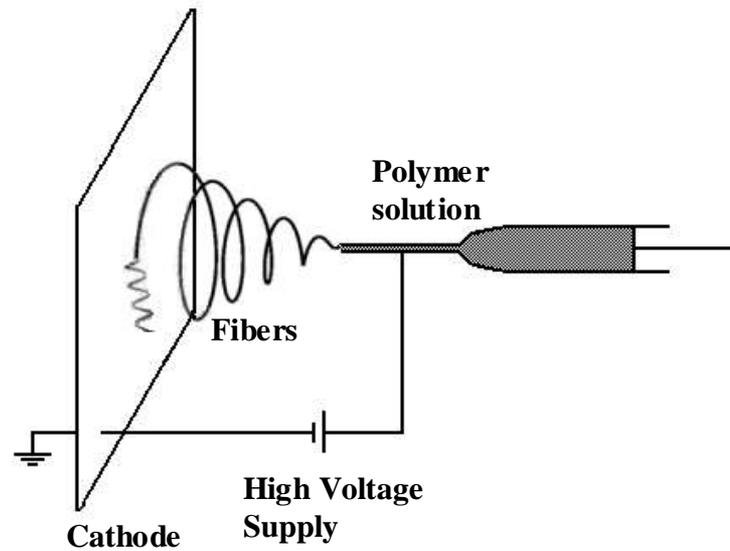


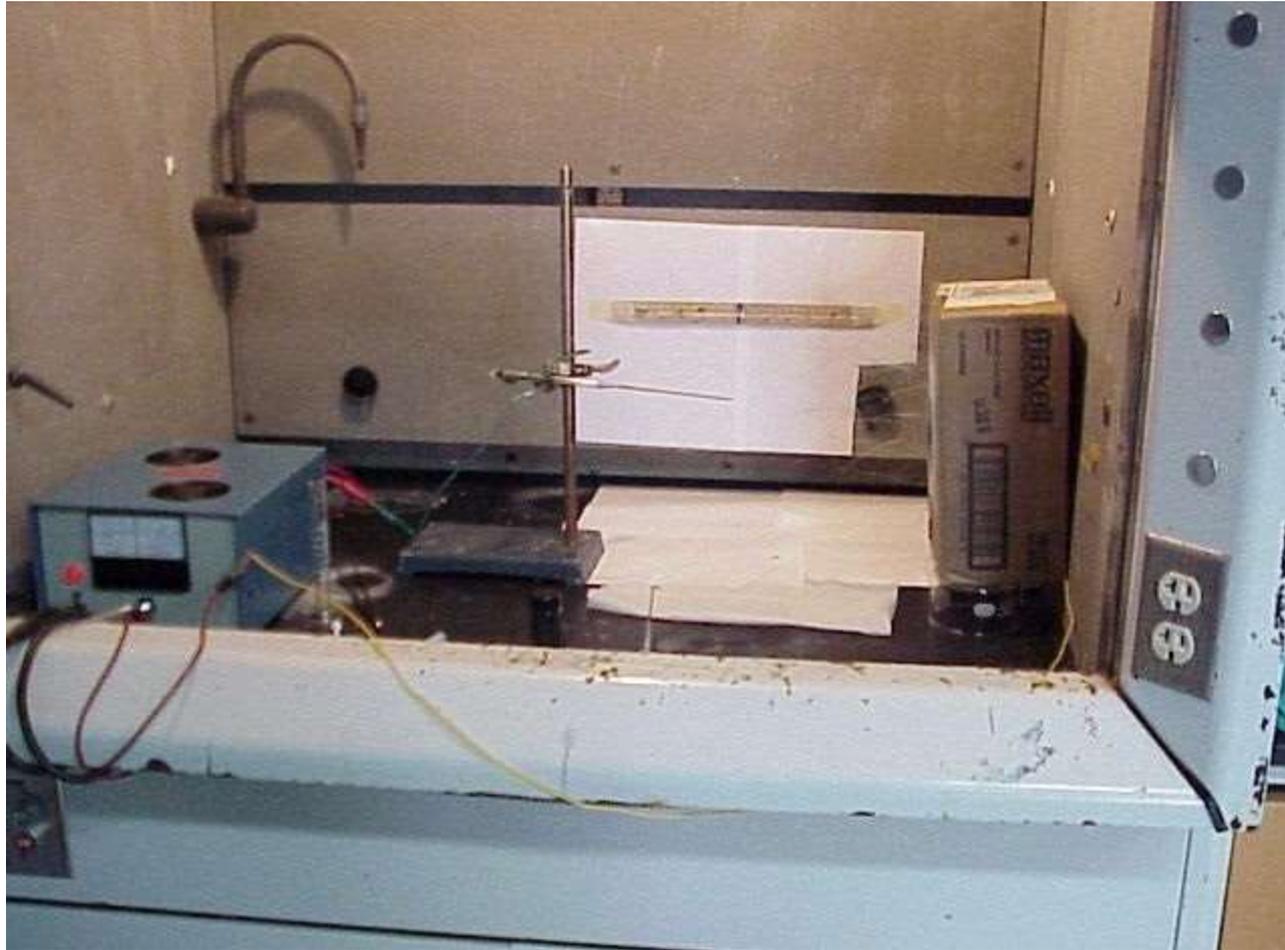
Conductivity of Electronic Polymers

Conductivity increases with increased doping



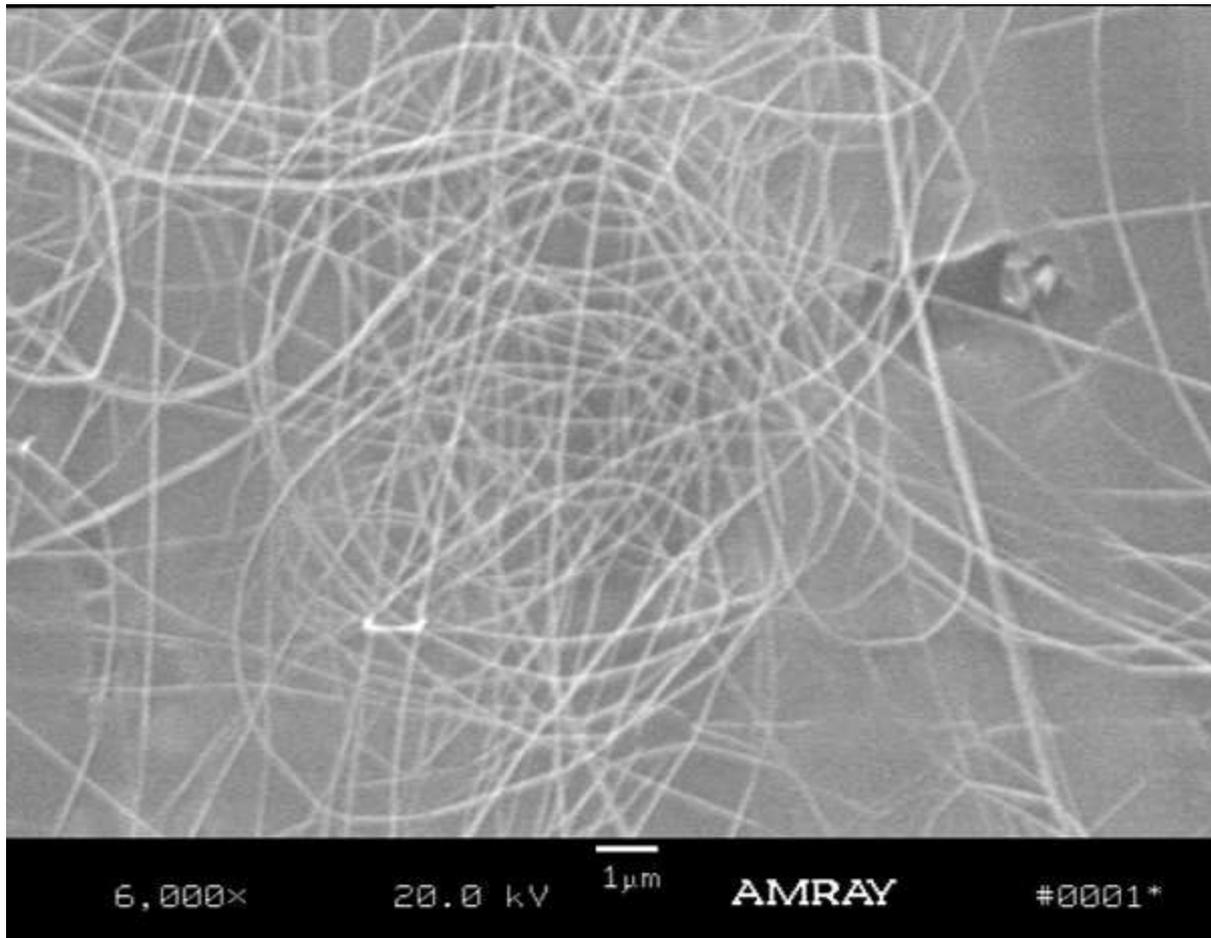
Electrospinning



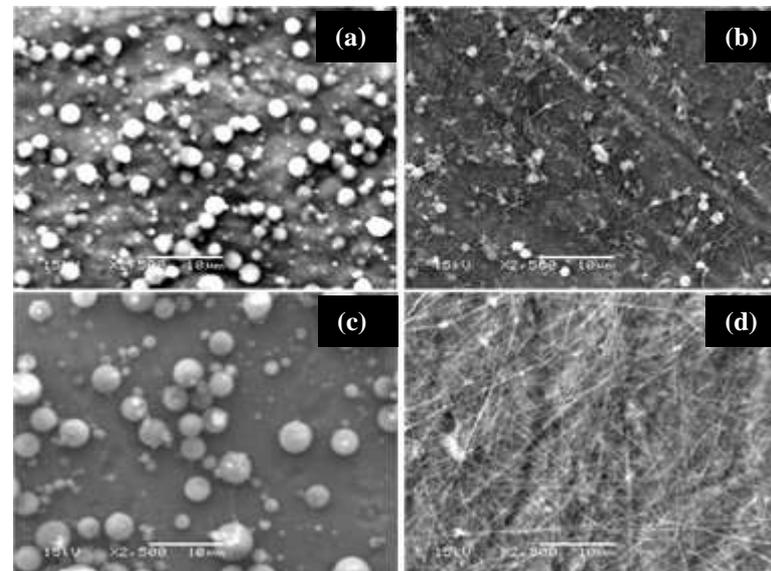
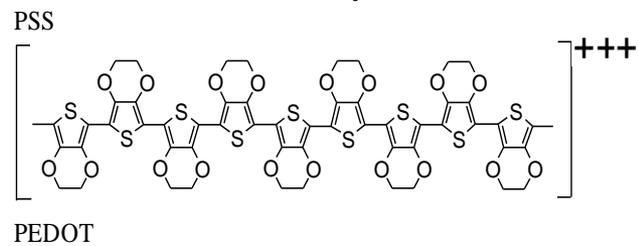
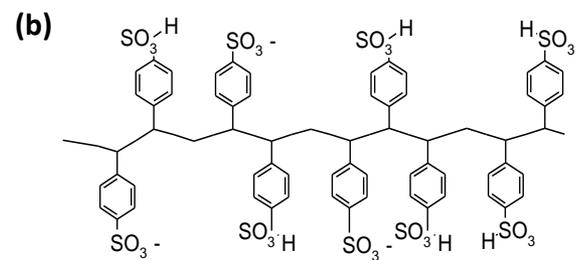
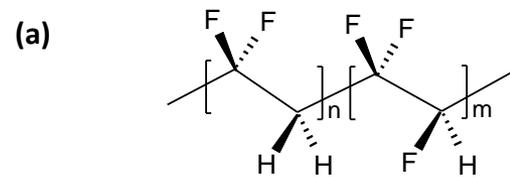




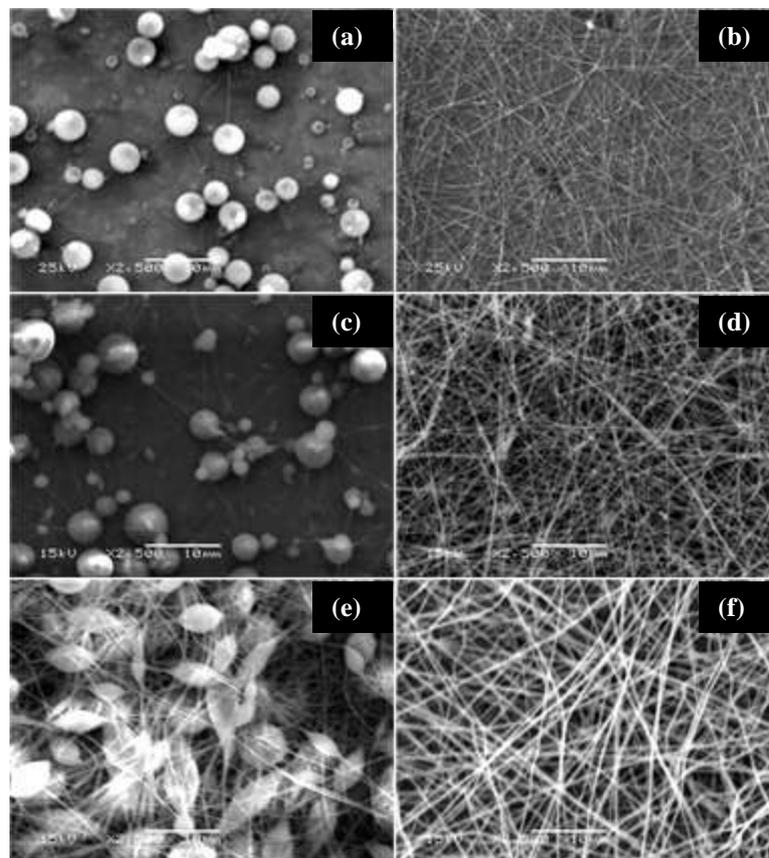
Polystyrene in THF (MW 212,000) – 20kV/ 20cm
Average diameter 60 nm



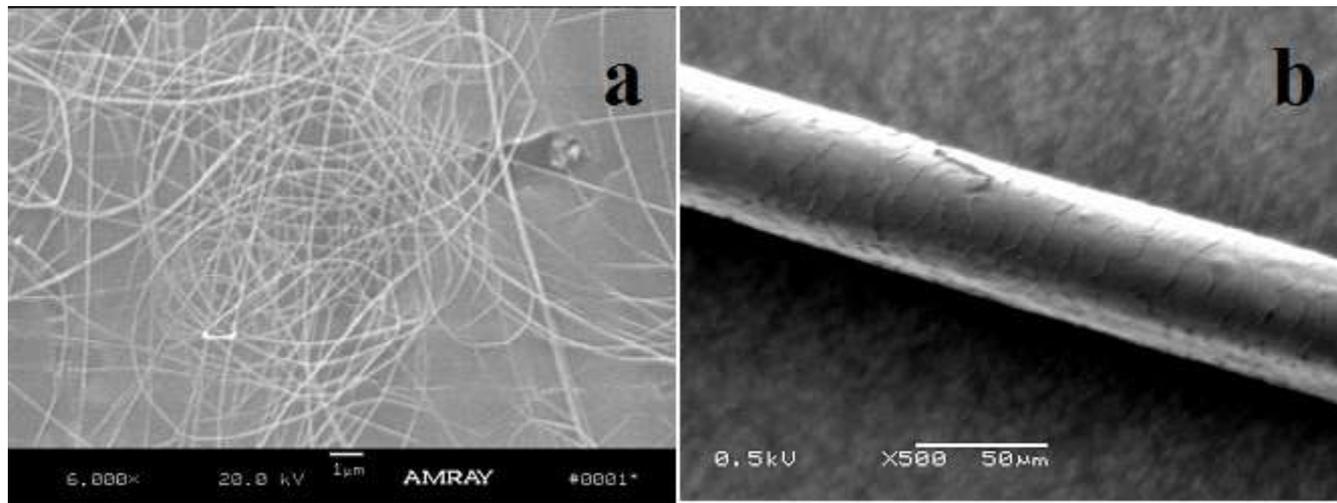
PVDF-TrFE/PEDOT-PSSA



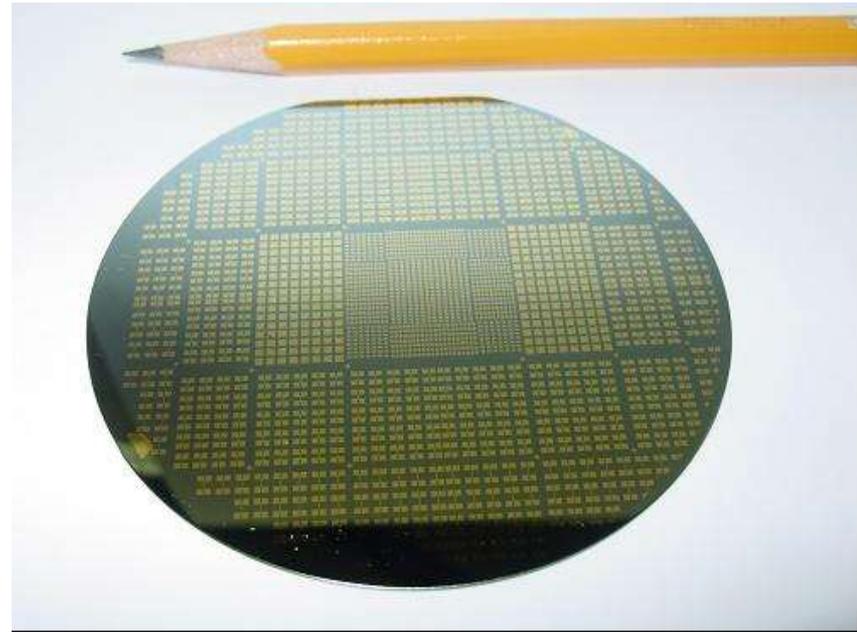
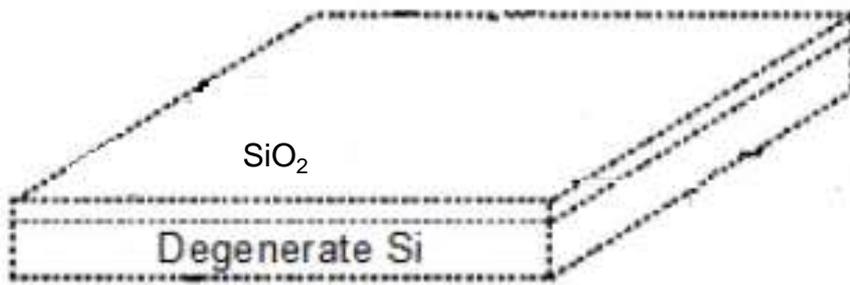
PVDF-TrFE/PEDOT-PSSA



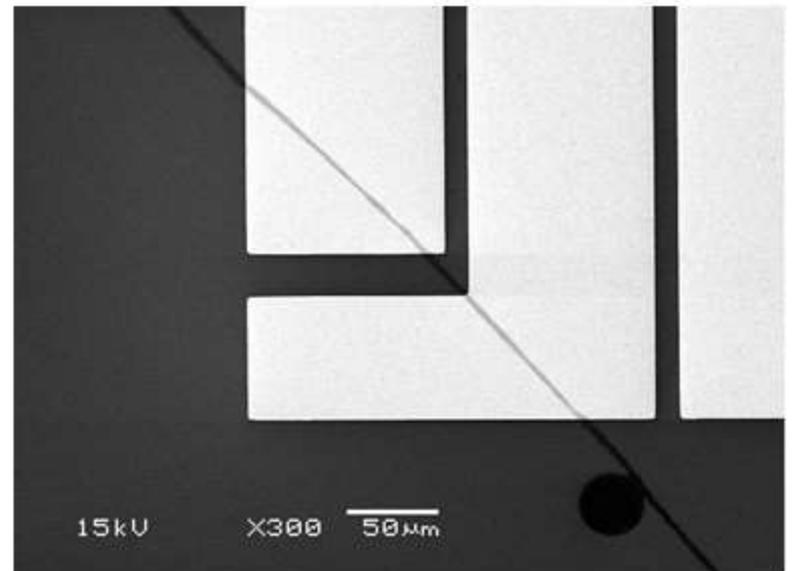
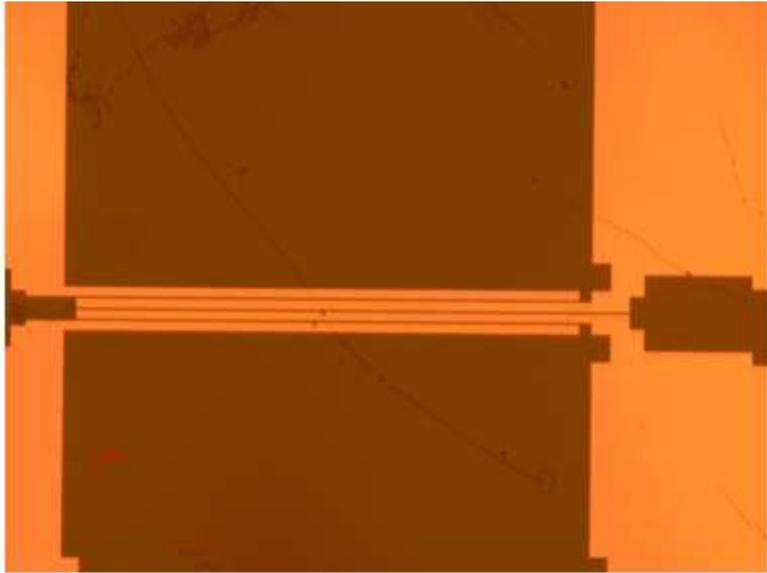
Diameter comparison between human hair and e-spun fiber

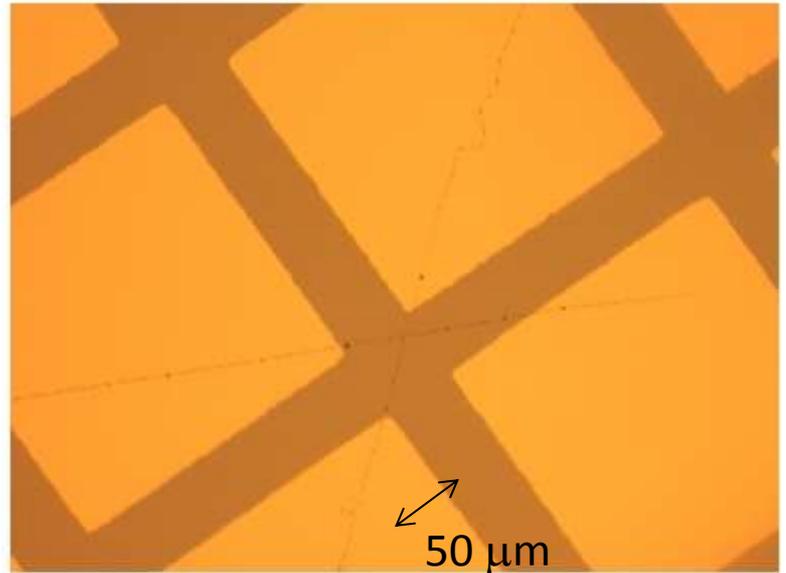
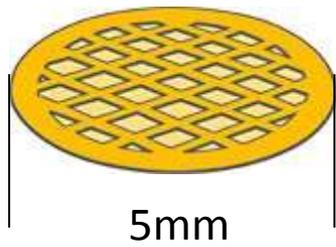
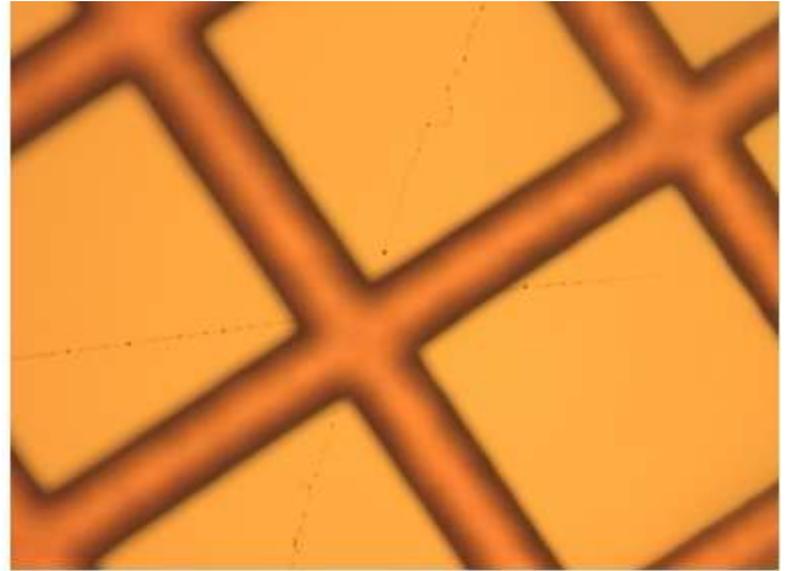


Substrates

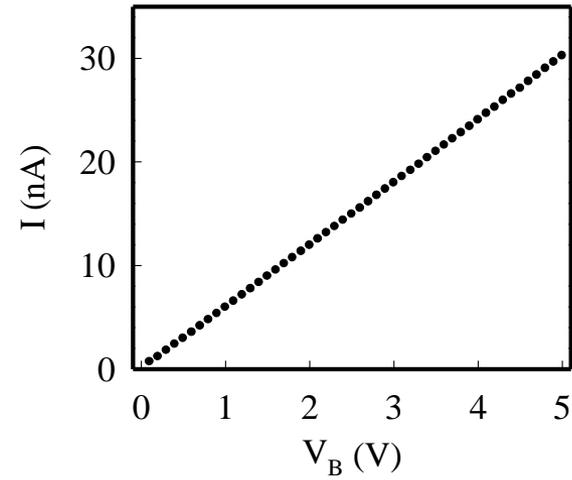
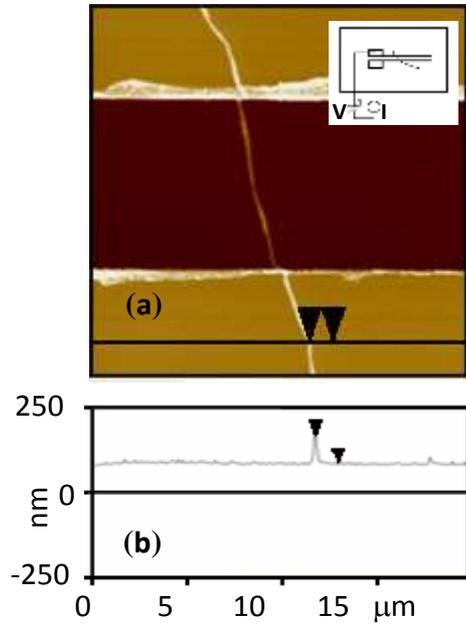


Isolated polymer nanofibers



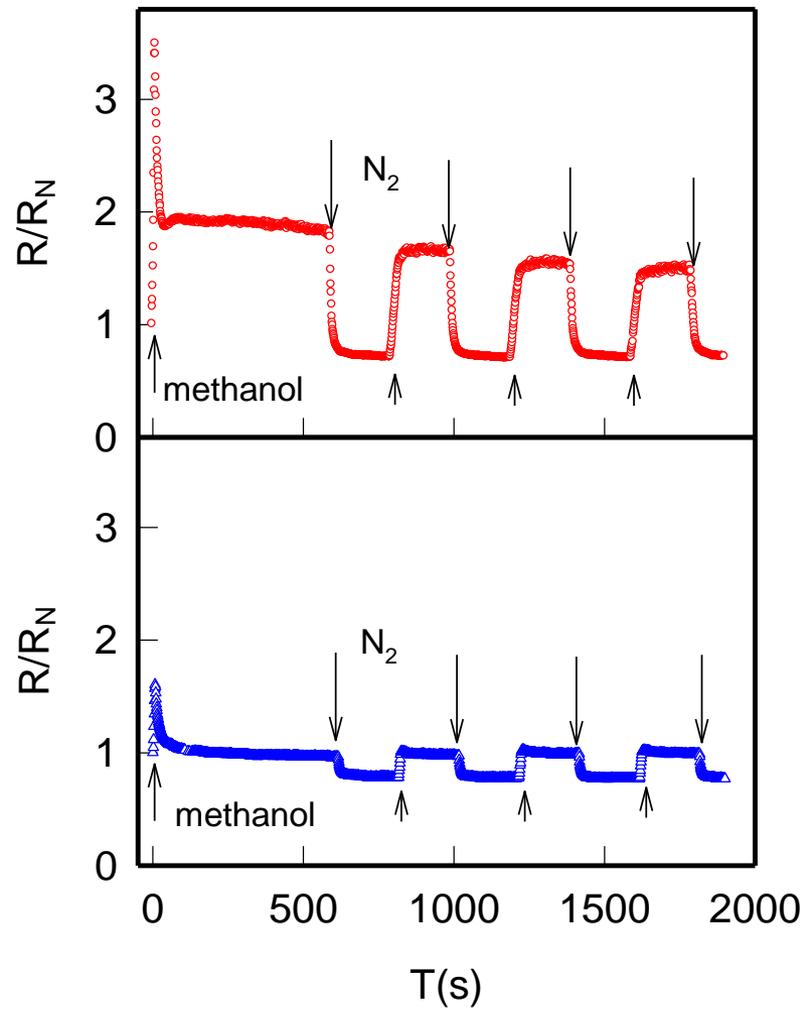


Simple resistor (PANi-HCSA)

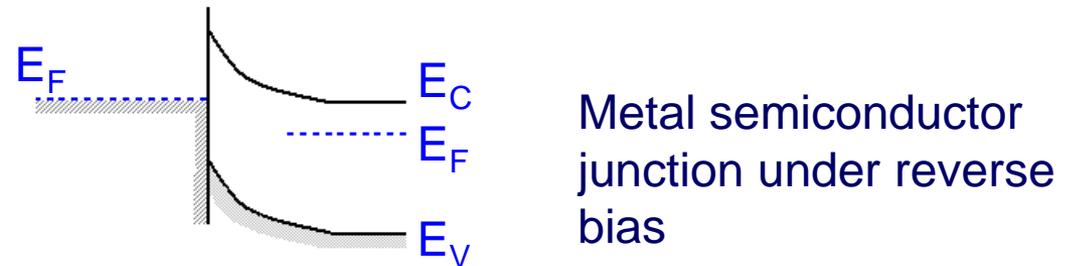
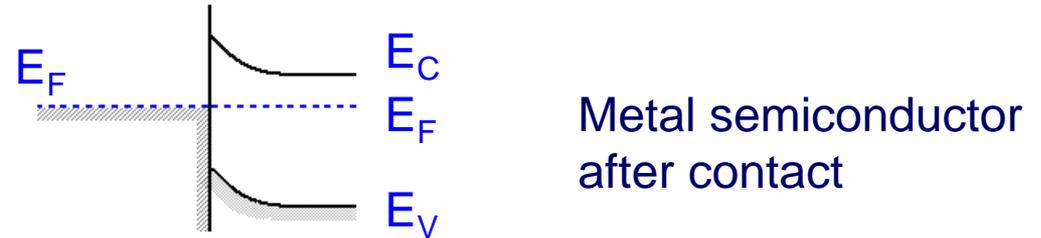
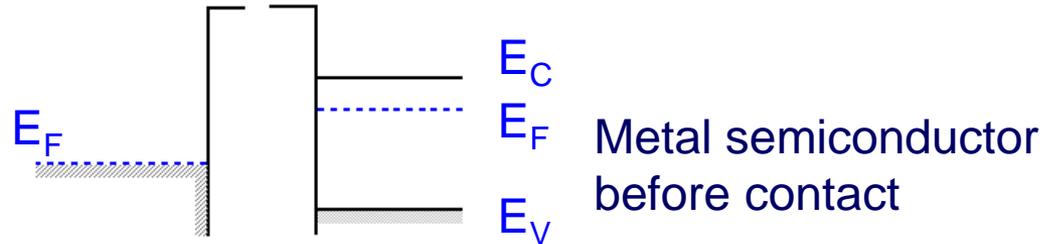
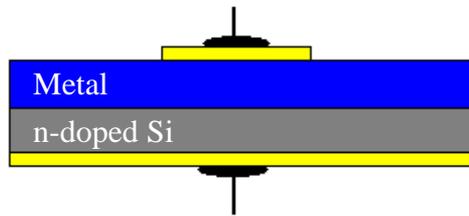


$$\sigma = 0.08 \text{ S/cm}$$

Gas sensor (PANi-HCSA)

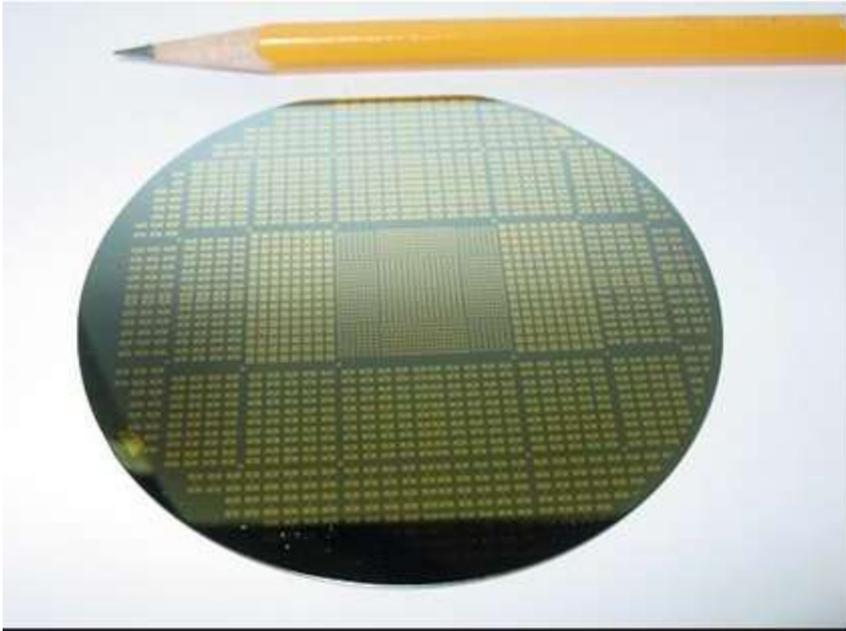


Schottky Diode

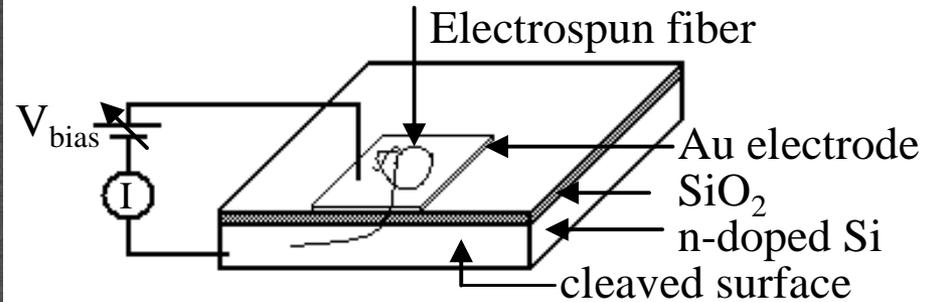
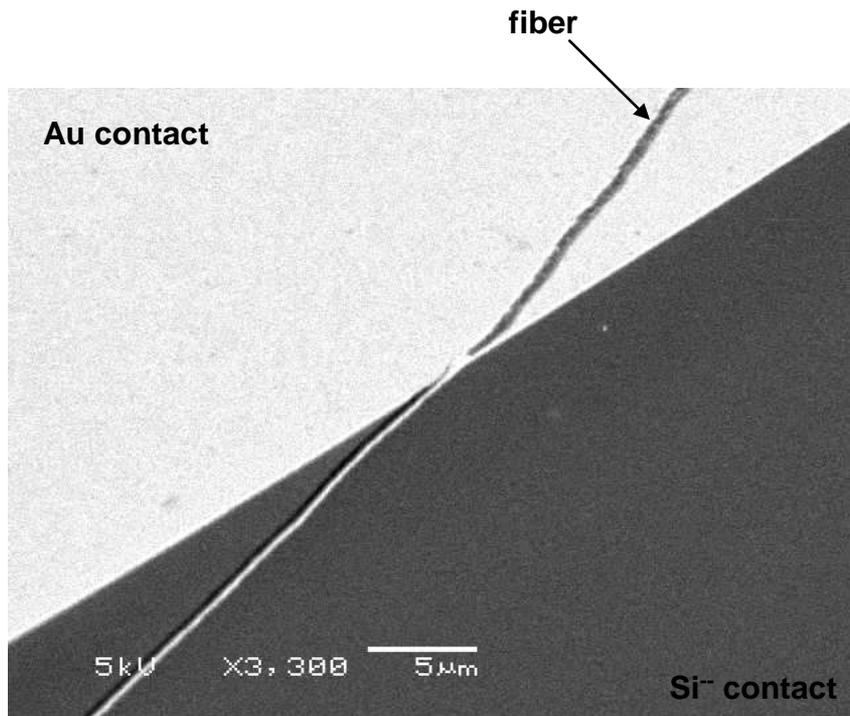


Schottky nano-diode (contd.)

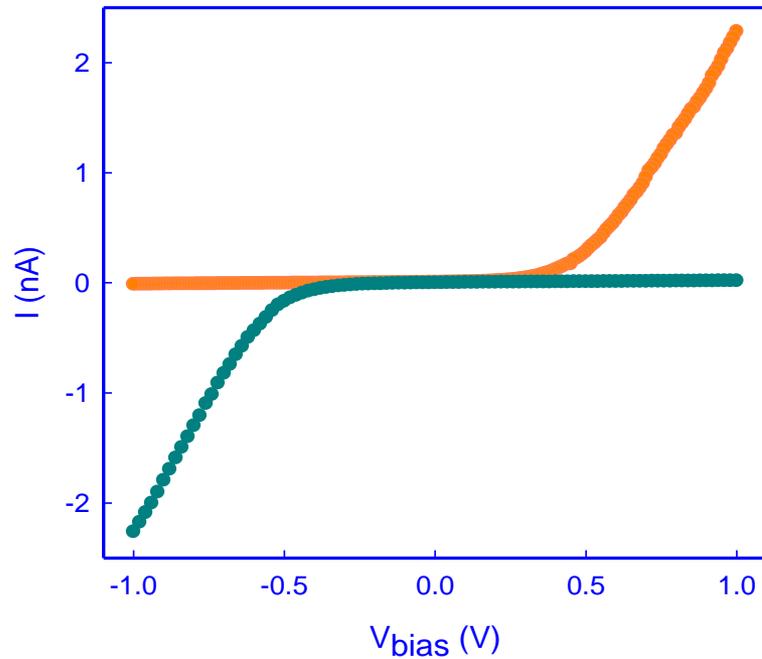
n-doped Si/SiO₂ ($\rho=0.1-1.0 \Omega\text{-m}$)



Schottky diode using PANi nanofibers

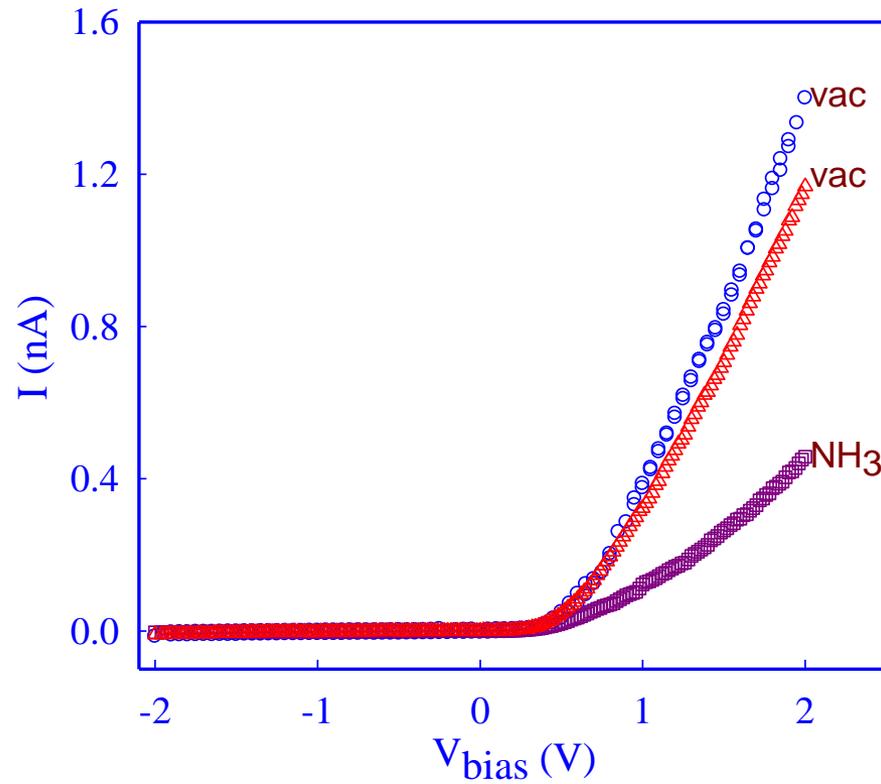


Device characteristics at 300 K

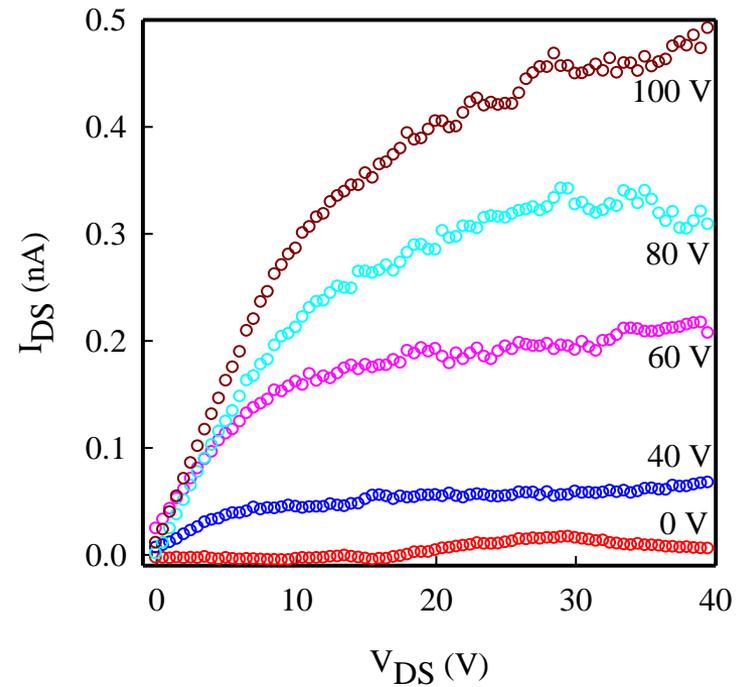
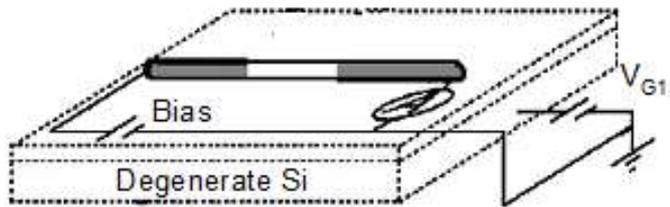
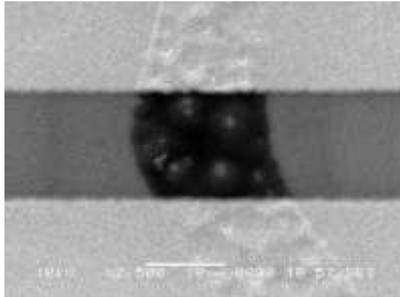


- $I_{\text{for}}/I_{\text{rev}} = 30$
- Ideality factor $n \approx 4$
- $0.4 \text{ V} < V_{\text{on}} < 0.6 \text{ V}$
- $\phi_b = 0.49 \text{ V}$

Diode / Sensor

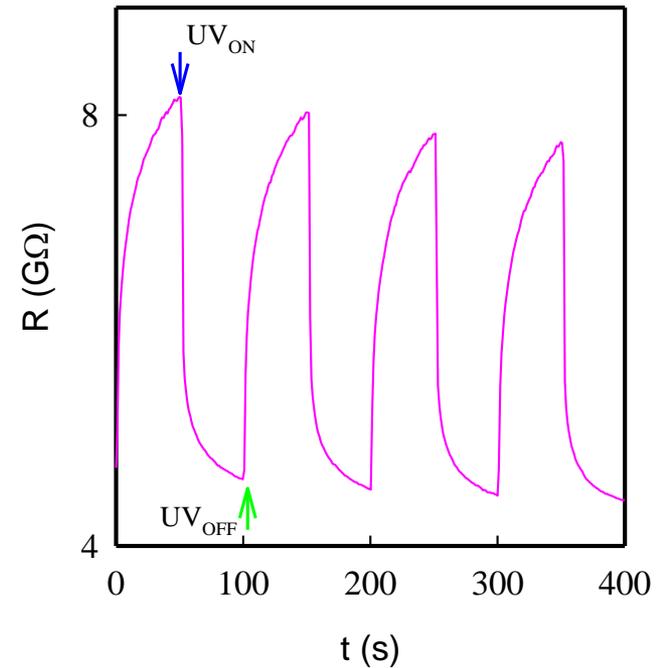
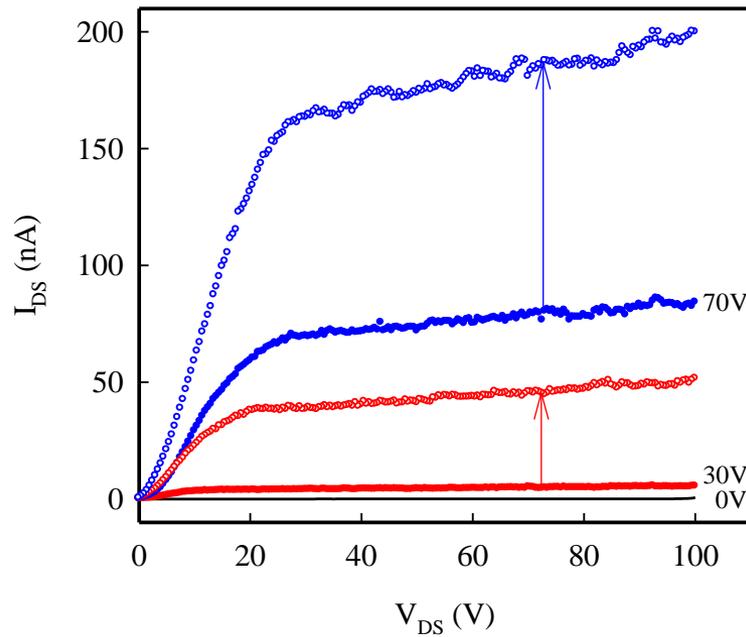


Field effect transistor ($[P(ND12OD-T2)]_n^*$)

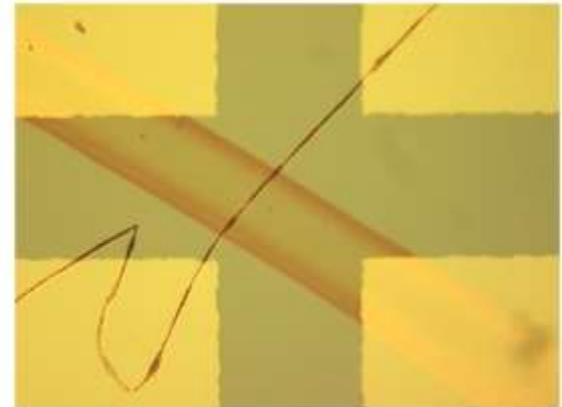
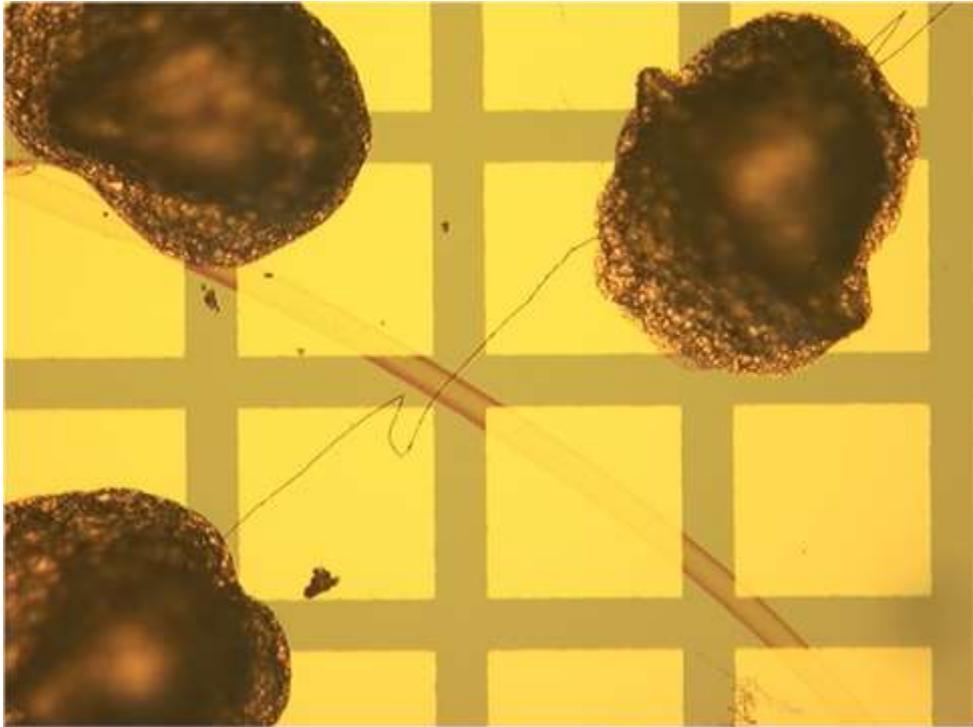


* poly[N,N'-bis(2-octyldodecyl)-naphthalene-1,4,5,8-bis(dicarboximide)-2,6-diyl-alt-5,5'-(2,2'-bithiophene)]

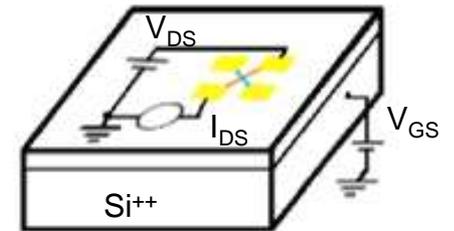
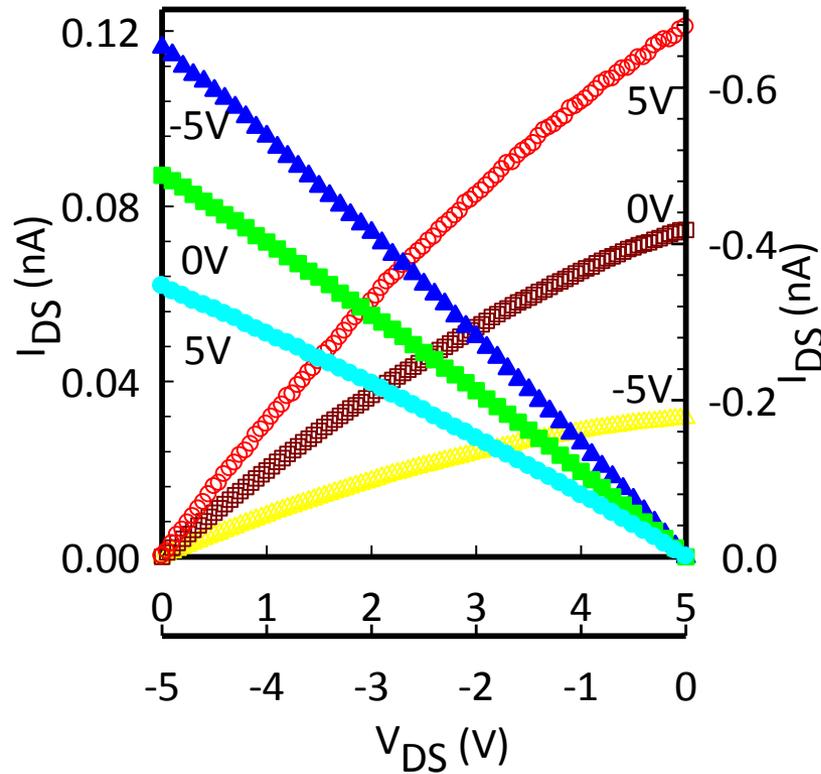
Effect of UV radiation ($[P(ND12OD-T2)]_n^*$)



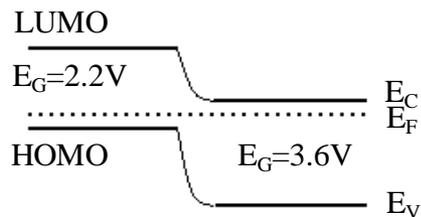
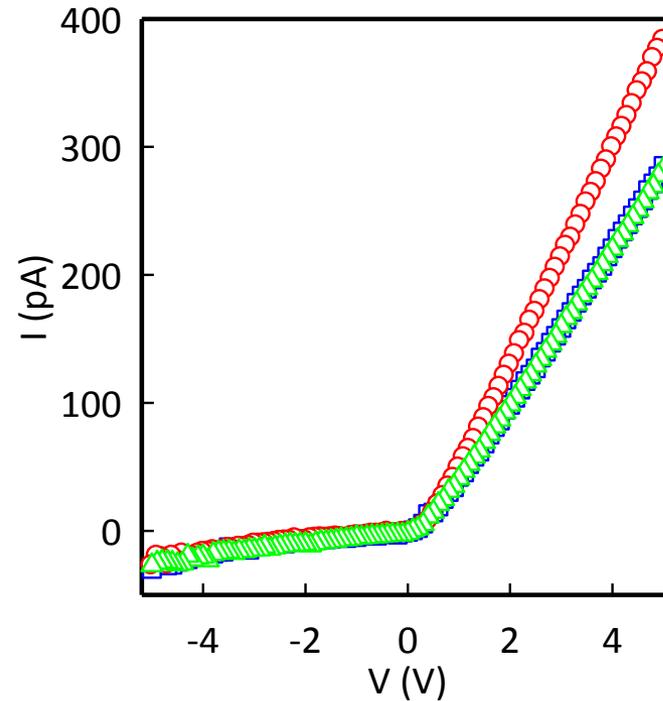
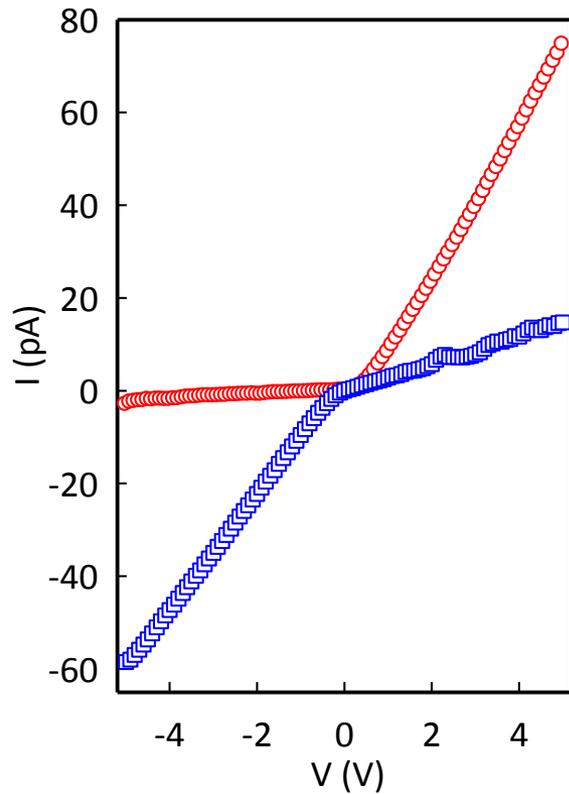
Crossed nanofibers: n -SnO₂ and p -P3HT



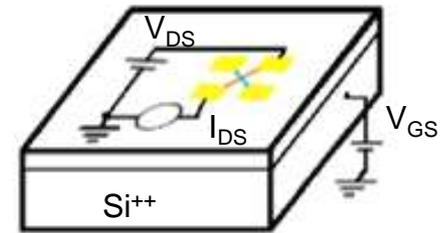
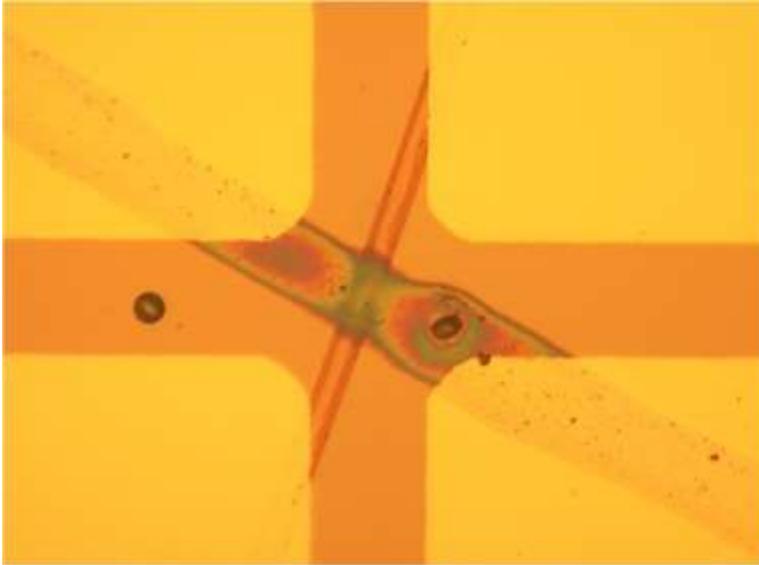
Crossed nanofibers: n -SnO₂ and p -P3HT



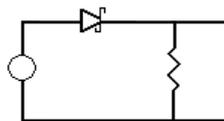
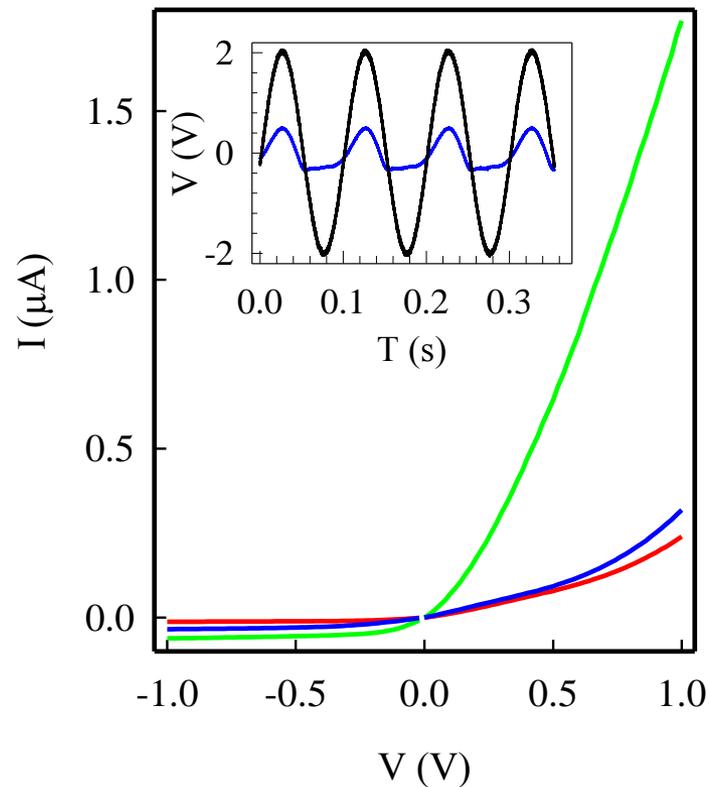
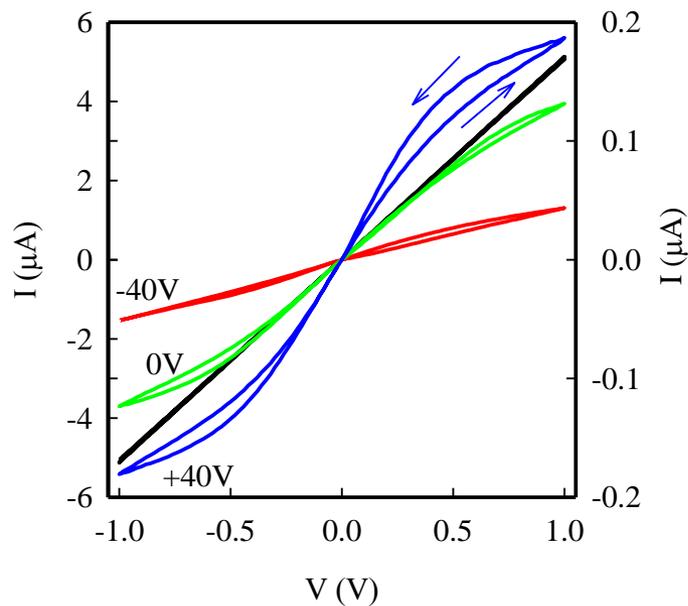
Crossed nanofibers: n -SnO₂ and p -P3HT



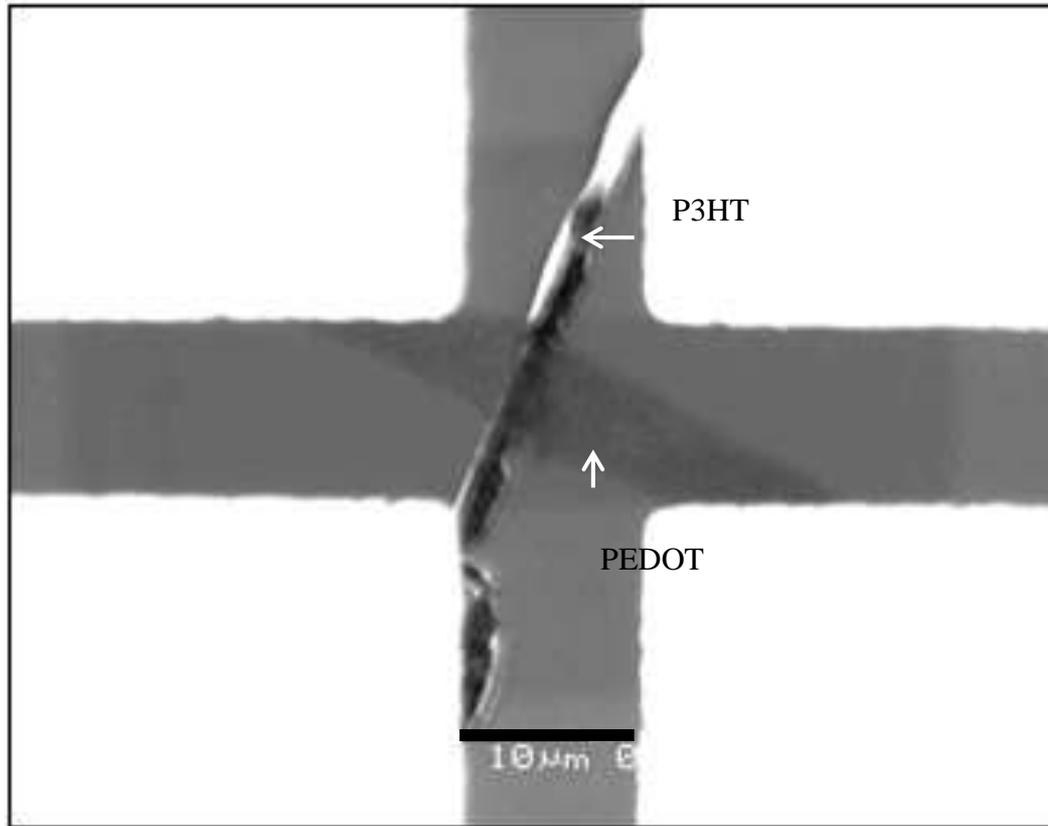
Crossed nanofibers: n -SnO₂ and PEDOT-PSSA



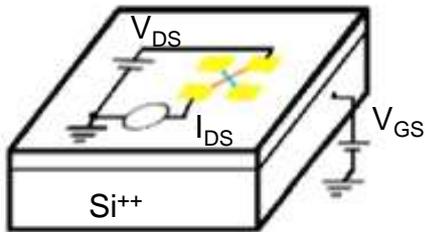
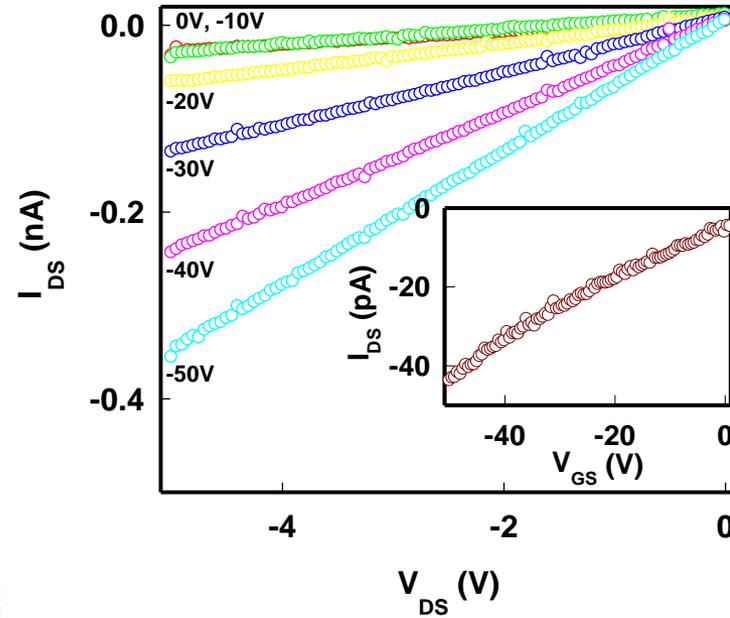
Crossed nanofibers: n -SnO₂ and PEDOT-PSSA



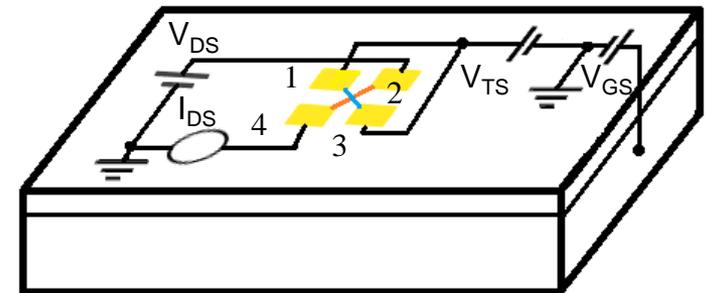
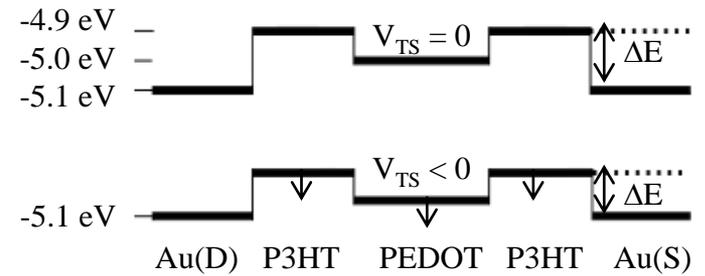
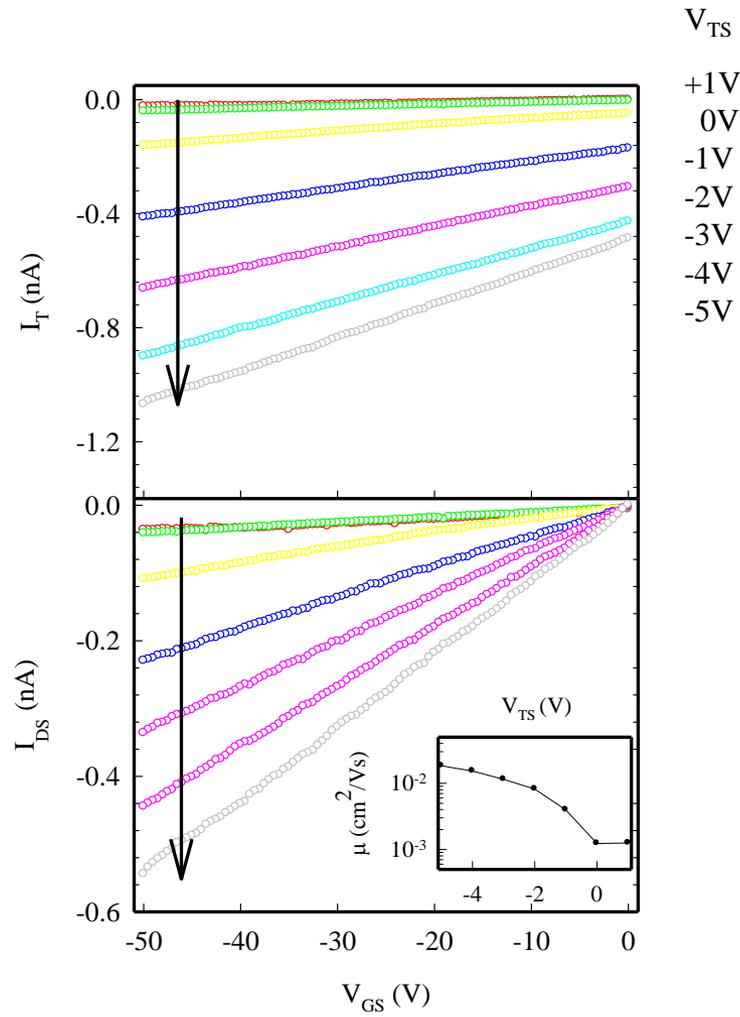
Crossed nanofibers: *p*-P3HT and PEDOT-PSSA



Crossed nanofibers: *p*-P3HT and PEDOT-PSSA



Crossed nanofibers: *p*-P3HT and PEDOT-PSSA





Conclusions

- Electrospinning is a simple technique to make fibers
- Diodes, FET's, Sensors
- Some of these devices are multifunctional
- All of the work presented was done by High School students and Undergraduates

Acknowledgements

National Science Foundation

DoD



Final Questions

Please type all questions into the Chat Box

How Can We Better Serve You?

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<http://questionpro.com/t/ABkVkZQFNq>

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2014 Events Calendar

- Aug 11 – 14:** Nanotechnology Course Resources II: Patterning, *Workshop* Characterization, and Applications
- June 4 – 6:** MNT Conference, Albuquerque, NM
- July 21 – 24:** HI-TEC Conference, Chicago, IL

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