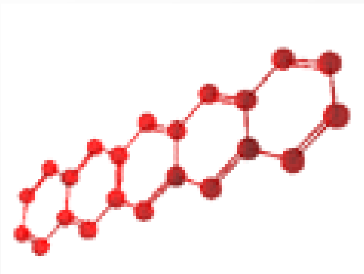
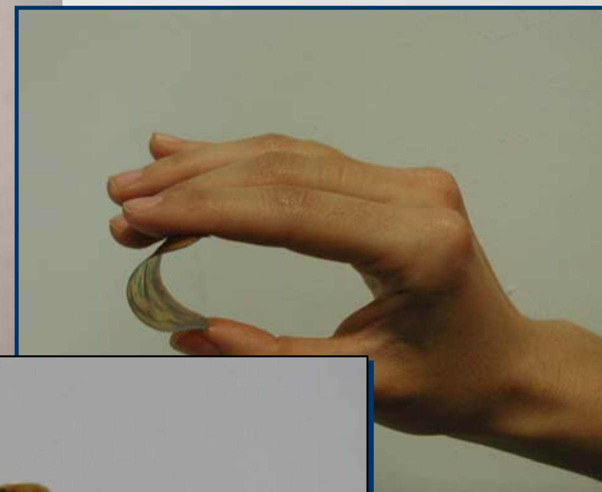
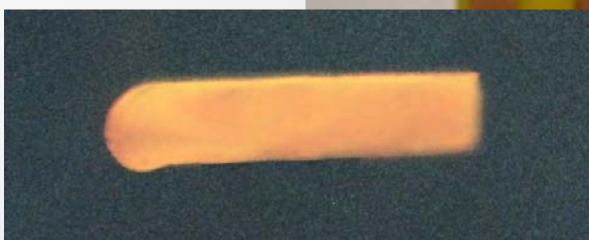
ORGANIC SEMICONDUCTORS

Organic electronic and optoelectronic devices







OLED

ORGANIC TRANSISTORS

PRINTED ANTENNAS

CARBON NANOTUBES

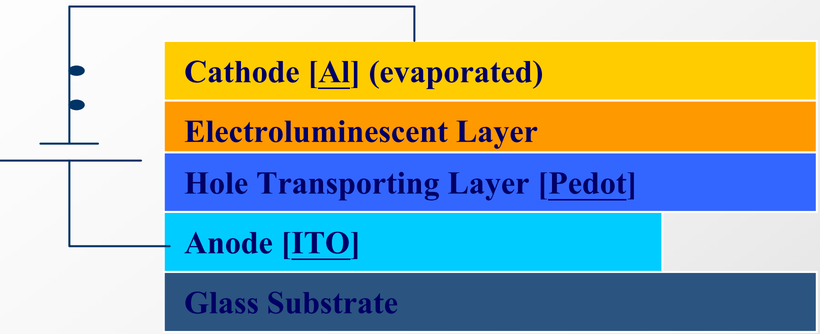
ORGANIC PHOTODETECTORS

Source: A. Di Carlo, Uni. Rome Tor Vergata

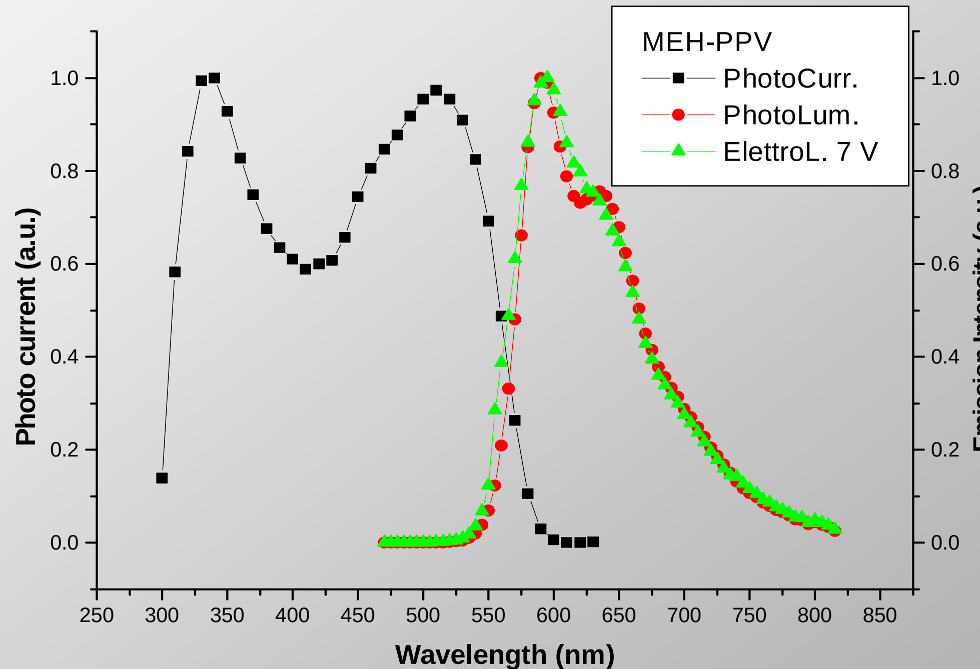
Pros and cons of Organic Electronic

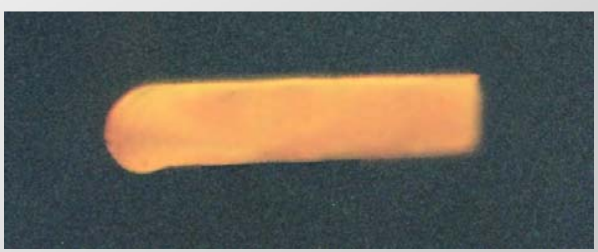
- **Organic devices are devices that use organic molecules rather than inorganic semiconductors for their active material. This active material can be composed of a wide variety of molecules.**
- **<u>The Pros</u>**
  - **compatibility with plastic substances**
  - **lower temperature manufacturing (60-120° C)**
  - **lower-cost deposition processes such as spin-coating, printing, evaporation**
  - **less need to worry about dangling bonds makes for simpler processing**
  - **flexible and large area devices.**
- **<u>The Cons</u>**
  - **lower mobility and switching speeds compared to silicon wafers**
  - **usually do not operate under inversion mode (more on this later)**

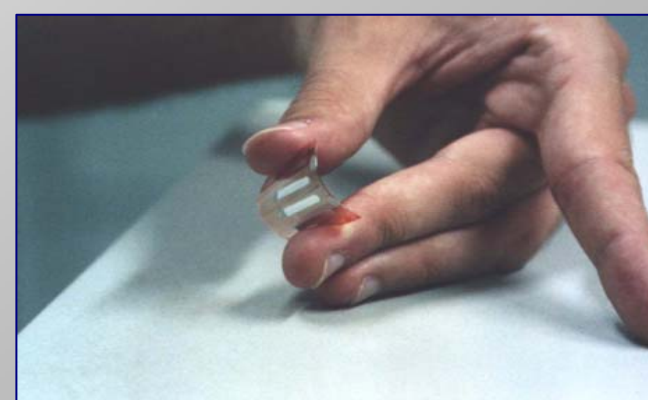
Organic LED



Section







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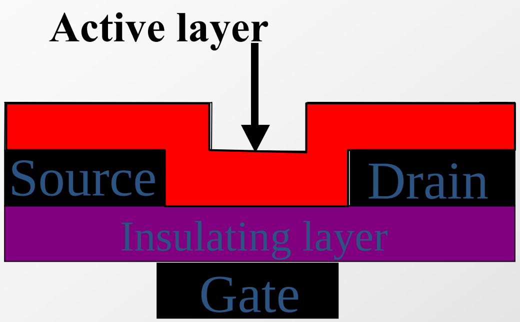
Organic Solar Cell (DSC)

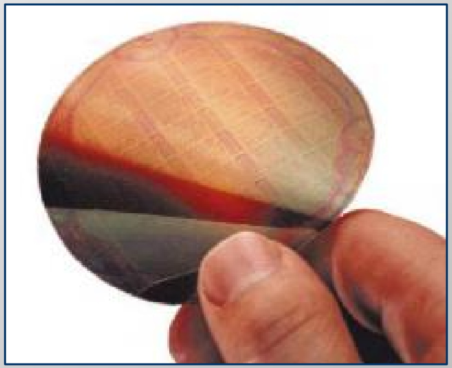
Different kind of organic Transistors

Organic Thin Film Transistors

Hybrid organic transistors

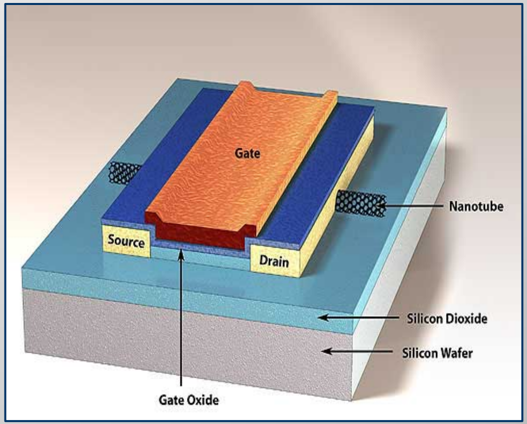


All organic flexible transistors

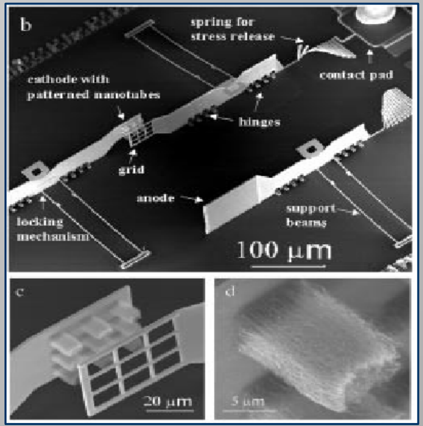


Carbon nanotube based transistors

Based on a single nanotube



Based on array of nanotubes



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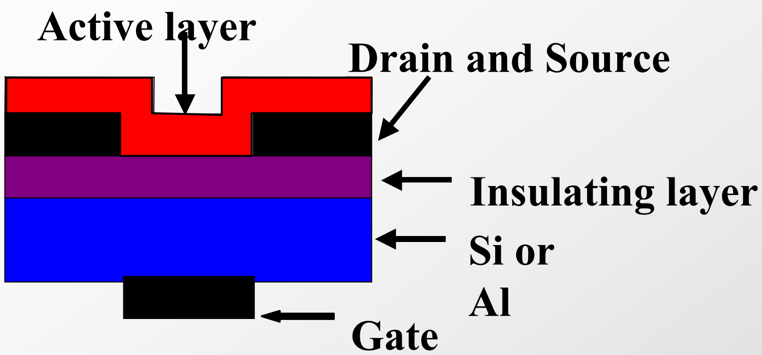
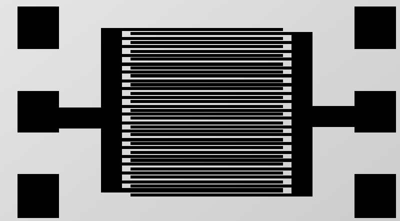
Organic thin film transistors (OTFT)

Overview



$$I_{DS} = \mu_{FE} \frac{W}{2L} \frac{\varepsilon_0 \varepsilon_r}{d} \left[\left(V_{GS} - V_{TH} \right)^2 \right]$$

Material	formula	Kox
Silicon oxide	SiO_2	3,9
Niobium oxide	Nb_2O_5	41
Aluminum oxide	Al_2O_3	9
tantalum pentoxide	Ta_2O_5	25
zirconium oxide	ZrO_2	25

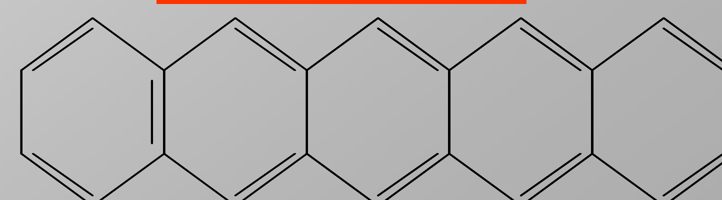


Drain and Source contacts (evaporated):

Spacing: 7, 10, 20, 40, 60 μm

Thickness: 50Å Cr / 600Å Au

Pentacene



Aldrich

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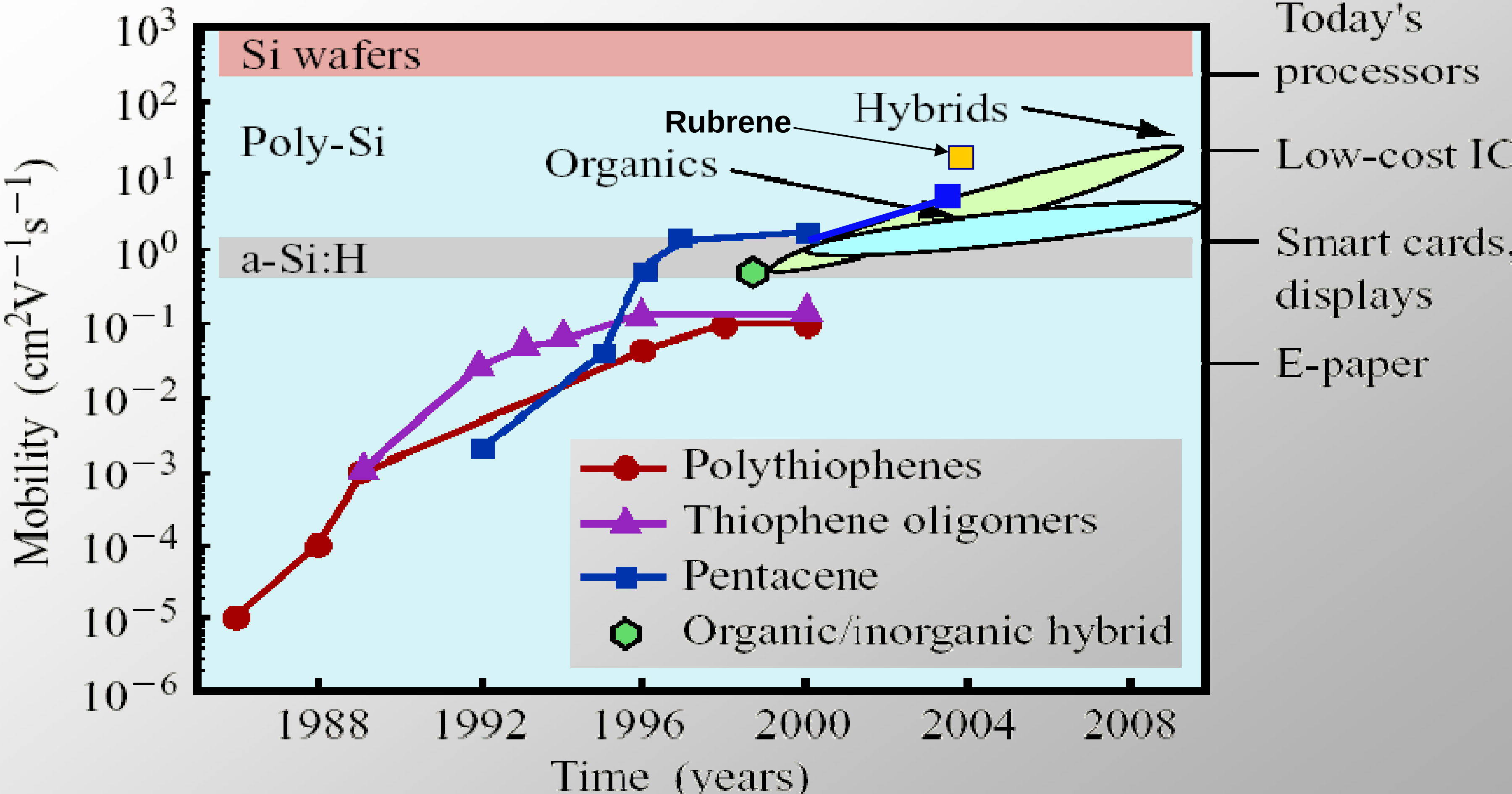
OTFT: materials & performances



Mobilities of organic semiconductors have improved by five orders of magnitude over the past 15 years. Large research efforts using materials such as these led to some of this increase.

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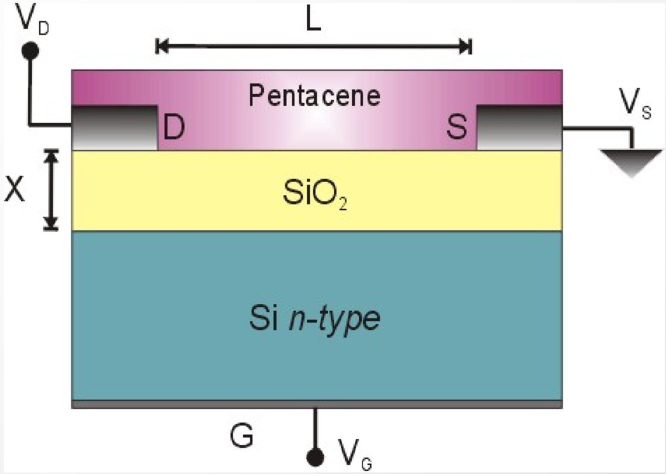
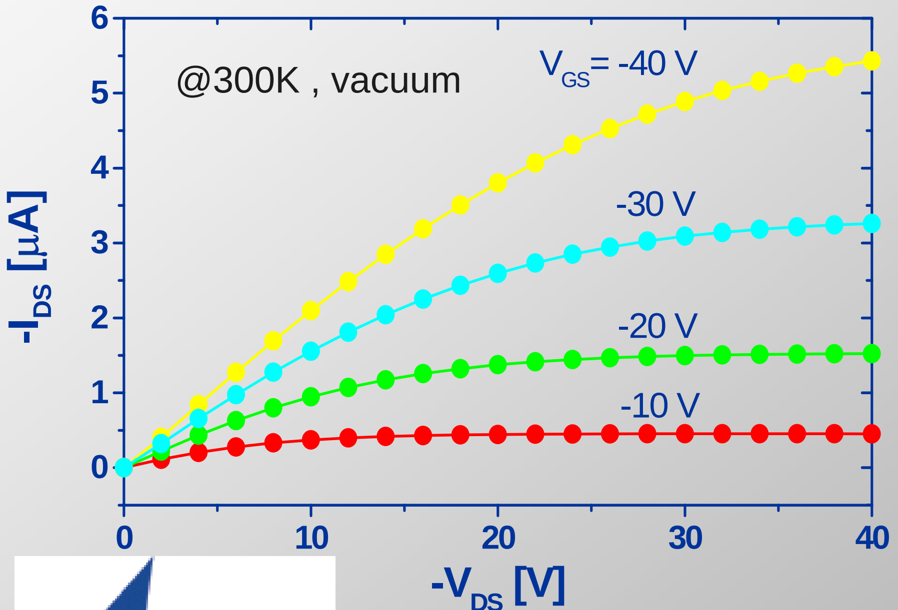
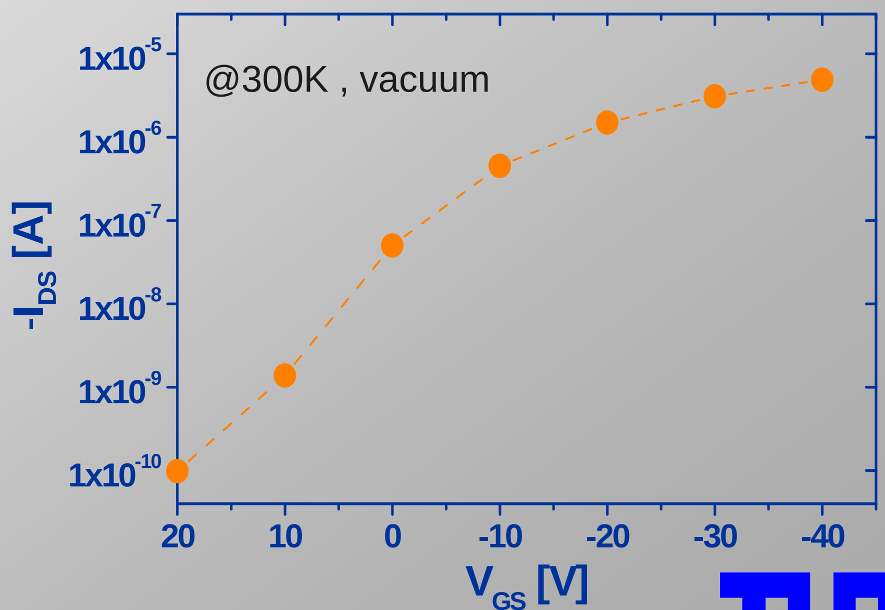
Experimental device



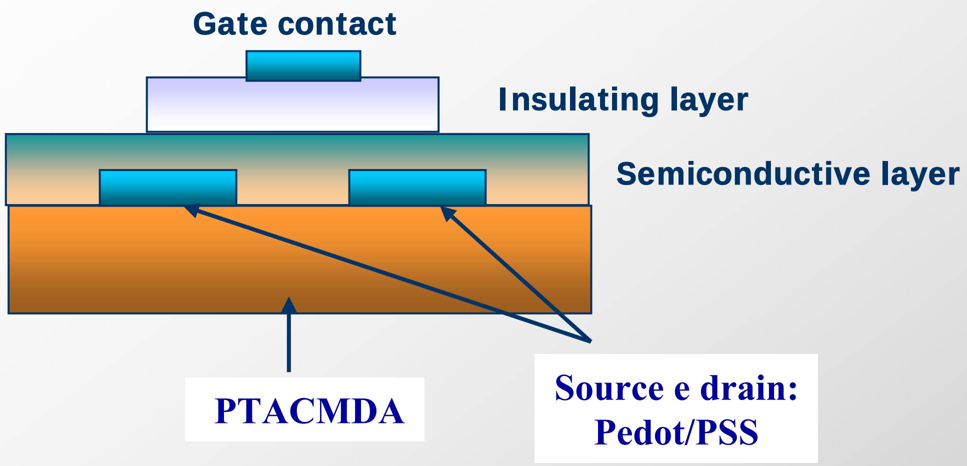
- Thin film transistor were fabricated using bottom contact configuration.
- Au Source/Drain Contact prepared by vacuum evaporation.
- Pentacene sublimated in vacuum at a rate of 0.2 A/sec.

Channel Length L=12μm
Oxide Thickness x=250 nm





All plastic Transistor



- Semiconductive layer: *Pentacene (evaporated), P3BT (spin coated)

- Insulating layer : Poly(vinyl-alchool)(PV-OH) ,Cyanoethylpullulan (CYNPL)

- Gate Contact : PEDOT/PSS spray cast from a solution

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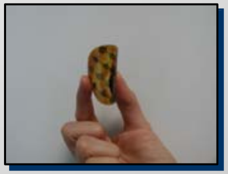
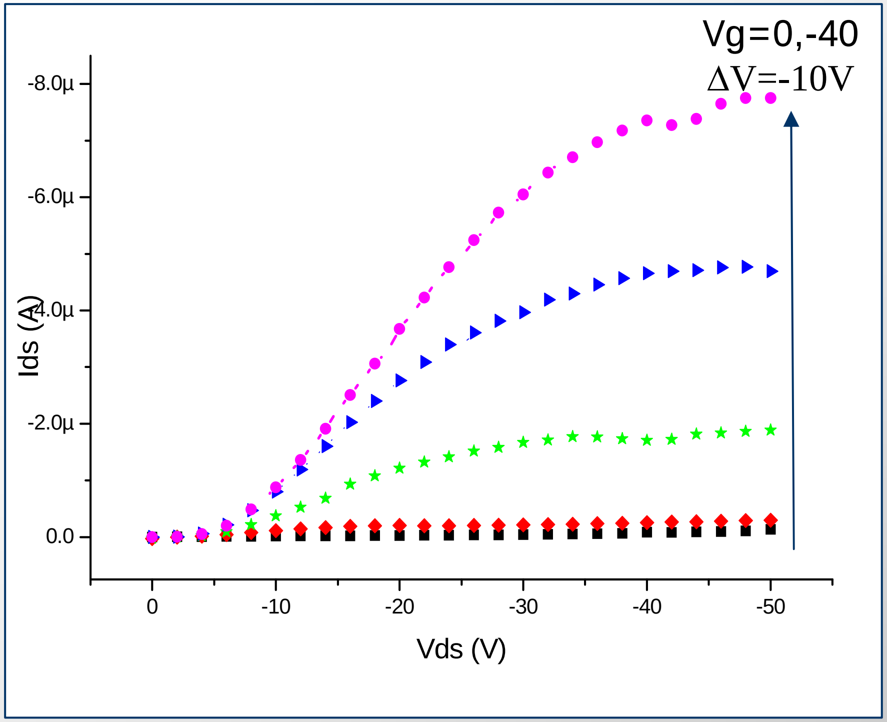
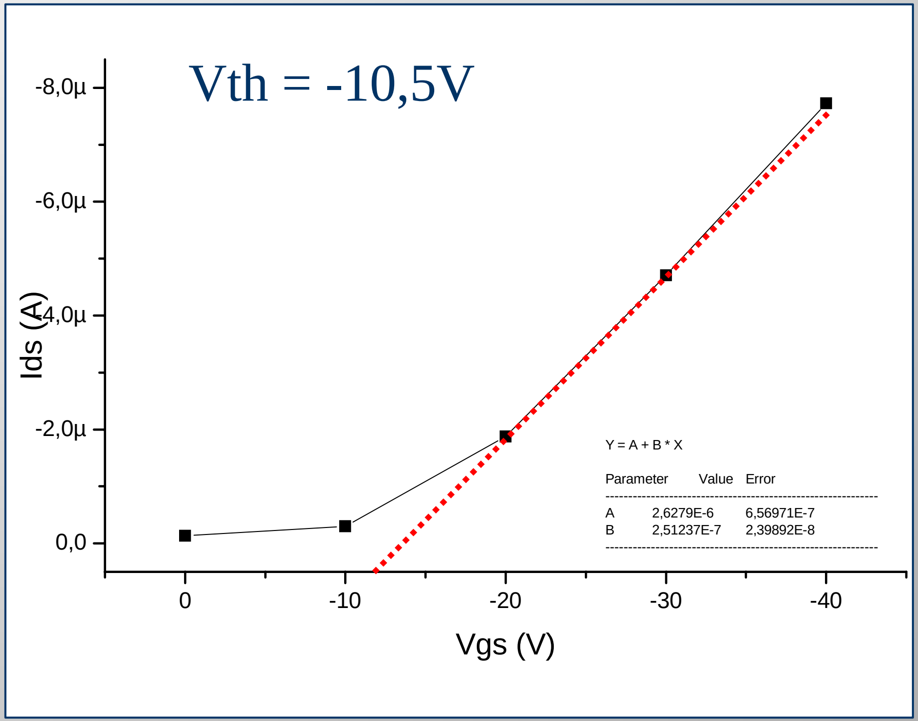
All organic Transistors:Some Results



Output Characteristic



Transfer Characteristic



Dielectric: 600 nm
Pentacene: 30 nm
Gate in Pedot: 100nm
Channel length: 40 µm
W/L=125

μ= 0,016 cm^2/Vs

@ Vgs=-50V

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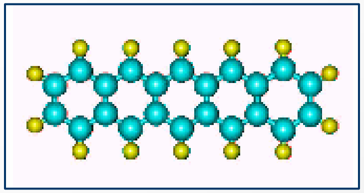
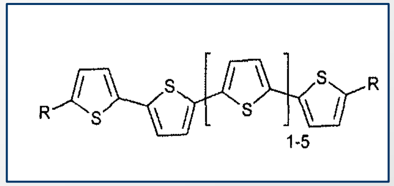
All organic Transistors : different materials

Semiconductive layers

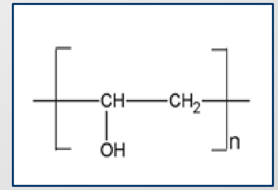


Pentacene

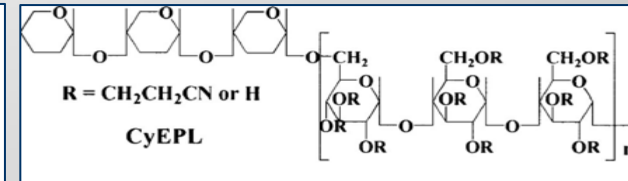


P3BT

Dielectric layers



PVOH

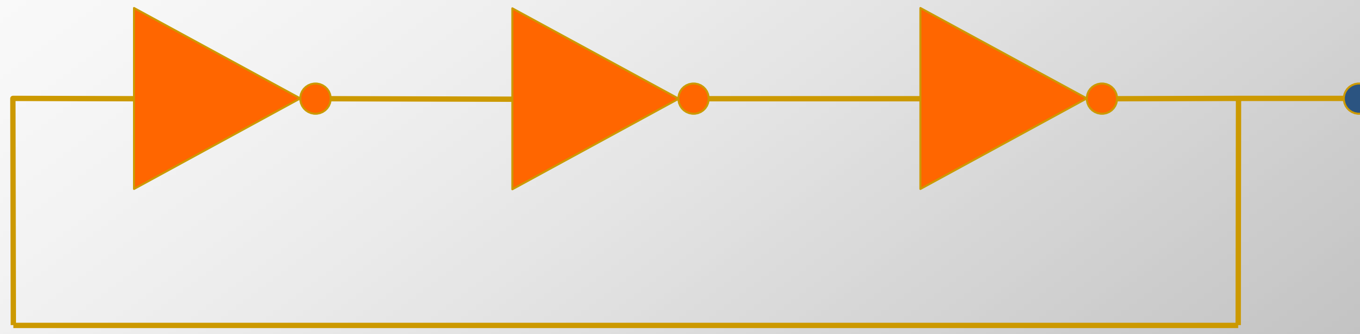


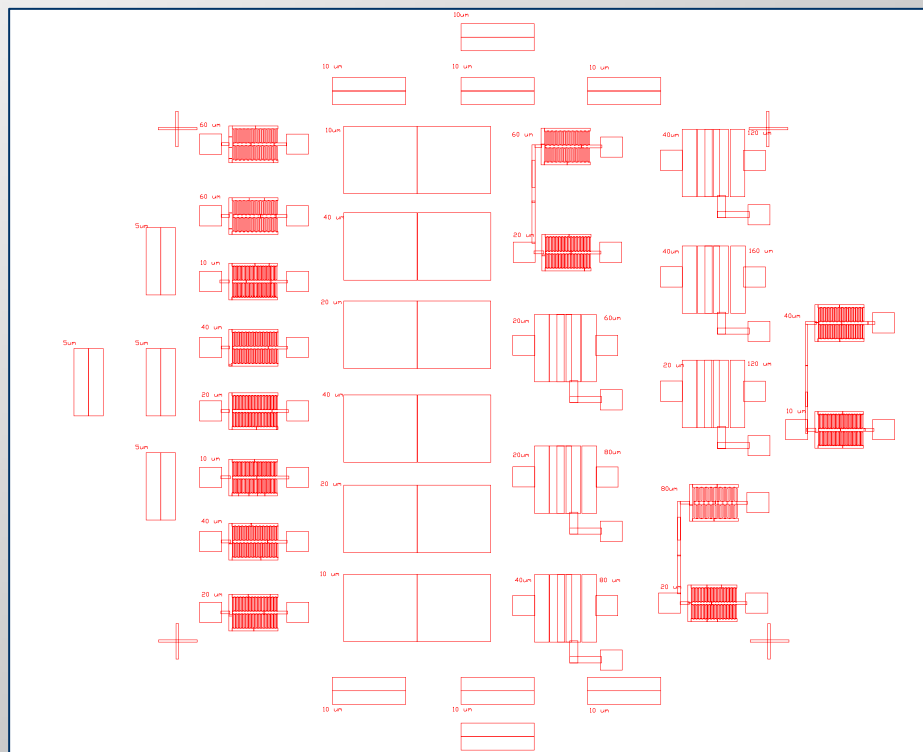
CYEPL

Semiconductor	Dielectric	Max out current
Pentacene	PVOH	~2 μA
P3BT	PVOH	~0,16 μA
P3BT	CYEPL	~0,8 μA

Logic Circuits

Ring Oscillator





Smart clothes