Transport Measurement

Measuring charge mobility in thin film field effect transistors

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Physics 211A

12/11/14

Mobility μ

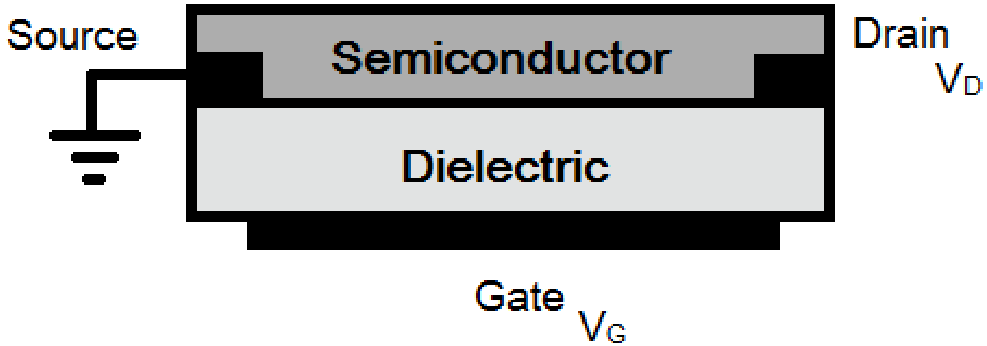
cm^2/Vs

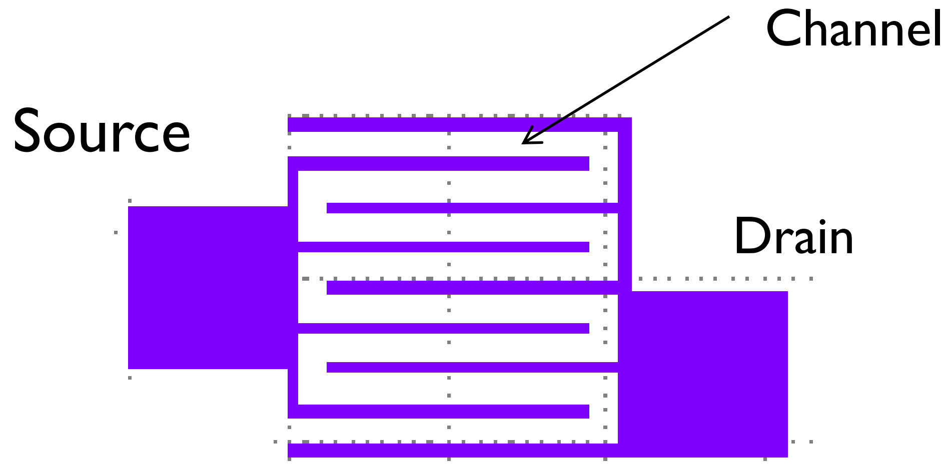
$$v_d = \mu E$$

Conductivity σ

$$\sigma = nq\mu$$

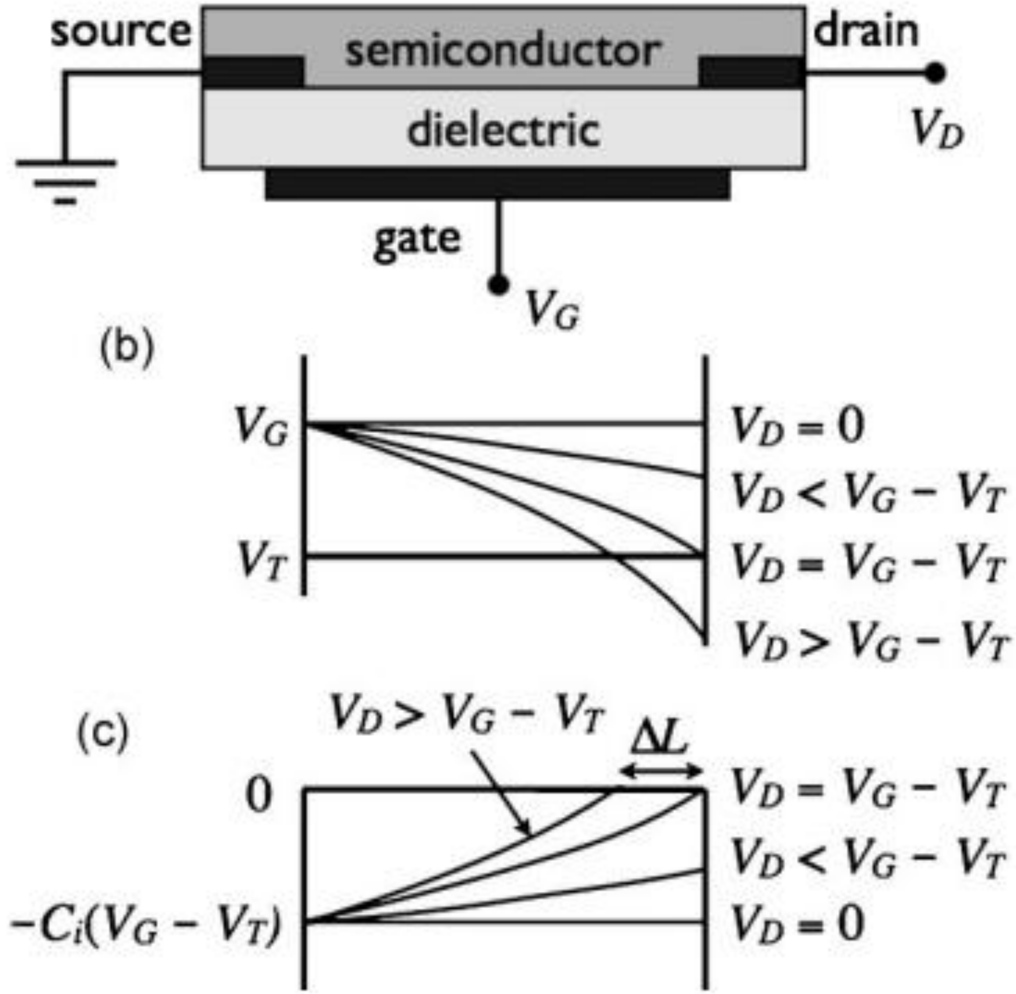
Field Effect Transistor Schematic





Increases Channel Width

Interdigitated Source/Drain Electrodes on thin film

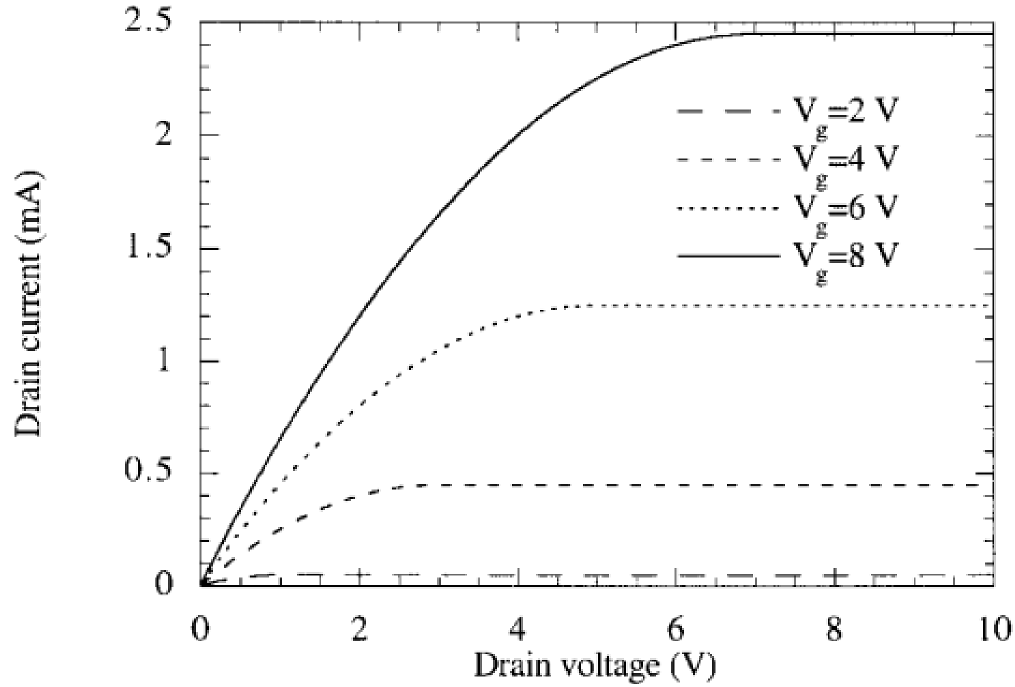


D. Braga, G. Horowitz, Adv. Materials 2009, 21, 1473

- For Vd > Vg – Vt , The drain current saturates and becomes fairly constant

- For Vd <Vg – Vt , The drain current scales linearly with voltage

- This creates linear and saturation regimes



G. Horowitz, Adv. Matterials, 1998, 10, No. 5

Linear Regime
Vd < Vg – Vt

$$I_D = \frac{W}{L} C\mu \left(V_G - V_T - \frac{V_d}{2} \right) V_d$$

Saturation Regime
Vd > Vg - Vt

$$I_{Dsat} = \frac{W}{2L} C\mu (V_G - V_T)^2$$

C = Effective Capacitance
W = Channel Width
L = Channel Length

D. Braga, G. Horowitz, Adv. Materials 2009, 21, 1473

Extracting the mobility

Saturation Regime

$$\sqrt{I_{Dsat}} = \sqrt{\frac{W}{2L} C\mu} \left(V_G - V_T \right)$$

Linear Regime

Calculate the Transconductance gm

$$g_m = \frac{\partial I_D}{\partial V_G} = \frac{W}{L} C\mu V_D$$

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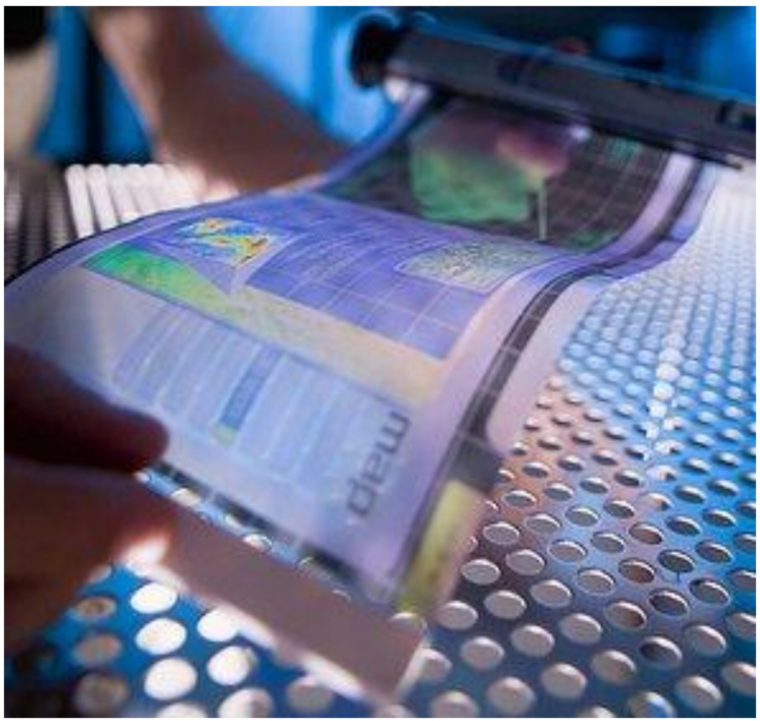
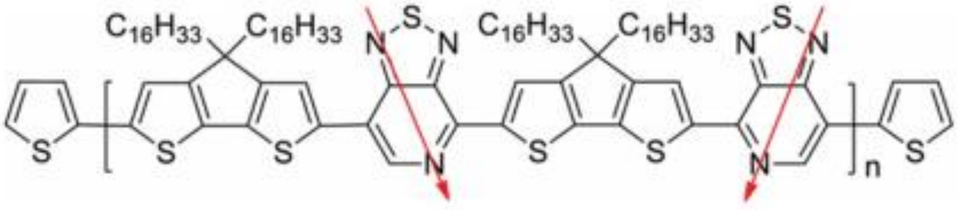
Organic Semiconductors



OFET – based flexible display

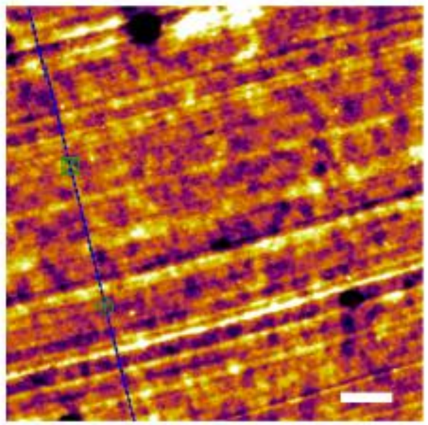
- Organic Field Effect Transistors
- Flexible ‘plastic’ electronics
- Cheap alternative for photovoltaic cells

http://en.wikipedia.org/wiki/Organic_field-effect_transistor



Polymer Chain

b



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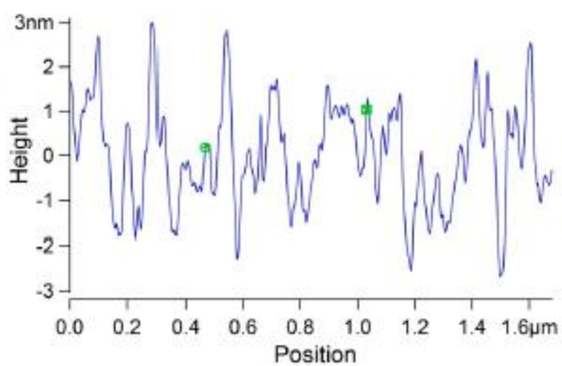

- Cut nano-spaced grooves in substrate to align long molecule chains
- Measured Mobility of 23.7 cm^2 /Vs
- Order of Magnitude greater than previous fabrications

A. Heeger, Adv. Materials, 2014, 26, 2993