

Pentacene-based organic transistors

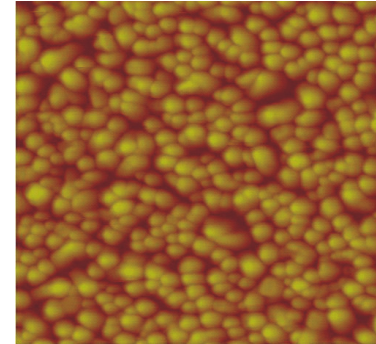
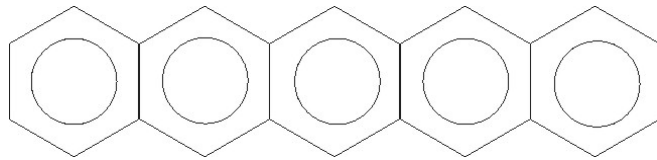
Dan Kolb

Molecular Electronics and Microsystems Stream

Background

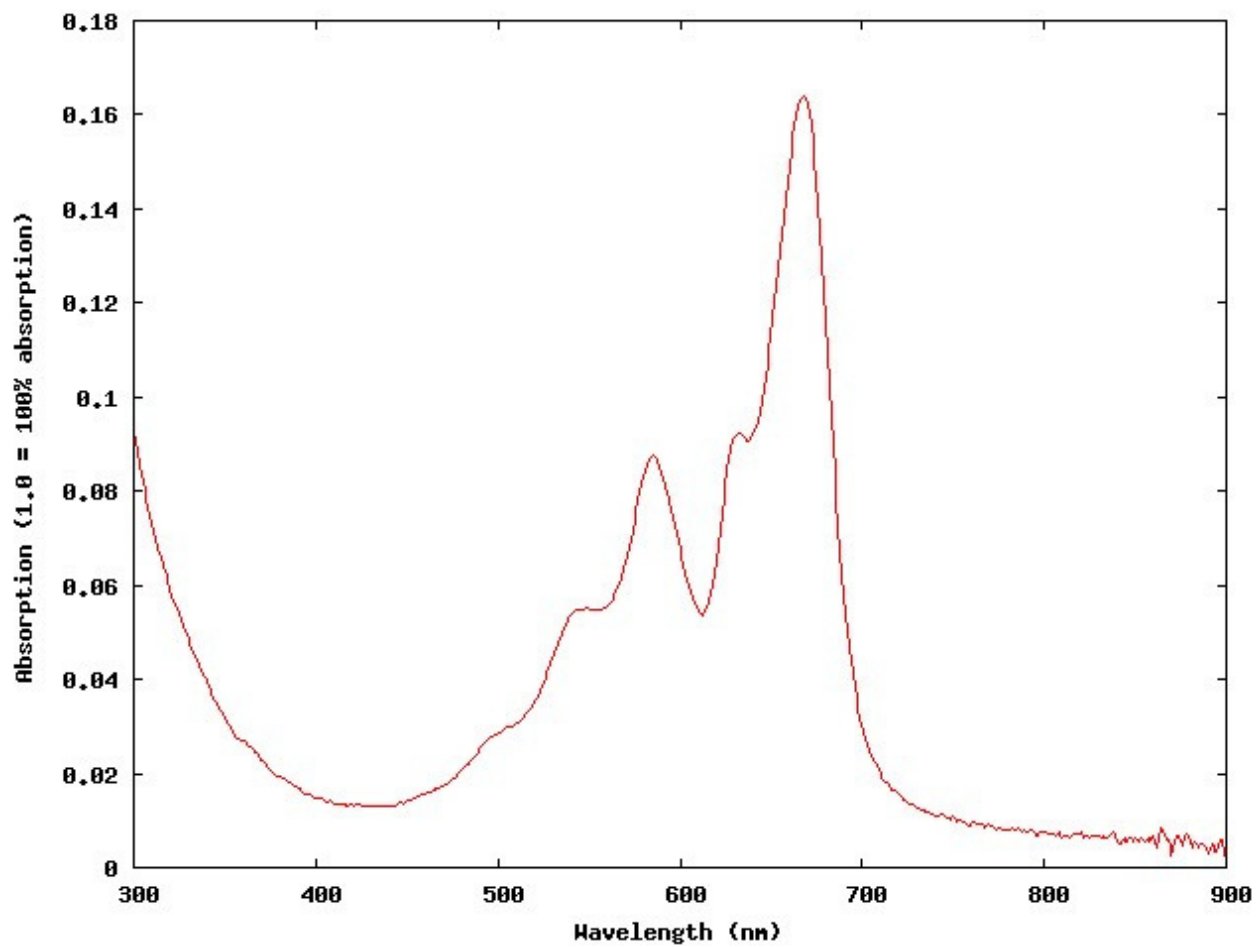
- Conductive plastics first discovered in late 1970s, principally by Alan J. Heeger, Alan G. MacDiarmid and Hideki Shirakawa; awarded Nobel Prize in Chemistry in 2000
- Lighter, more flexible, (often) less expensive than inorganic semiconductors
- Slower than Silicon; better for niche applications; won't replace Si for high-speed applications
- Applications include smart windows, electronic paper, RFID tags, etc.

Pentacene



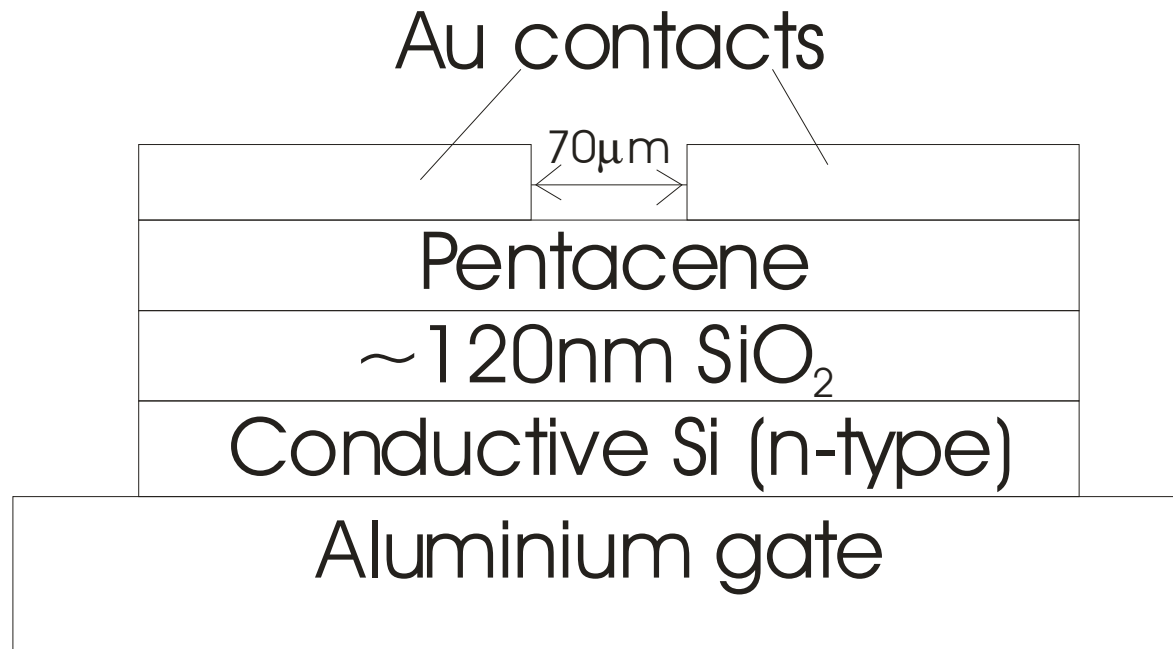
- p-type semiconducting material
- Charge carriers arise from π -bonds
- Direct sharing of electrons between atoms' p orbitals; hence electrons can be mobile

Pentacene



Research Day 2005

Transistor Structure

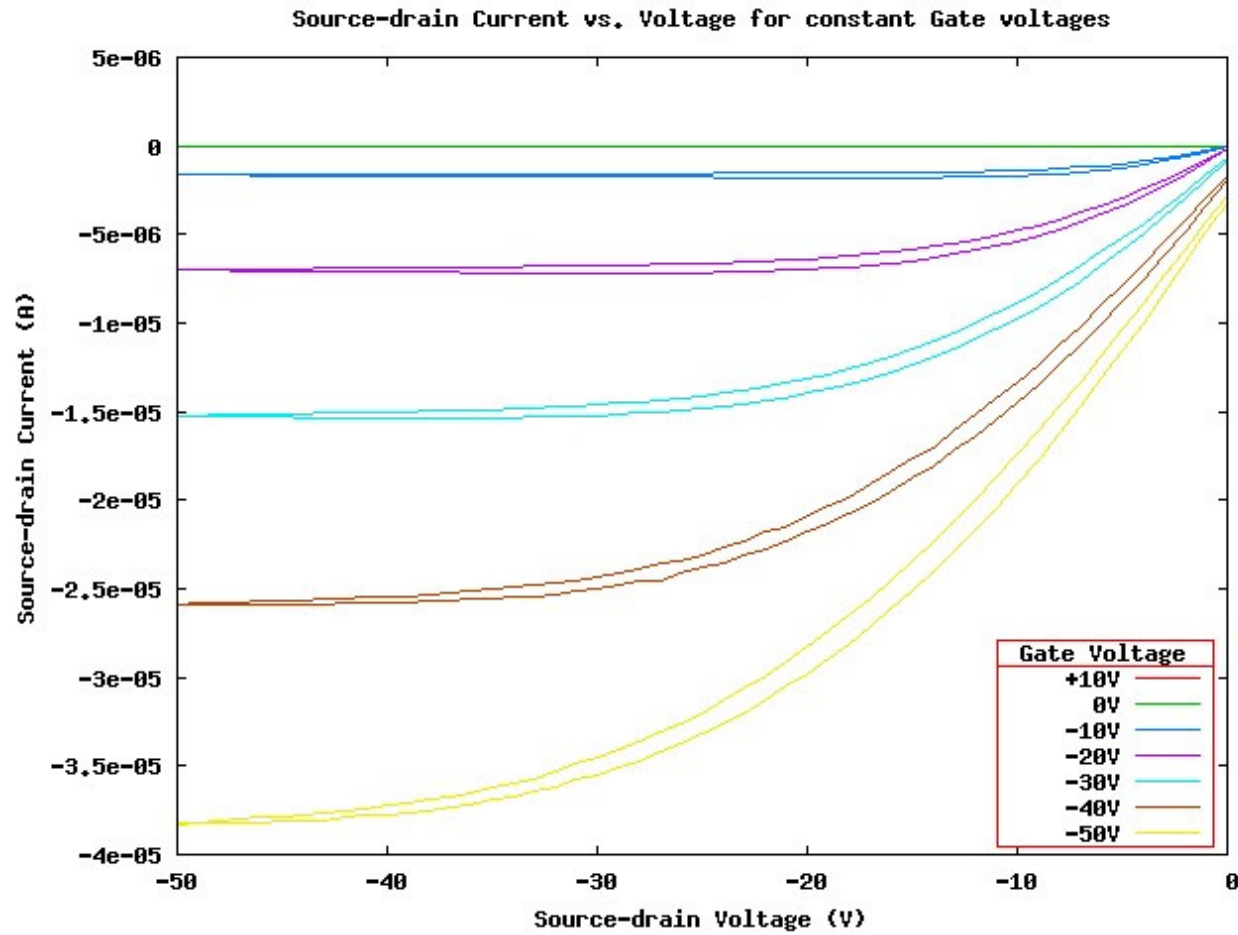




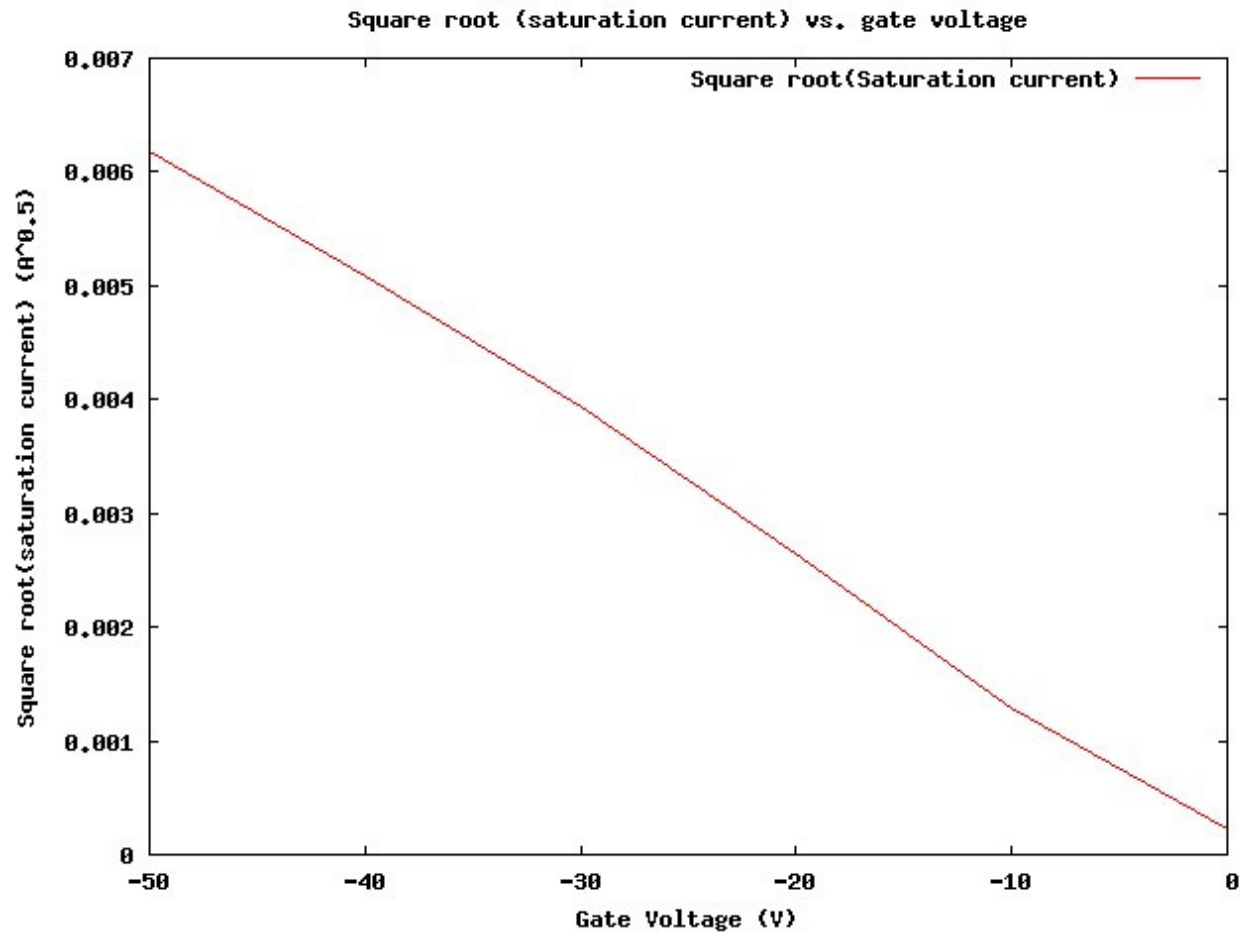
Transistor fabrication

- Clean Si wafer in H_2SO_4 / H_2O_2 mix
- Etch in HF to remove any SiO_2
- Grow $\sim 120\text{nm}$ SiO_2 in furnace with dry oxidation
- Treat SiO_2 with DMDS
- Evaporate pentacene under vacuum
- Evaporate gold through shadow mask to form top contacts
- Expose Si underneath wafer; use silver paste and Al foil to provide gate contact

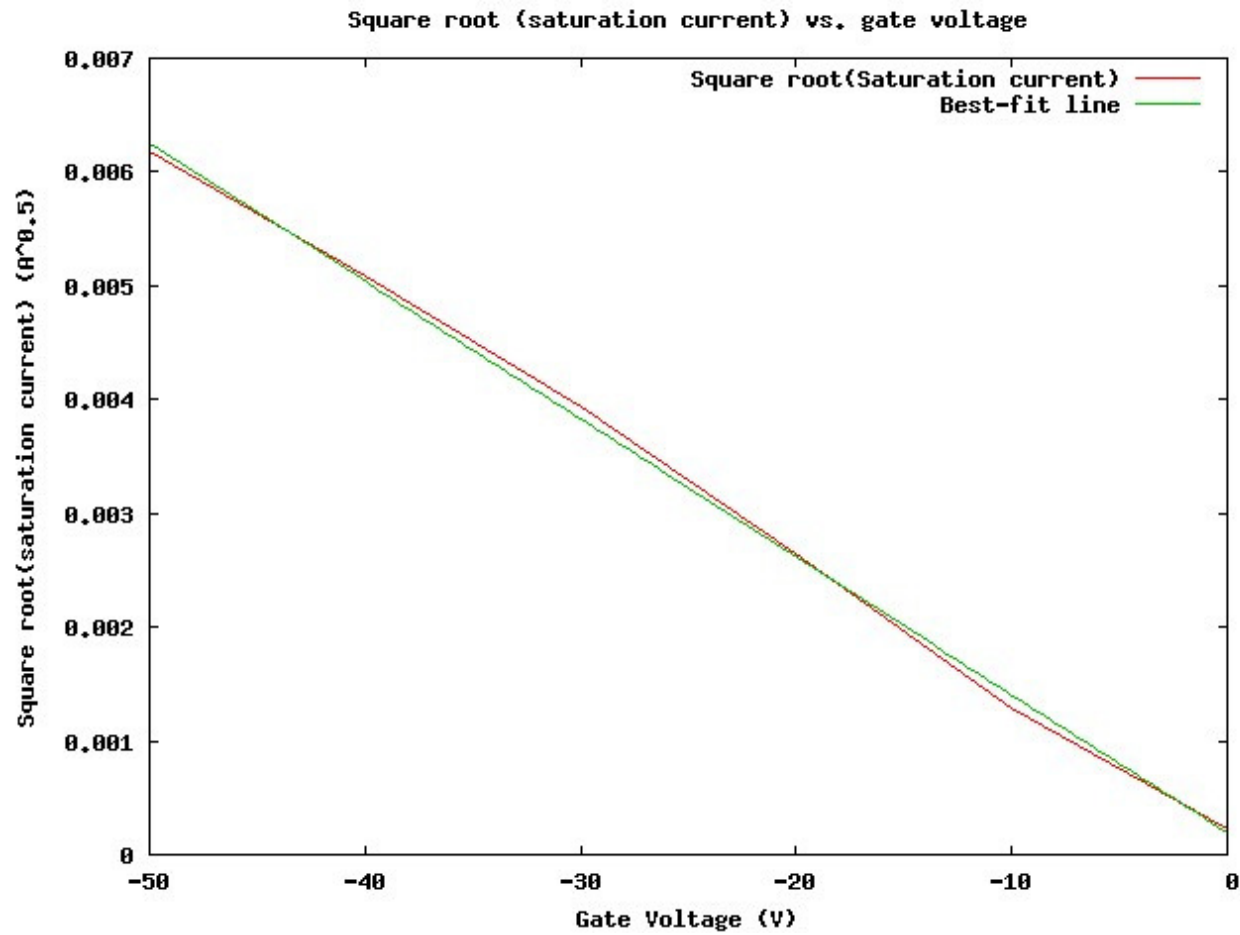
Results



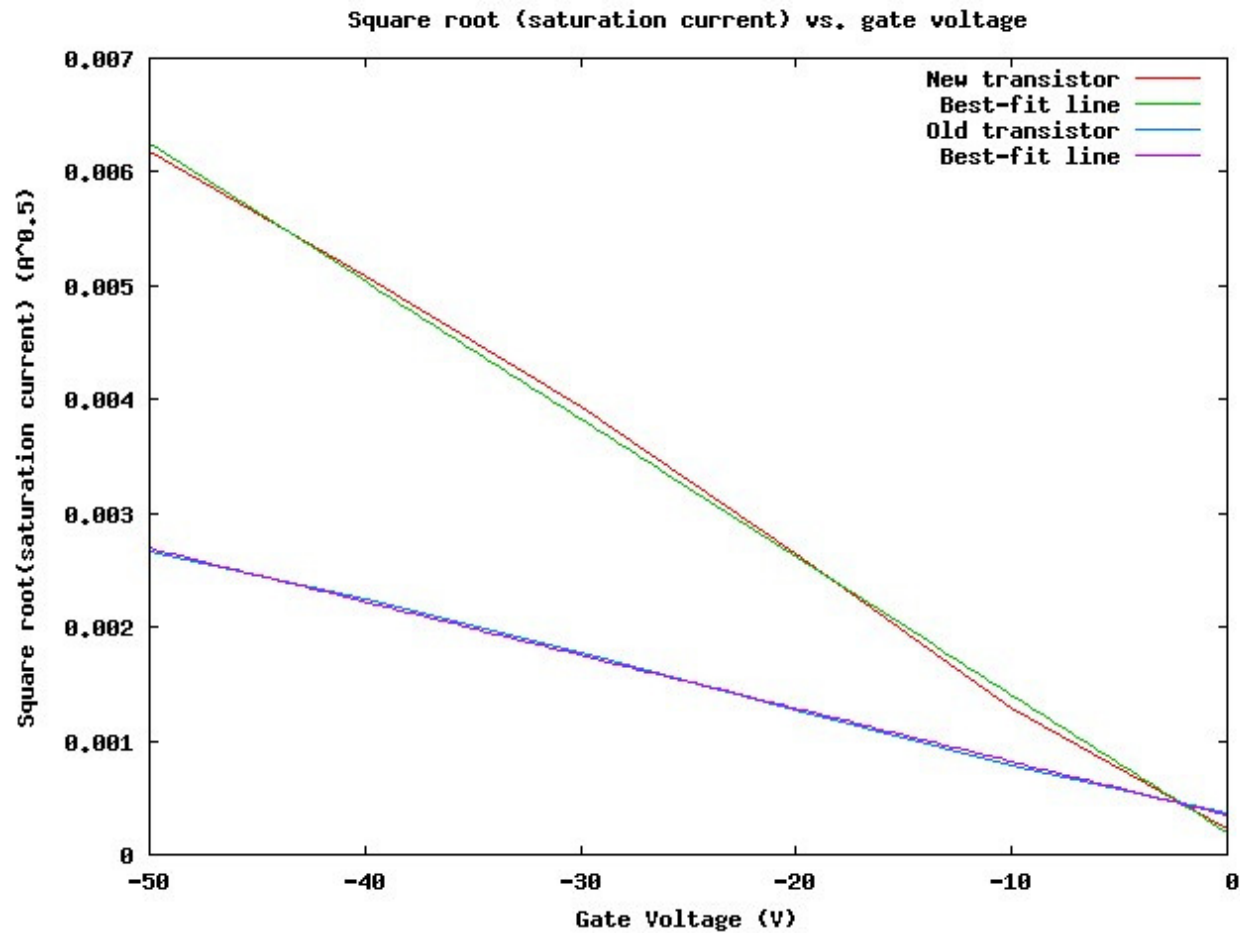
Results



Results



Results



Further Work

- Use top-contacts for gate
- Compare with bottom-contact devices (semiconductor on top of contacts)
- Alternate dielectrics
- Alternate semiconducting material (n-type semiconductors)