

Organic Semiconductors for Future Space Applications

Conjugated Polymers

Gustaf Winroth

Dept. of Physics & Astronomy

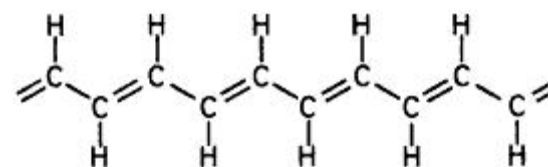
University College London

Outline

- Introduction to Conjugated Polymers
- My PhD-project – Polyrotaxanes & threaded molecular wires
- Today's devices
 - Advantages/disadvantages
- Devices for space apps in the future

Conjugated Polymers

- Iodine-doped polyacetylene, $4 \cdot 10^5$ S/cm close to a single crystal of copper
- Alternating pi-bonds conduct electrons, when backbone is not twisted
- Side groups dope the material, both p- and n-doping
- Band gaps of a few eV's

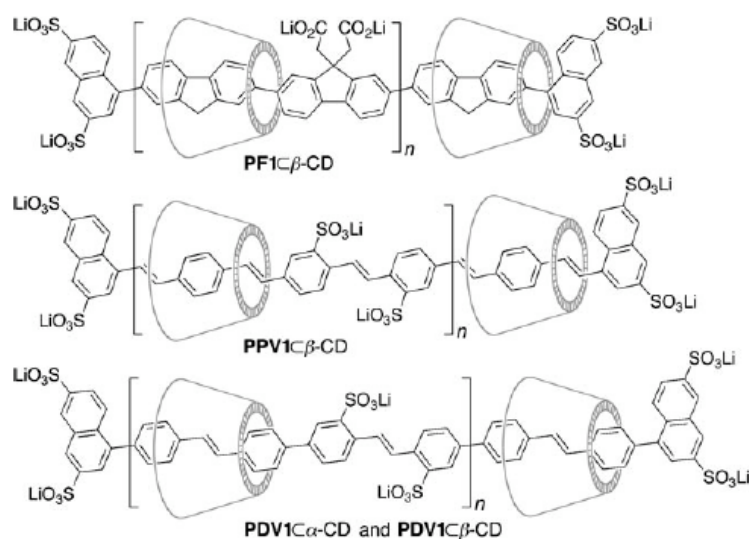


***trans*-polyacetylene**

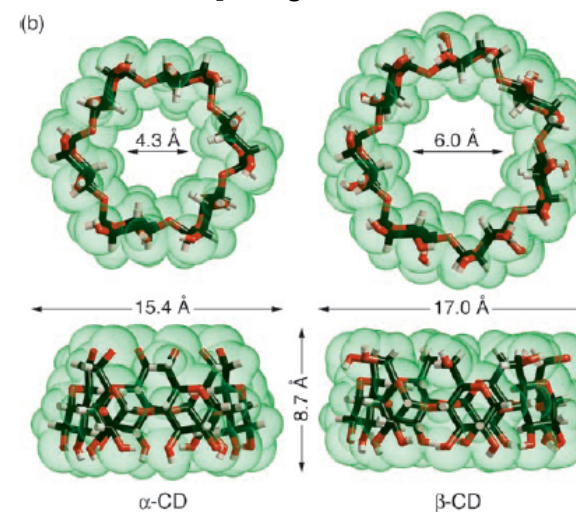
R.H. Friend et al., (1985), Phil. Trans. R. Soc. Lond.
A 314, 37-49

My Subject - Polyrotaxanes

- Insulated polymer chains by sugar molecules, such as cyclodextrin derivatives
- Better efficiency, easier to align since the structure is more rigid, more stable, can build long fibers



α - and β -cyclodextrin

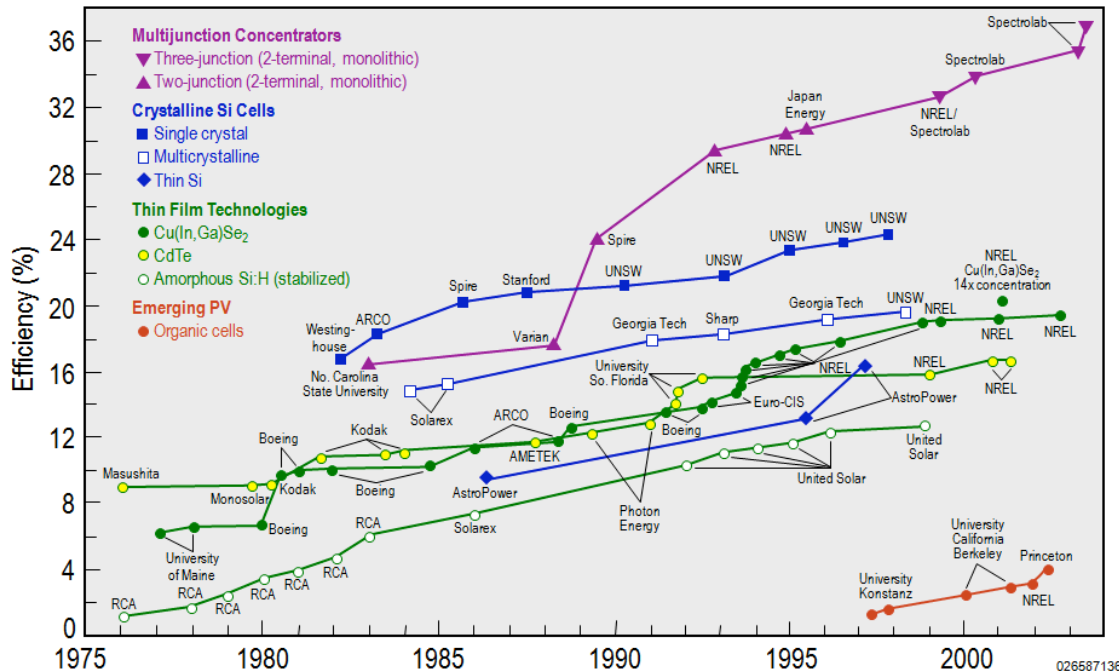


Polyfluorene, poly(phenylenevinylene), poly(4,4'- diphenylenevinylene)

M.J. Frampton, Anderson, H., (2007), *Angew. Chem. Int. Ed.*, **46**, 1028 – 1064

Devices today

Best Research-Cell Efficiencies

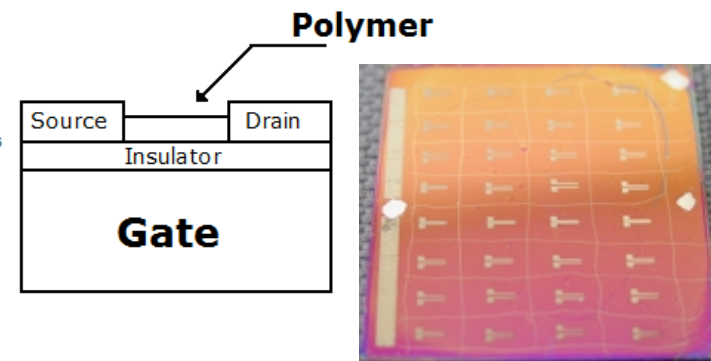


Efficiency of Solar Cells

NREL – www.nrel.gov/pv/thin_film/docs/kaz_best_research_cells.ppt



OLED TV displays
Sony Corporation - CES 2007



Organic Field Effect Transistor

www.isotec-cluster.at

Possibilities/Limitations (1)

- Advantages
 - Low cost
 - » Non-costly production steps (more environmentally friendly)
 - Solution based
 - » Spincoating
 - » Easy to make blends
 - Flexible films
 - » Foldable
 - Lightweight
 - » Cover large areas
 - » Easy handling



Foldable image scanner
New Scientist, Dec 25, 2004

Possibilities/Limitations (2)

- Disadvantages
 - Short lifetime
 - Can degrade when exposed to light, especially UV-light
 - Temperature sensitive – more than the inorganic counterparts
 - Efficiencies not even close to efficiencies measured in inorganic devices
 - Charge transfer mechanisms not well known

Devices for Space tomorrow (1)

- Power Supply
 - Foldable large area solar cells
 - Ultrathin electrical circuits

Year of realisation - 2020

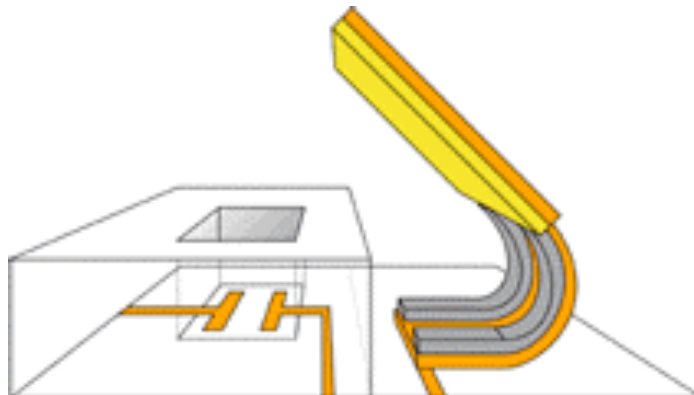


P6 solar array jam on ISS
ESA/NASA, 2006

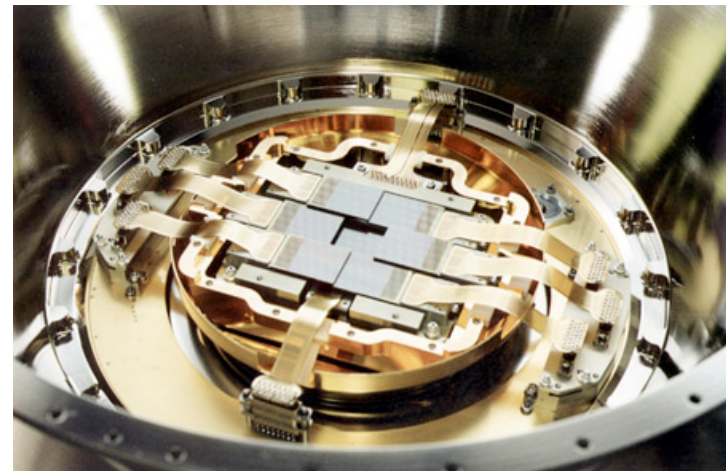
Devices for Space tomorrow (2)

- Organic Cameras in the Visual Spectral Range
 - Large detectable area
 - Dynamic optical corrections

Year of realisation - 2030



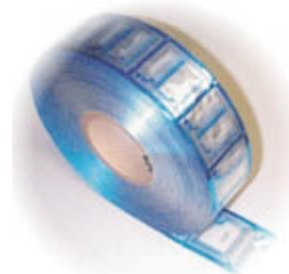
Electromechanics with bilayers
Micromuscle AB



One of the MOS of EPIC
ESA

Devices for Space tomorrow (3)

- Radio communication



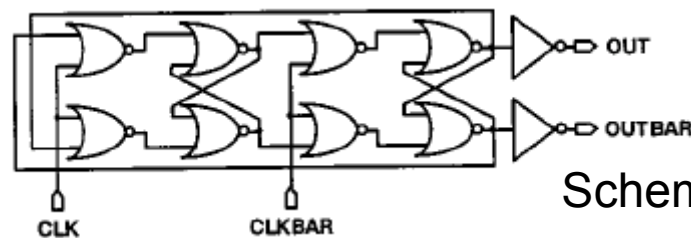
RFID Roll
MobileCommerceNet, 2002

- Batteries

» Polyacetylene batteries described in 1981

(D. MacInnes et al., *J. Chem. Soc., Chem. Commun.*, 1981, 317 - 319)

- Logics



Schematics of a digital circuit

M.G. Kane et al.,

IEEE Electron Device Letters, 21, 11, Nov. 2000

- Etc..

Year of realisation – 2010-15

Thank you for your attention!

