Organic Electronics

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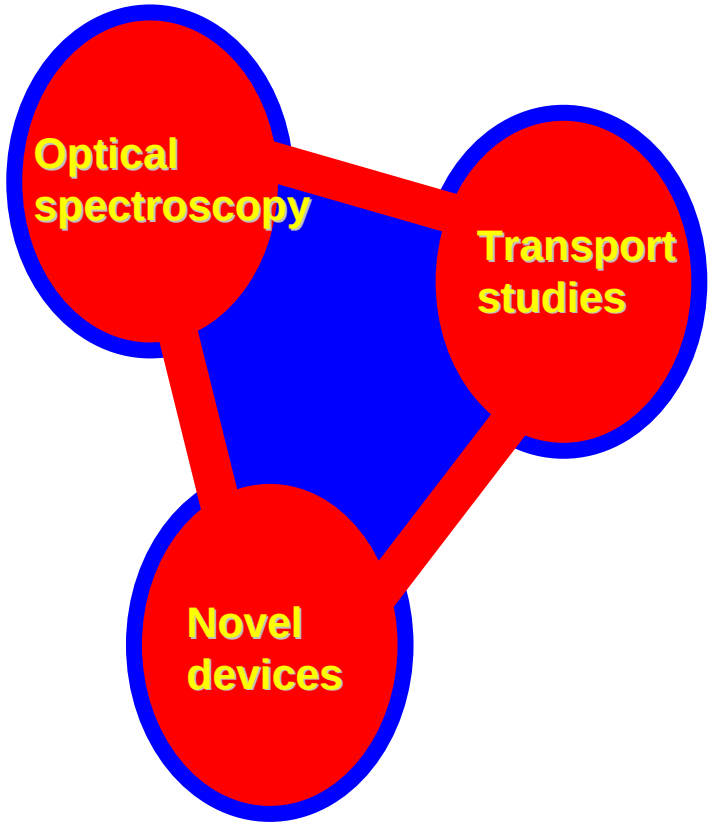
http://www.abo.fi/fak/mnf/fysik/

Our goal

To understand the electro-optical properties of disordered organic materials to be able to demonstrate novel devices

To achieve the goals:

- To achieve the goals we have specialized in the following:
- Transport studies using novel transient techniques
- Electro-Optical characterization of disordered organic materials



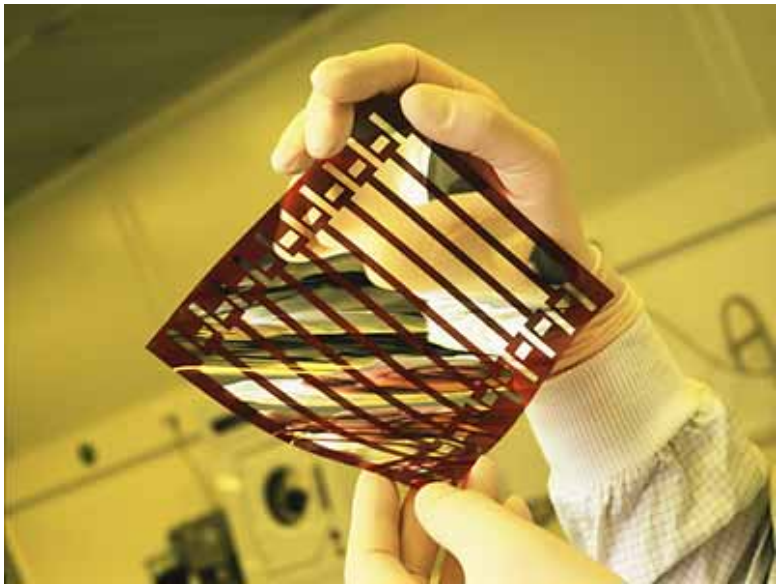
Towards printed organic electronics

- Active electronic components on plastic or fiber based materials
- Novel device concepts needed!
  - Solution processable
  - Simple design
  - Linewidths of >10 μm, avoid critical alignments etc
  - Recyclable or disposable
- All components needed for stand-alone operation
  - Power supplies, transistors, memories, output
- Low-voltage operation needed
- Plastic electronics will never replace Silicon!

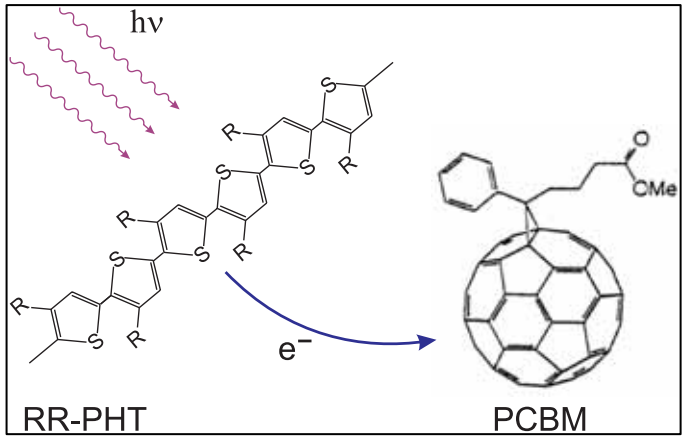
What have we done?

1) Plastic Solar Cells

Partner V



http://www.konarkatech.com



Today η >5%

The goal is to understand **transport** and **recombination** of photogenerated charge carriers

A. Pivrikas, Phys. Rev. Lett., **94** 176806 (2005)
G. Juska et al., Appl. Phys. Lett. (2005)
A.J. Mozer et al., Phys. Rev. B, B, **72**, 035217 (2005)

1) Plastic Solar Cells

Partner V

Efficiency proportional to current

$$j = en\mu E$$

n= carrier density

μ= carrier mobility

e= electron charge

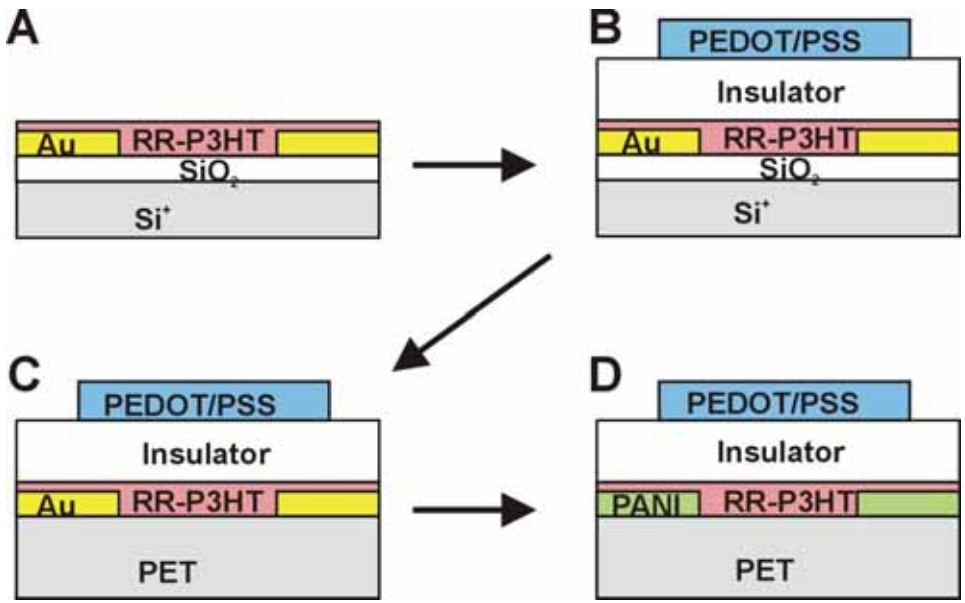
E=electric field

- Organic materials have low mobility leading to higher carrier density!
- Higher density leads to lower carrier lifetime -> Lower current!
- We have shown that recombination can be reduced with a factor of 10 000!
- Reason is the carrier delocalization on the nano-scale!

A. Pivrikas, et al., Phys. Rev. Letters, **94** 176806 (2005)
R. Österbacka et al., Science **287**, 839 (2000)

2) Polymeric transistors

- Replacing inorganic materials with polymeric
- Performance change with materials and processing

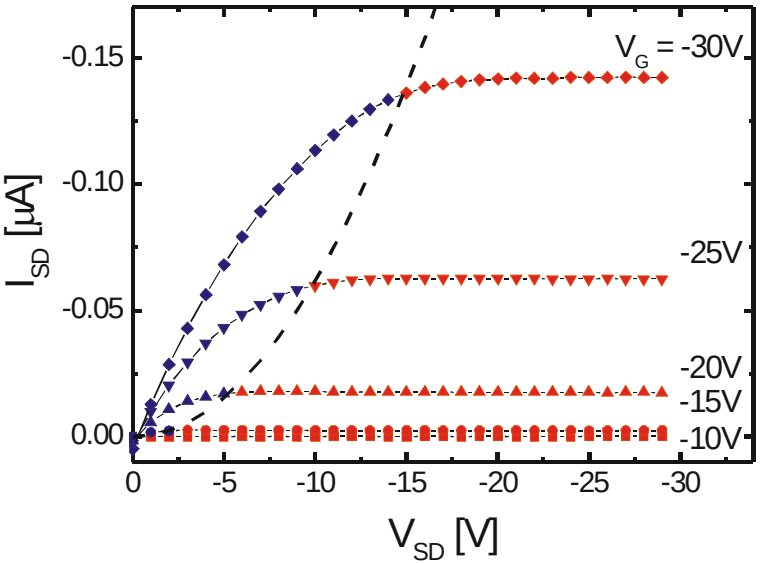


T.G. Bäcklund et al. Synthetic Metals, 148:87-91, 2005.

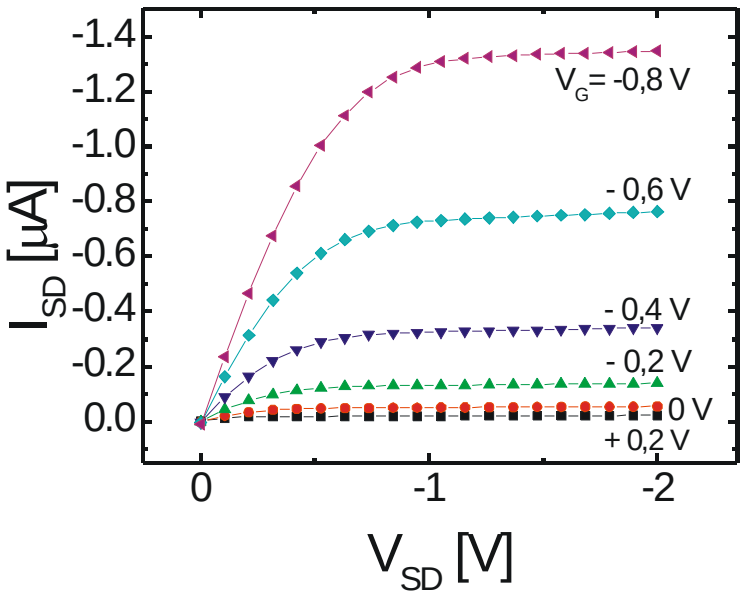
Hygroscopic Insulator FET

Partner V

Traditional OFET



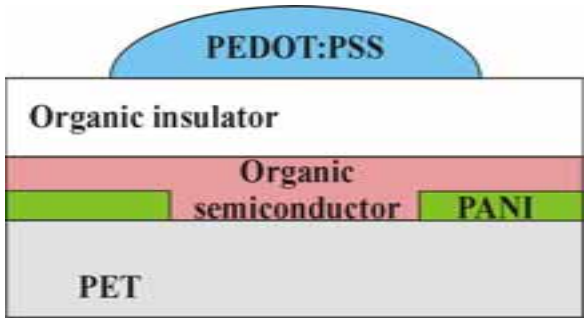
HIFET



Using the hygroscopicity we could:

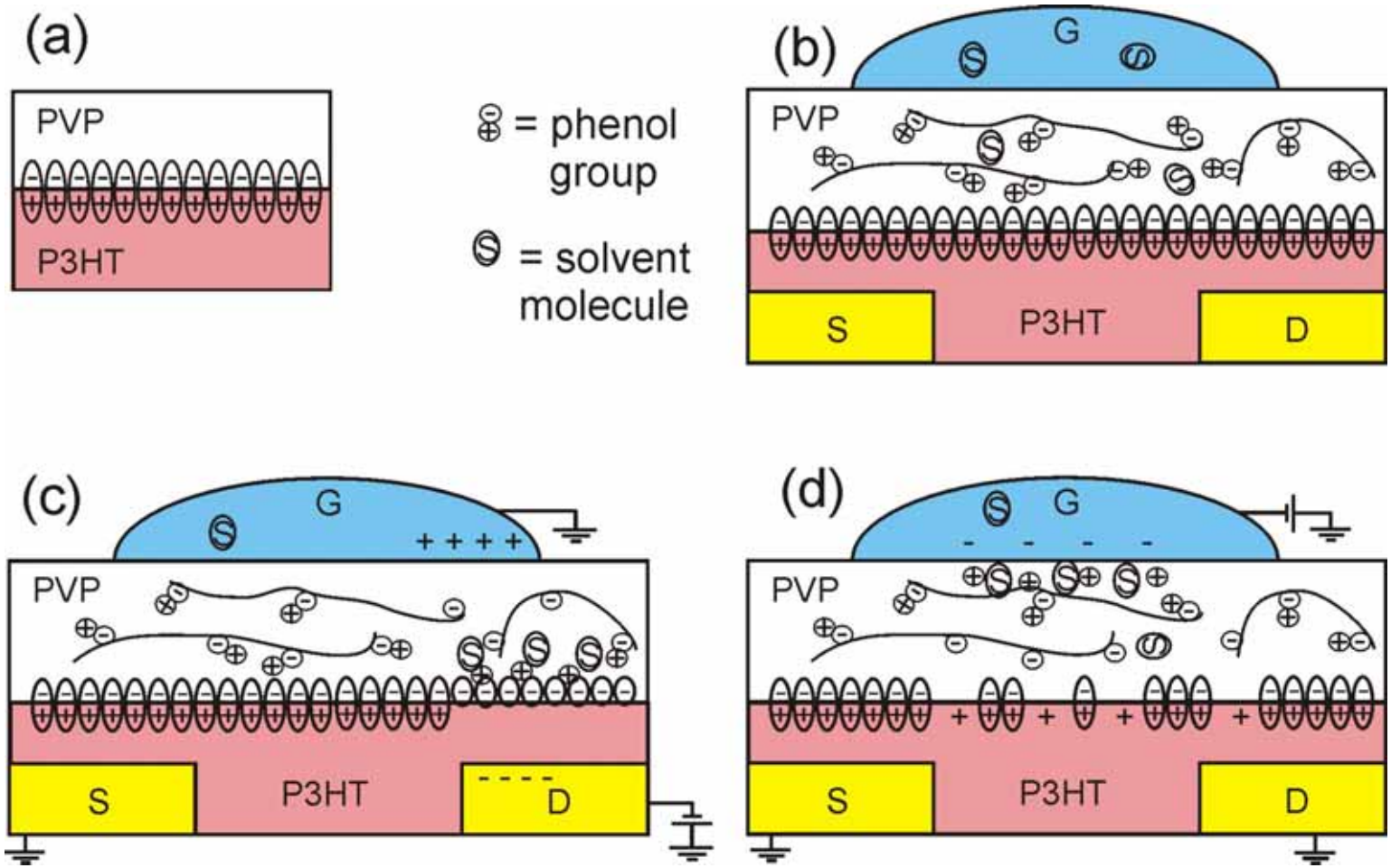
-Lower drive voltages (<1/10)

-Enhance the current levels (>10)



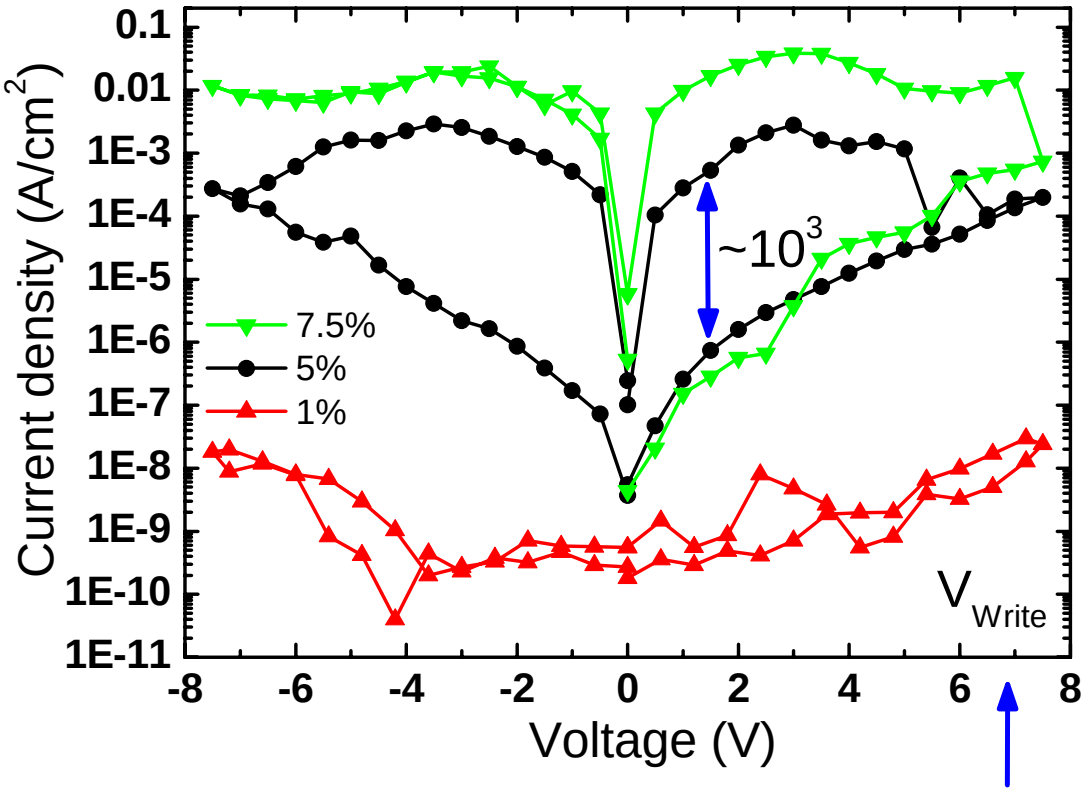
H. G. O. Sandberg et al. Advanced Materials **16**, 1112 (2004)
Finnish patent FI20031435, PCT application filed by Avantone

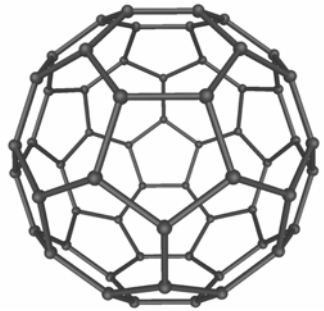
Device model



T. Bäcklund et al., J. Appl. Phys., **98**, 074504 (2005)

3) Novel memory device



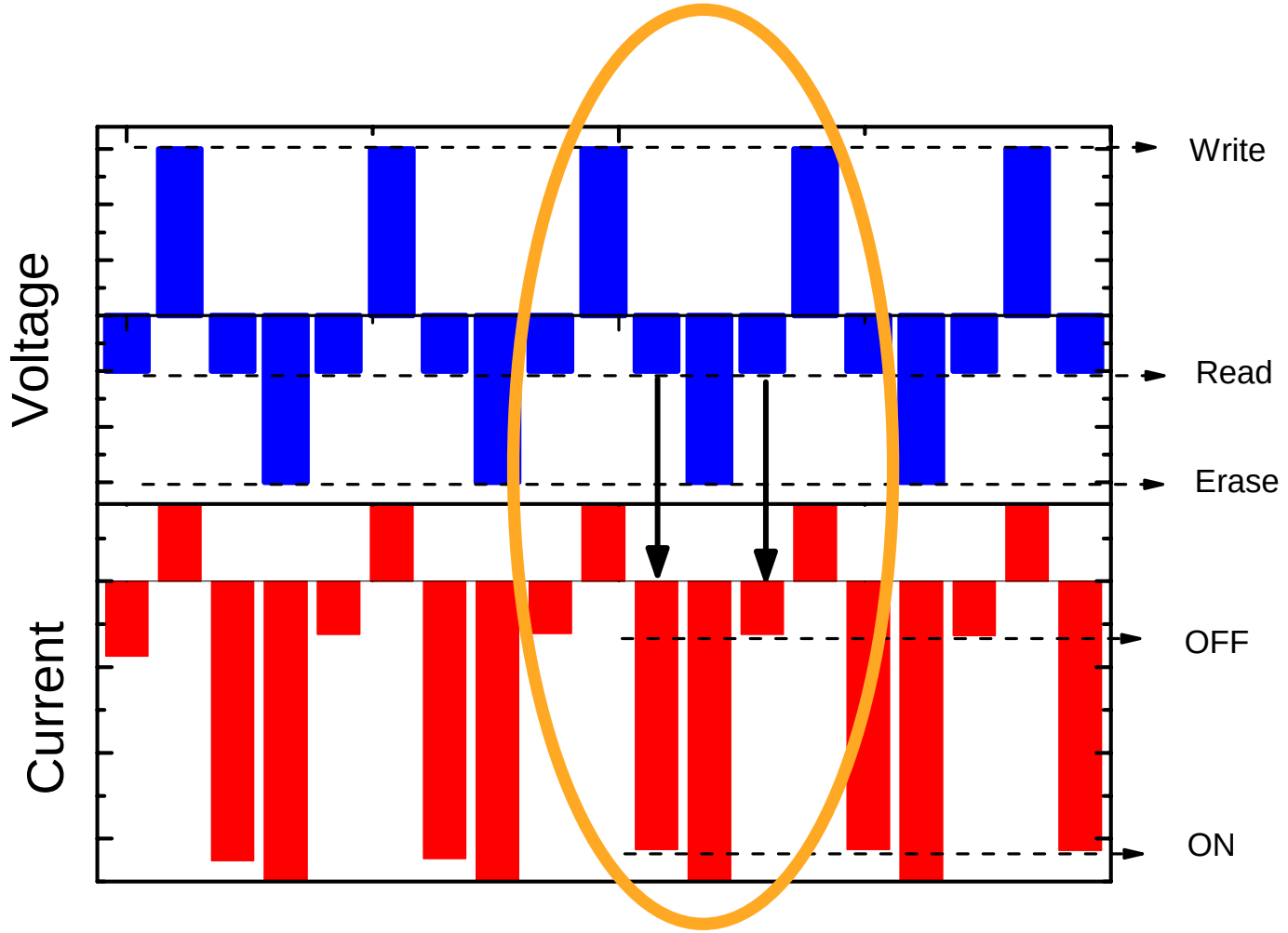


C60 fullerene

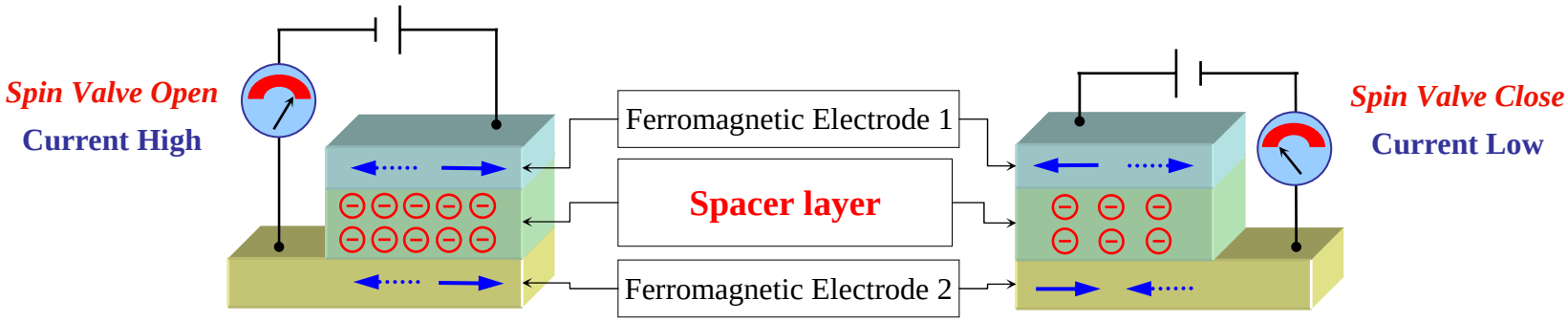
Single layer nano-composites of fullerenes and polystyrene gives us a solution-processable memory device!

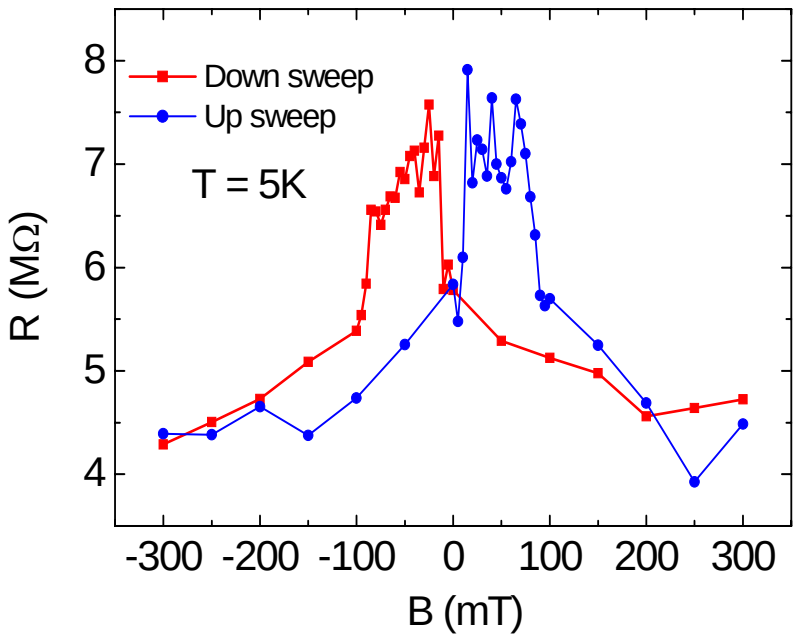
H. Majumdar et al., Org. Electronics Letters, **6**, 188 (2005)

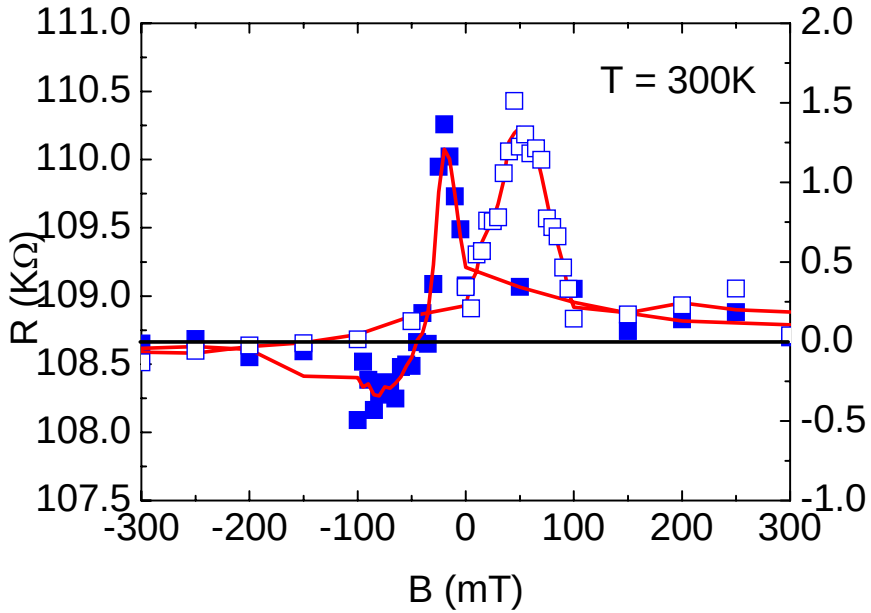
How it works as a memory



4) Polymeric spin-valve







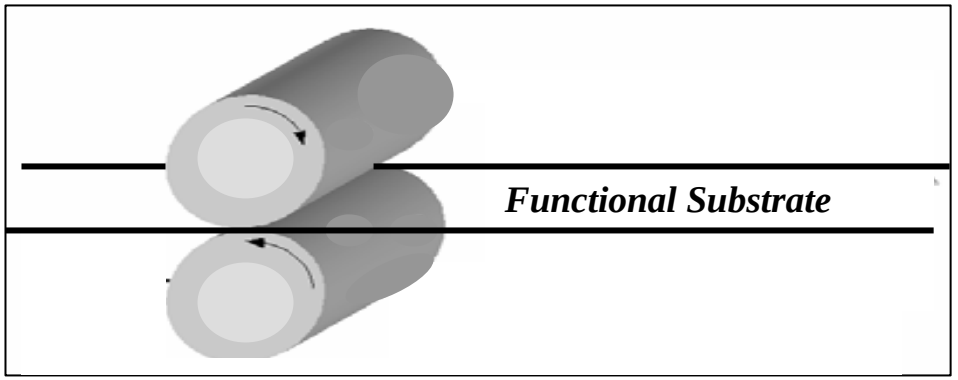
Future electronics?!

S. Majumdar, et al., APL **89**, 122114 (2006).

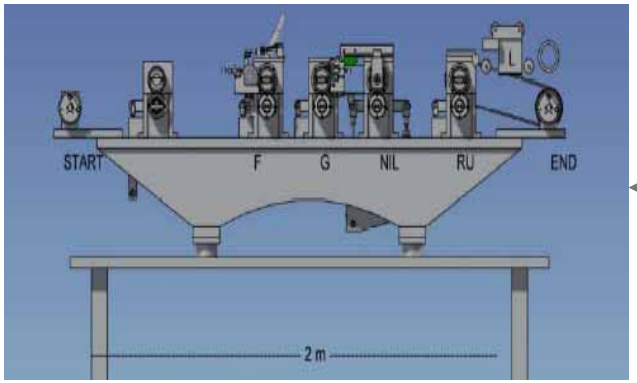
FunMat

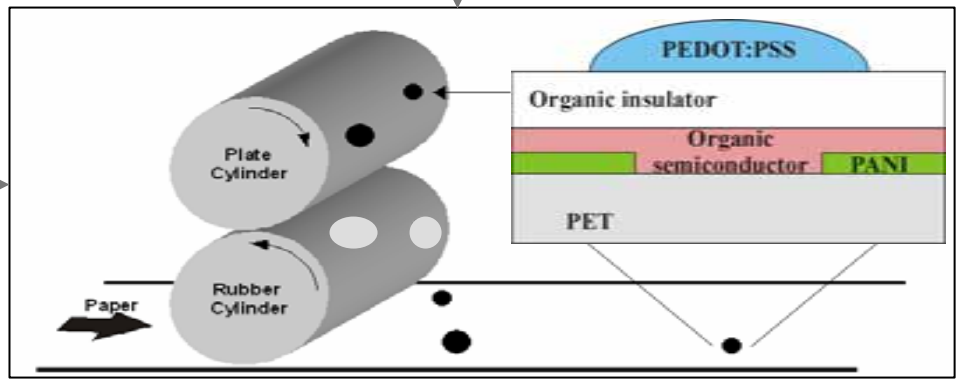
Functionalisation

- **Functional Coatings (Phys Chem)**
- **Functional binders/Modifiers(PT)**
- **Functional polymers (PChem/HU)**



Substrate manufacturing (PCL)





Sensor & Device Printing (FunPrint)

Sensor&Device Assembly (Phys)

Acknowledgements

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