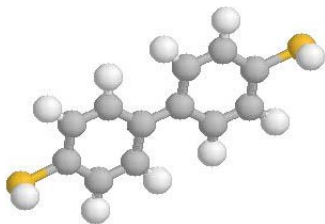




# **Nano FETs using SAMs**

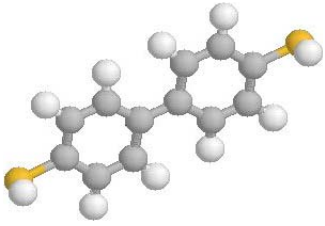
**Maggie Kirlakovsky**

**November 27, 2002**



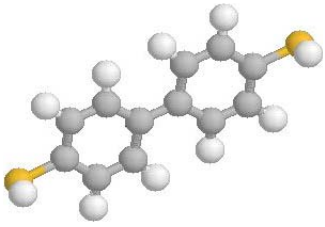
# Why Molecular?

- Continuing minimization of silicon elements will not be easy or cheap
- Prediction – by 2010 fabs may cost \$30 to \$50 billion
- Molecular components assembled using simple chemistry - cheap
- Most importantly: favorable operating attributes

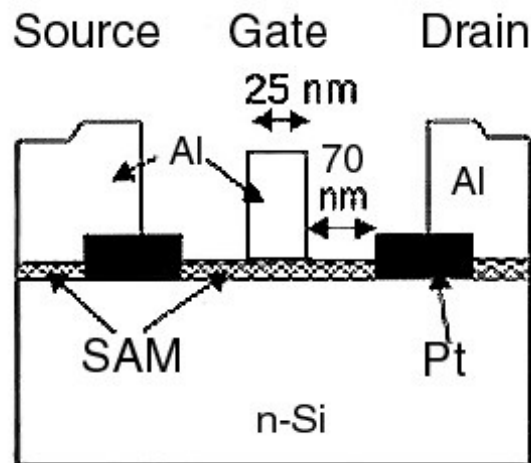


# SAMFET Outline

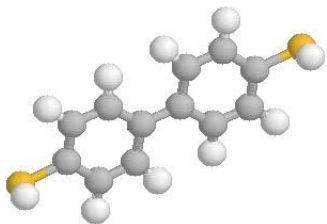
- SAM as gate insulator
  - Much lower leakage currents
  - Very small gate length ( $L_g = 25\text{nm}$ )
- SAM as bulk material
  - Bell Labs scandal
  - Falsification of data
  - Claims to have achieved conduction through SAM
- Possible charge transport problems



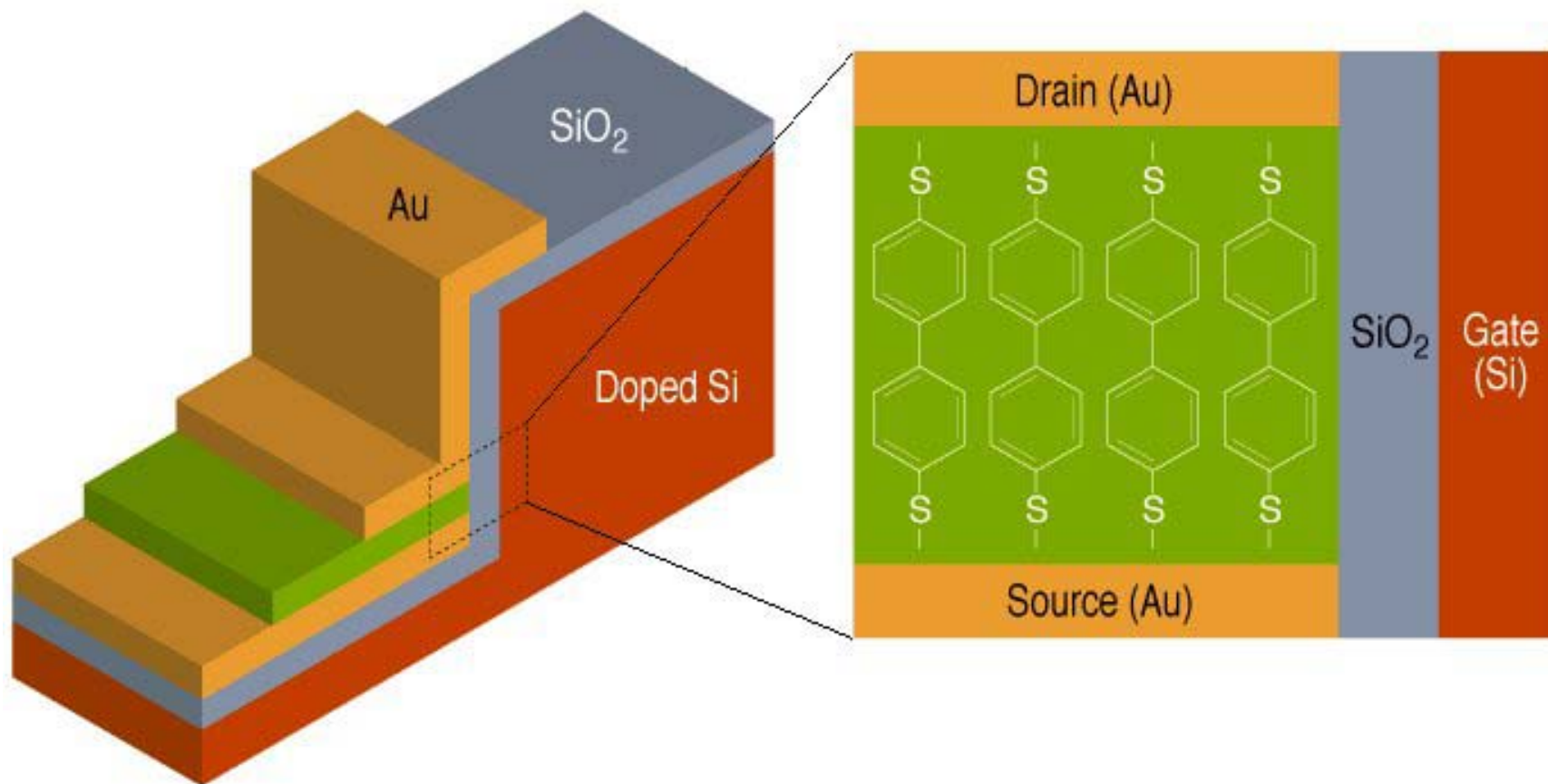
# Organic Gate Insulator

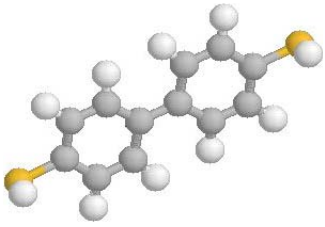


- Insulating layer ( $\text{SiO}_2$ ) getting thinner
- $\text{SiO}_2$  ( $< 3\text{nm}$ ) has high  $I_{\text{leak}} \sim 10\text{-}100 \text{ mA/cm}^2$
- SAM has  $I_{\text{leak}} \sim 100 \text{ nA/cm}^2$ 
  - At  $1.9\text{nm}$  thickness
- 5 step fabrication process

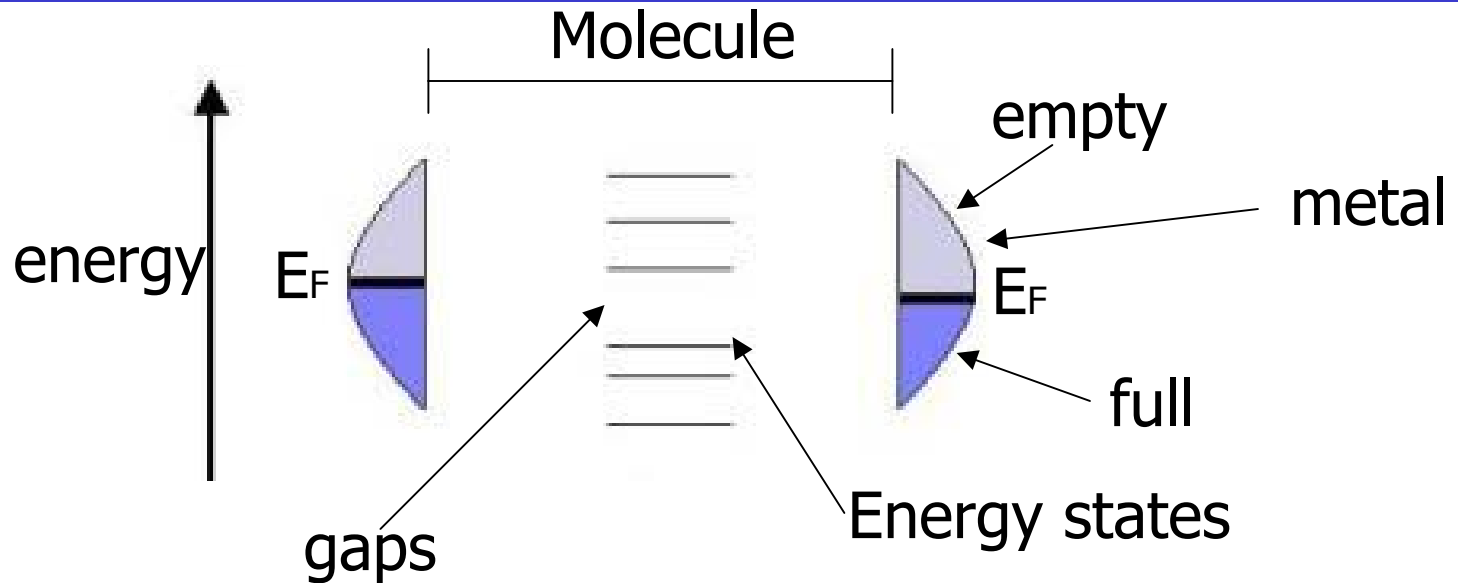


# Bell Labs' SAMFET

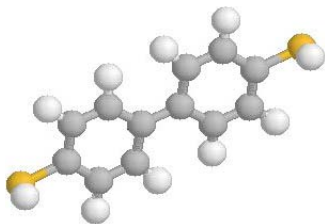




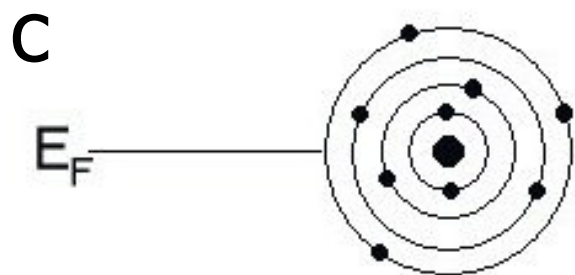
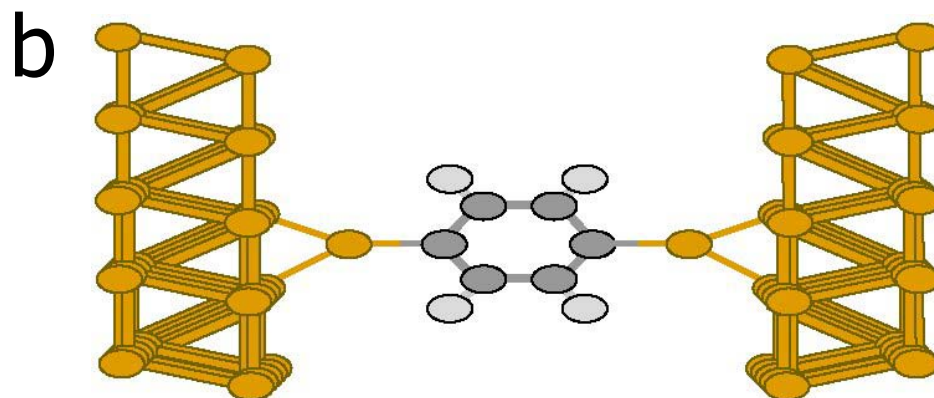
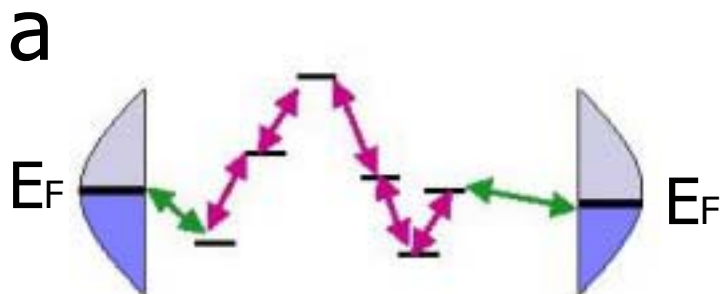
# Charge Transport Problem



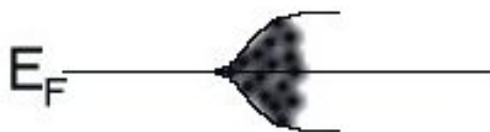
- Continuous vs. discrete energy states
- Must make gap jumps
- Availability of energy states



# Various Models



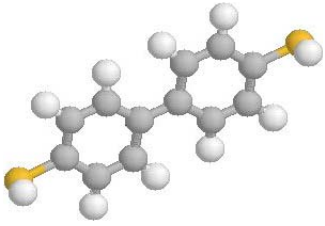
1 atom



multiple atoms



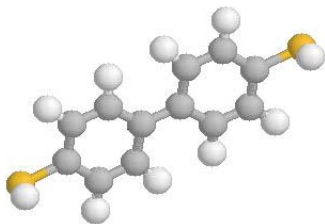
energy states



# A Downfall

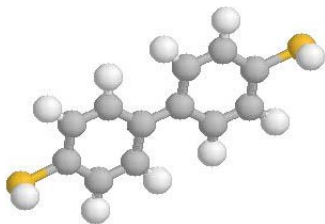
- Molecular devices synthesized in vats of chemicals will inherently have defects
  - At individual molecule level, chemistry is prone to statistical fluctuations
- Answers may lie in the field of software
  - Taramac uses chips so flawed, they're deemed worthless
  - Assembled in crossbar architecture
  - Programmed to identify and route around any defects





# Who's Interested?

ORGANIZATION	FOCUS
<b>Delft University of Technology</b>	Using carbon nanotubes as nanowires and electronic devices; has built a transistor out of a single nanotube
<b>Harvard University</b>	Synthesizing arrays of carbon nanotubes that can act as both wires and electronic devices
<b>Hewlett-Packard/UCLA</b>	Chemically assembling arrays of reconfigurable switches for memory and logic; goal is to build a molecular computer
<b>IBM Research</b>	Studying the properties of nanotubes; has made a transistor out of a single nanotube
<b>Rice University</b>	Developing a self-assembled computer with a highly interconnected network of logic and memory; has synthesized molecules with desirable properties
<b>University of Colorado</b>	Building a molecular computer; has made suitable molecules and short wires
<b>Yale University</b>	Collaborating with Rice University to build a molecular computer; has fabricated molecular switches and memory devices



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