Molecular Devices:
A Potential Replacement for Semiconductors

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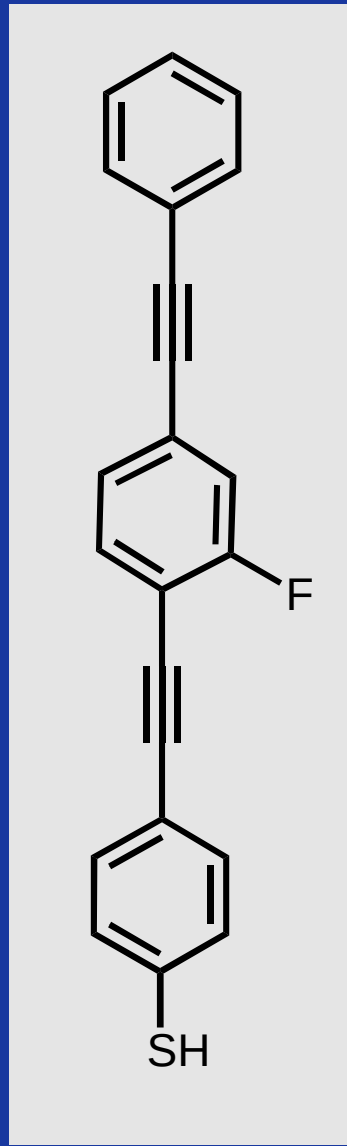
Introduction

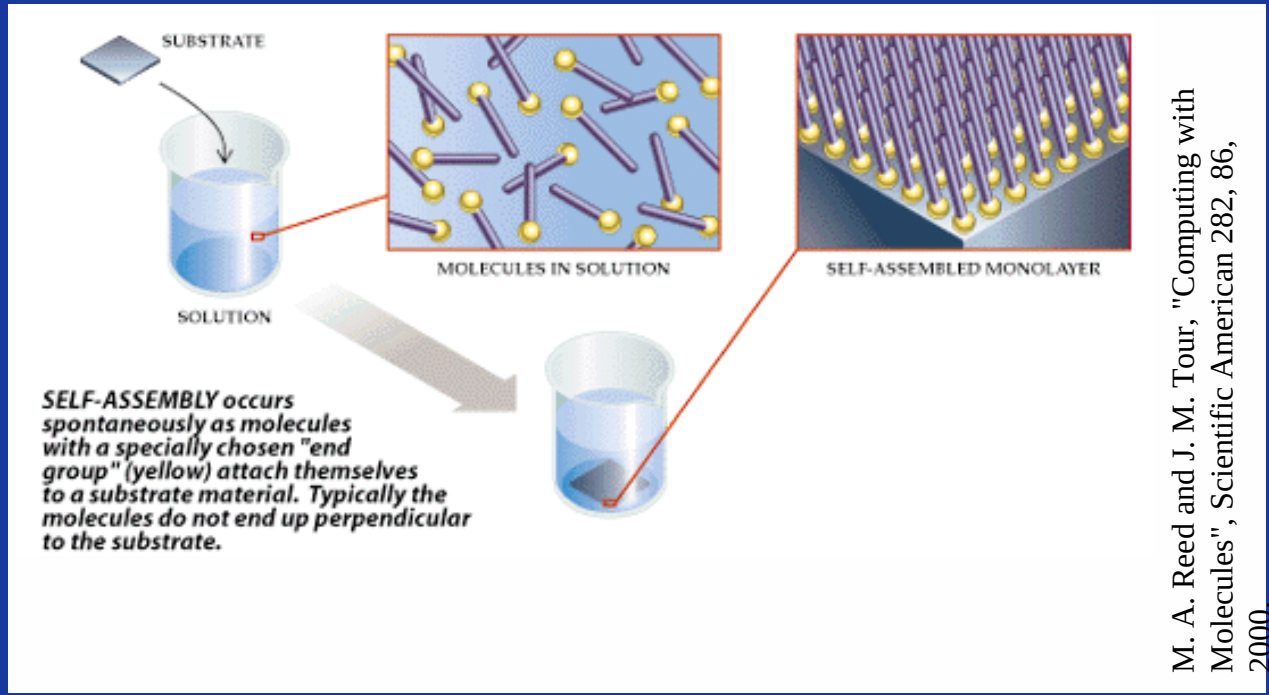
- Si and other semiconductor devices
  - Lower limit to size will soon be reached
- If successful, molecular electronics will allow much smaller devices to be constructed
  - molecules used are roughly 20 x 10 Å

The Molecule

- 2-fluoro-4-phenylethynyl-1-[(4-acetylthio)-phenylethynyl] benzene
  - Theorized that the molecule changes states when a voltage is applied
  - This property should allow the molecule to be used in the construction of electronic devices



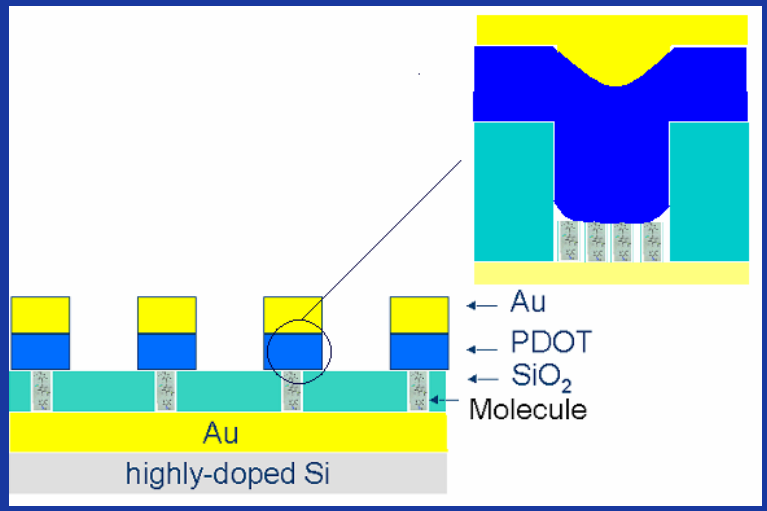
Self Assembly



M. A. Reed and J. M. Tour, "Computing with Molecules", Scientific American 282, 86, 2000

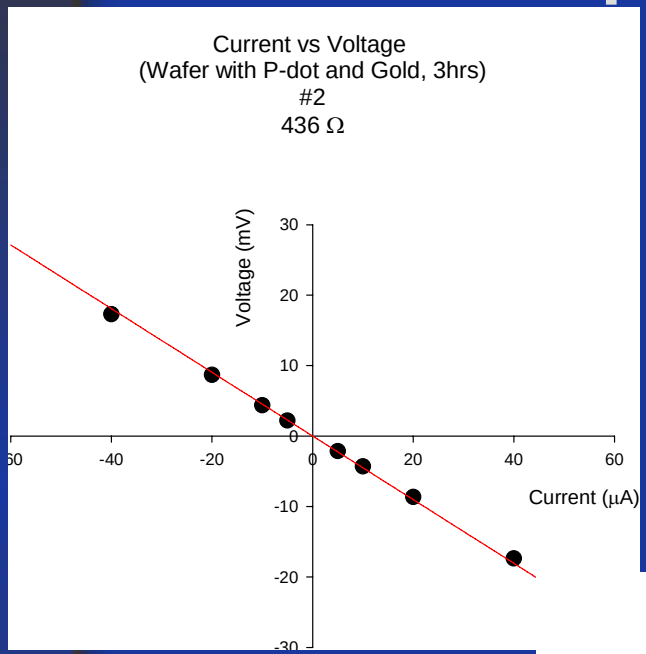
- How do you attach electrodes to the end of a molecule?
- Self assembles on Au

Electrical Contact With Molecule



- Doped Si wafer, layer of Au, layer of oxide
- Nanobuckets in oxide layer
- poly(ethylenedioxythiophene) (PDOT) , a conducting polymer, spun on wafer
- Au dots evaporated onto PDOT
- Etch PDOT around Au dots

Optimizing PDOT

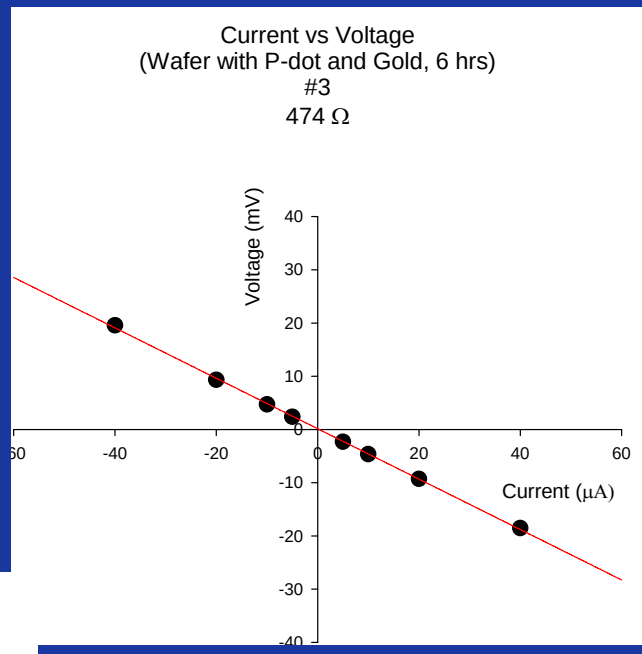


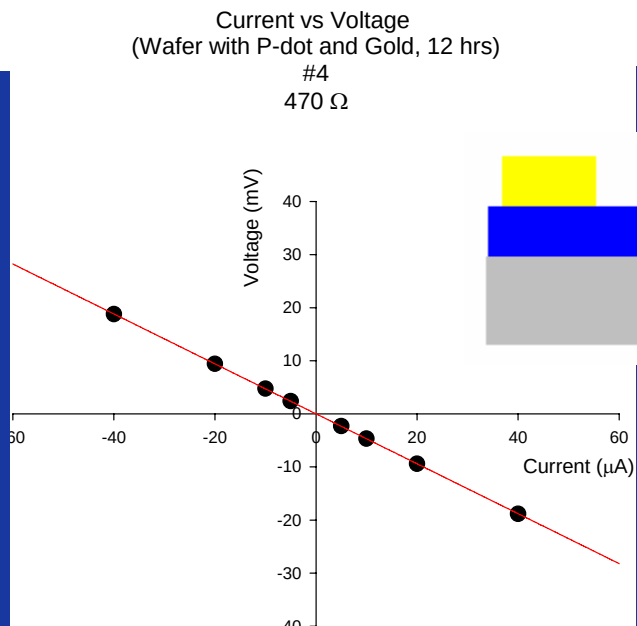
PDOT spinning

5s at 400 rpm

45 s at 2000 rpm

Baked at 50°C in vacuum oven



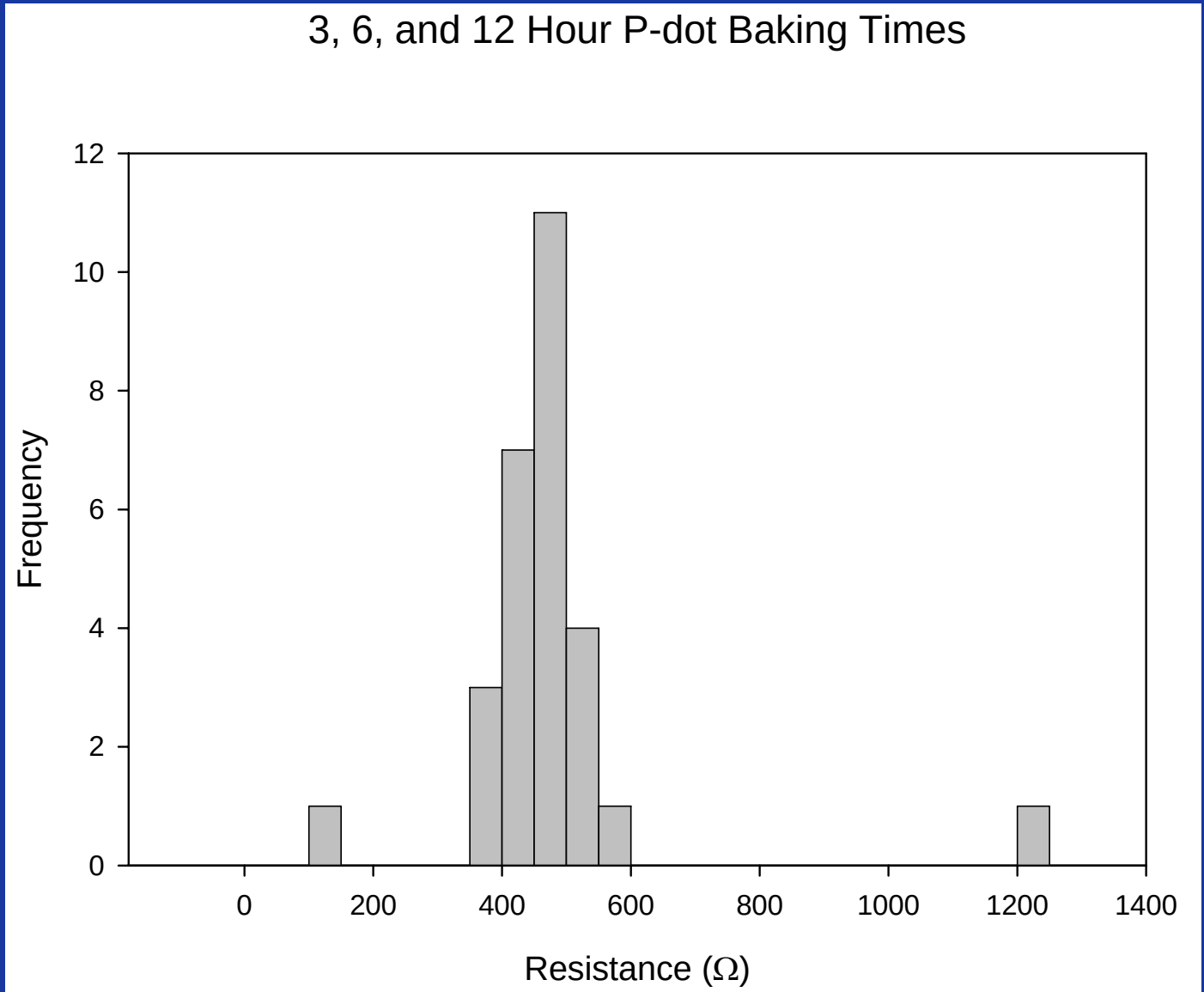


Au dots

PDOT

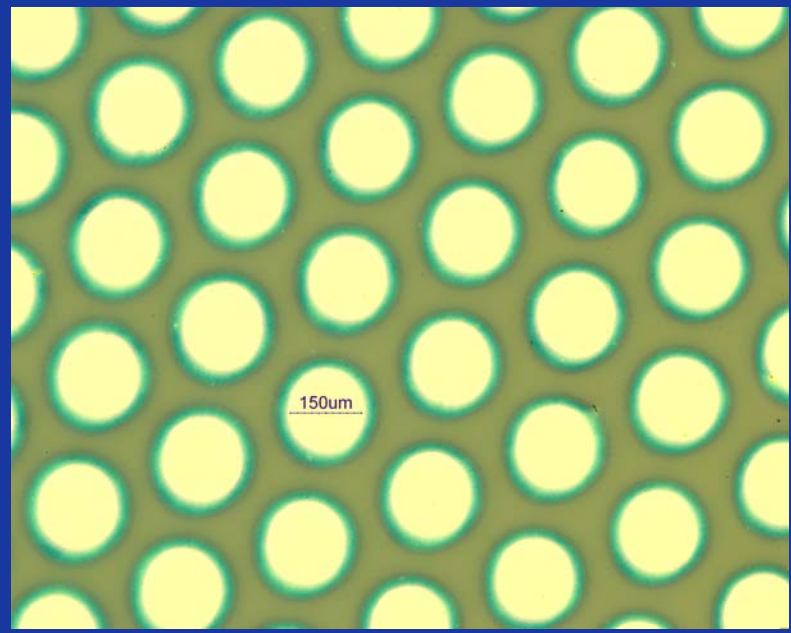
oxidized wafer

Distribution of Resistances



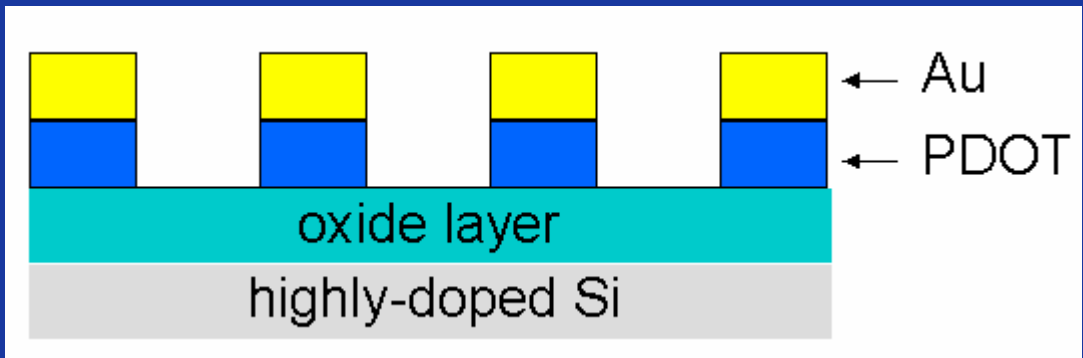
Etching the PDOT

- Reactive Ion Etching (RIE)
  - Oxygen plasma is used to etch the PDOT around the Au dots
  - 2 minutes is sufficient to etch through the PDOT film

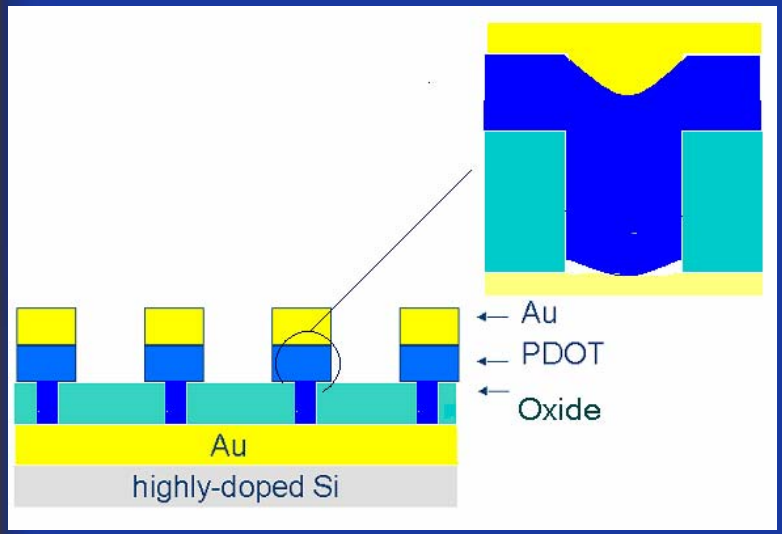


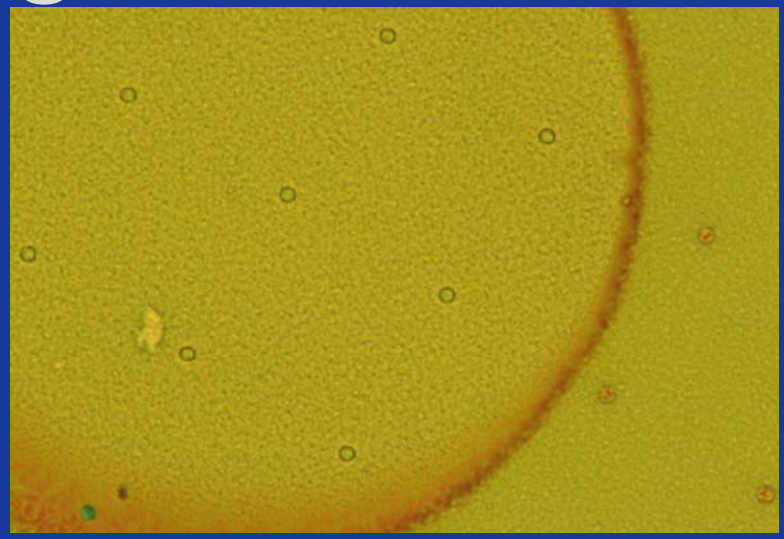
Depositing an Oxide

- Plasma Enhanced Chemical Vapor Deposition (PECVD)
  - Recipe used contains nitrogen, so layer deposited is not pure SiO_2
  - Deposition rate is about 500 Å/min
  - 500 Å layer of oxide deposited onto doped wafer, PDOT was spun on top, Au dots were evaporated on top, and the PDOT was etched



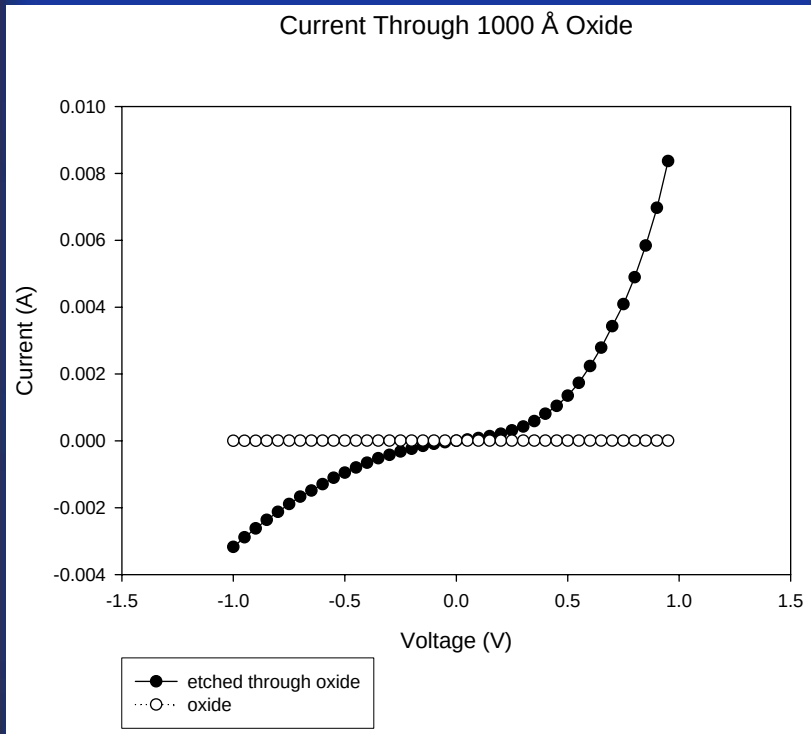
Etching Through the Oxide

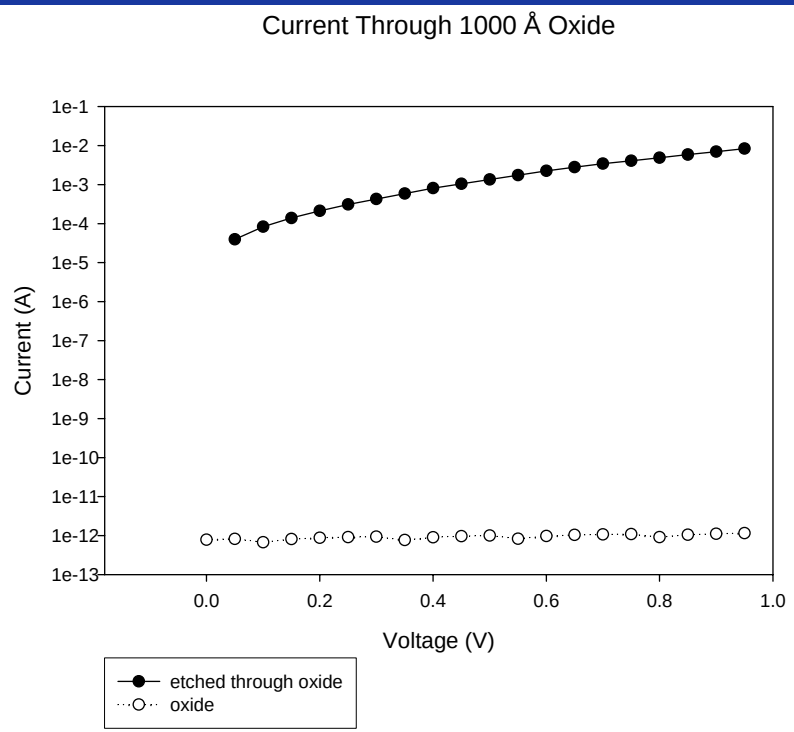




- Oxide layers of 500 Å and 1000 Å deposited onto Au coated wafers
- Nanobuckets etched in oxide using photolithography and RIE
- PDOT spun, Au dots evaporated, and PDOT etched

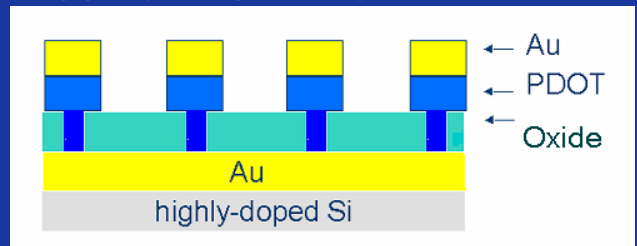
Current Through Etched and Unetched Oxide





Unetched Oxide

Etched Oxide

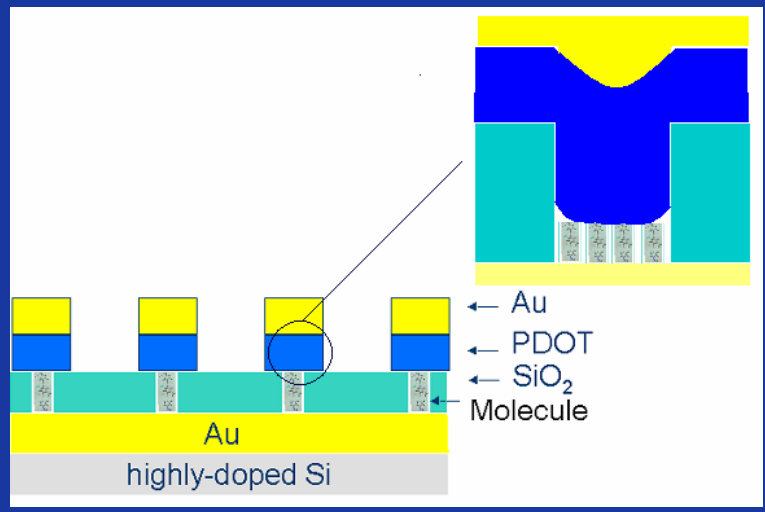


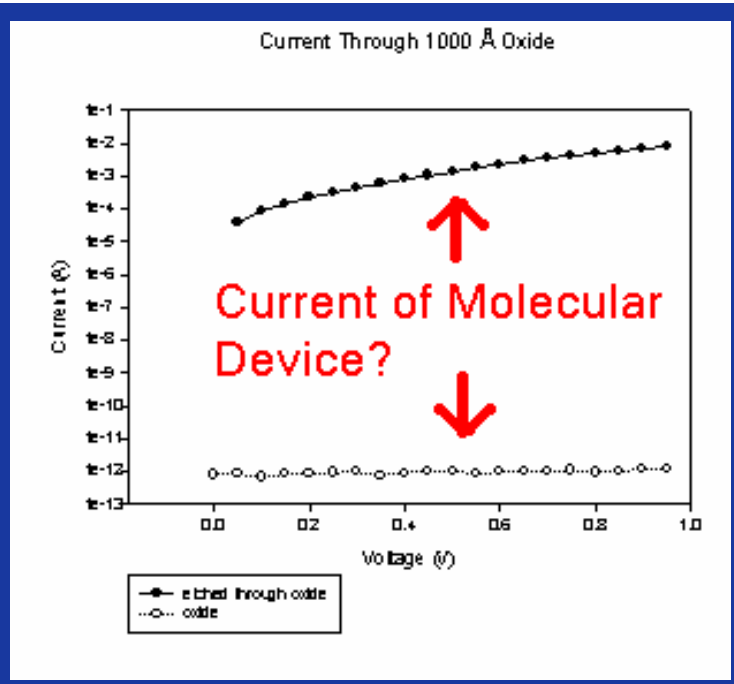
Conclusion

- Processes leading to the the construction of a molecular device were optimized
  - Spinning and curing of PDOT
  - Etching PDOT
  - Depositing an oxide
  - Etching oxide
- A structure ready for the addition of the molecule has been made and the current through the oxide has been measured

Future Work

- Assembling the molecules through holes etched in oxide onto gold
- Measure the current through the molecule





Acknowledgements

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