APPLCATIONS OF COULTER COUNTER BASED SENSORS

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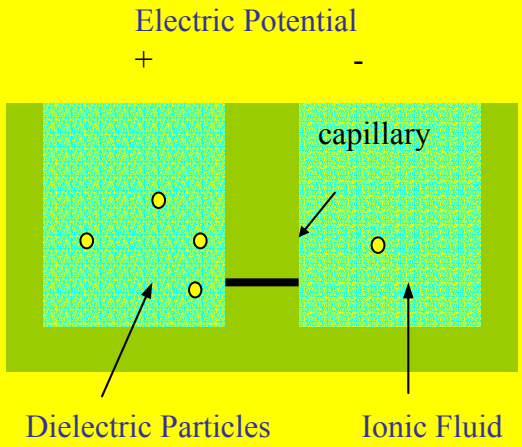
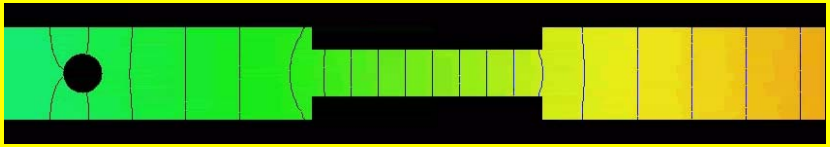
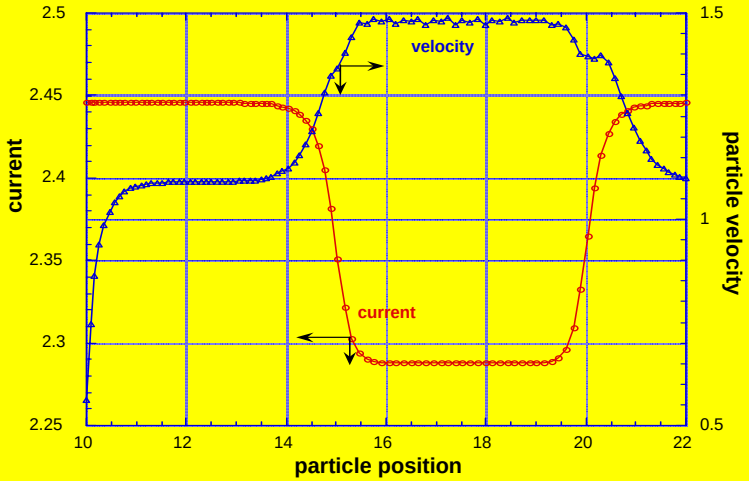
Applications and Principles

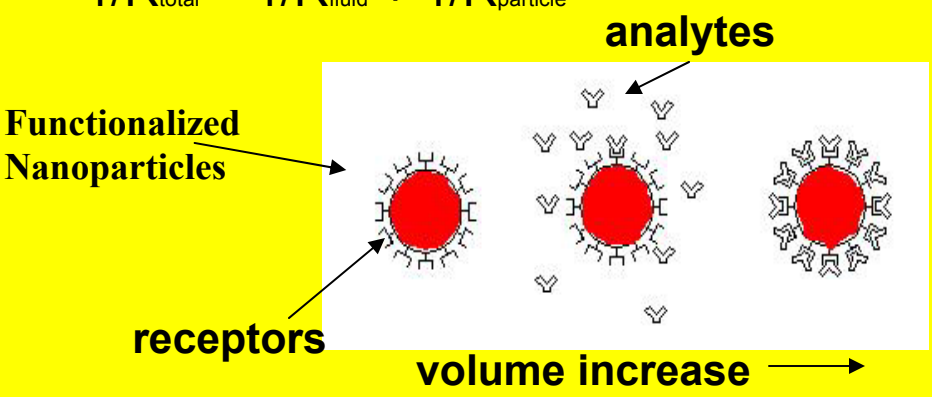
What Exactly is a Coulter Counter?







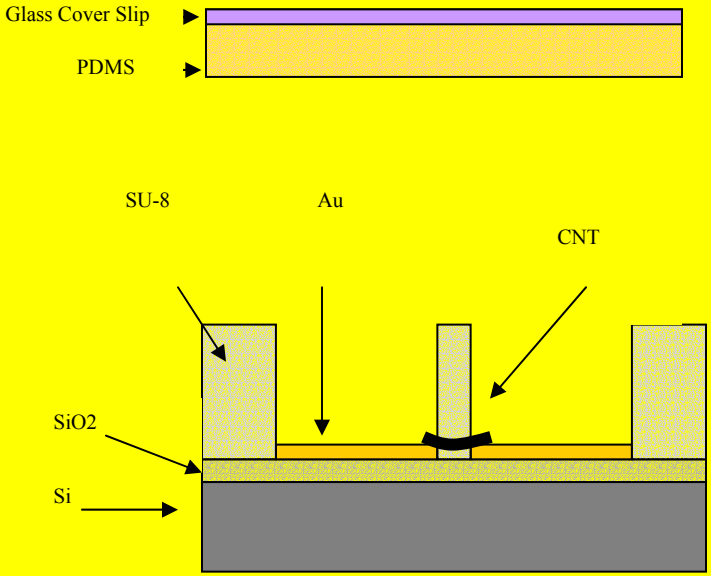
$1/R_{total} = 1/R_{fluid} + 1/R_{particle}$



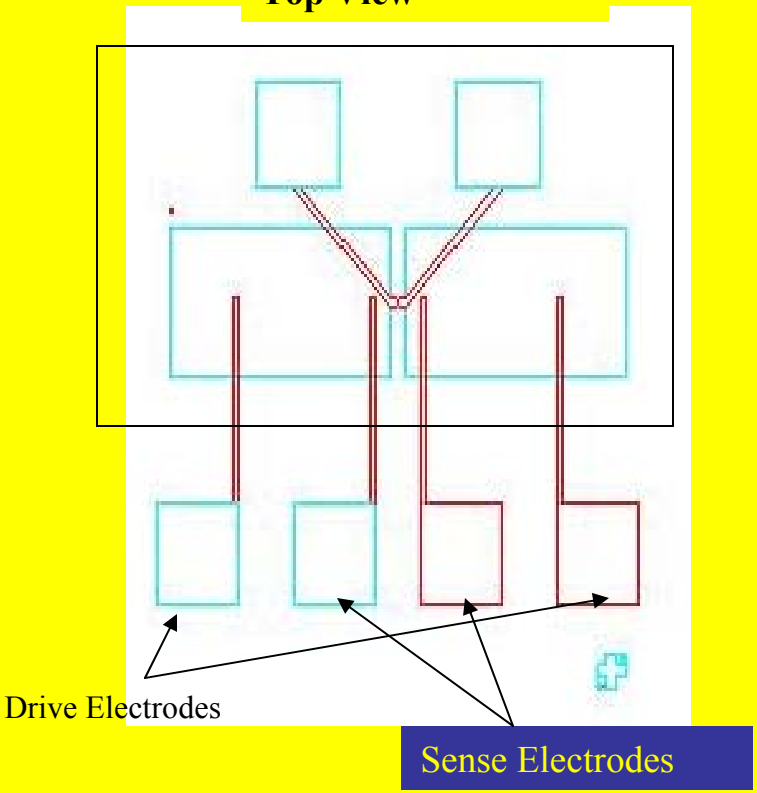
- This device can be used as a chemical or biosensor to detect the binding of target analyte to functionalized nanoparticles

Device Design

Side View



Top View



MICROFABRICATION

Knowledge, Hands on Experience, Skills:

Photolithography
Polymer Processing
Electron Beam Evaporator
Electroplating
Bulk/Surface Micromachining (etching)
Chemical Vapor Deposition (CVD)
Oxidation and Doping Processes
Magnetron sputtering
Probe Station →
Optical Microscope
Scanning Electron Microscope (SEM)
Ultrasonic Transduction

Nanofabrication Procedure

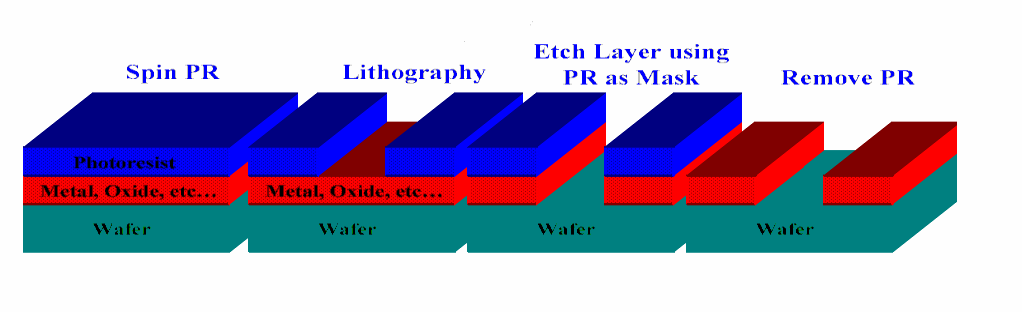
1) On p-type <100> silicon wafer, perform basic cleaning

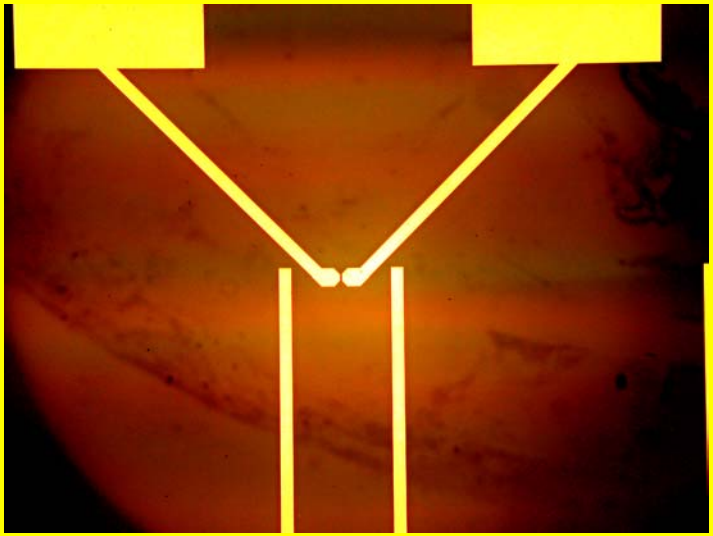
2) Grow 1 micron of thermal oxide for electrical insulation

3) E-beam evaporate gold onto wafers

4) Pattern gold electrodes through the liftoff/wet etching process
   - Spin on positive/negative photoresist
   - Expose wafer with mask 1

5) Strip resist and electrodes will be patterned



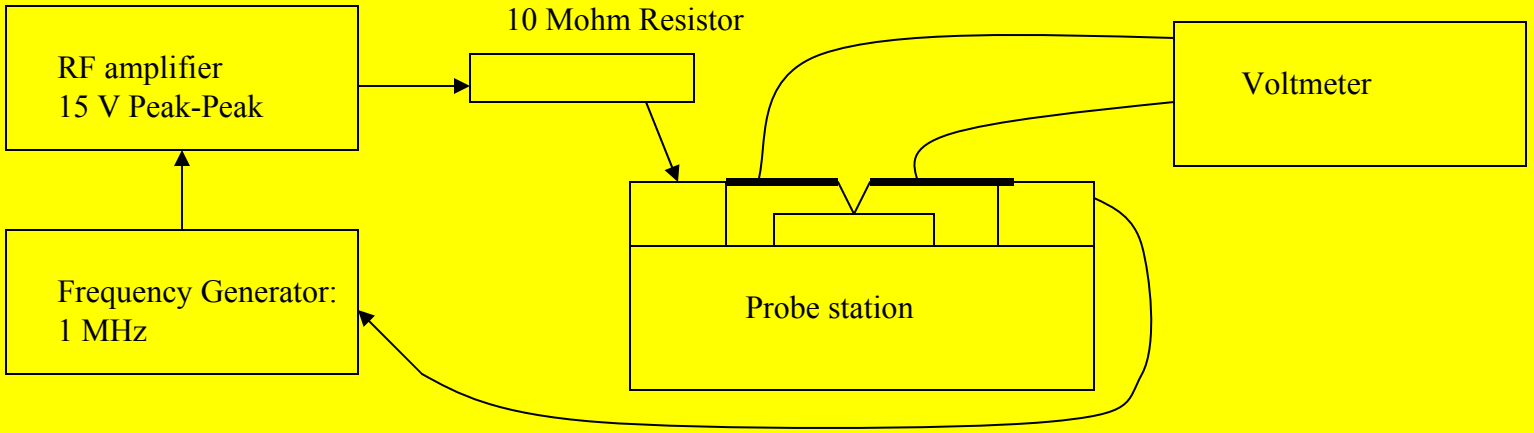


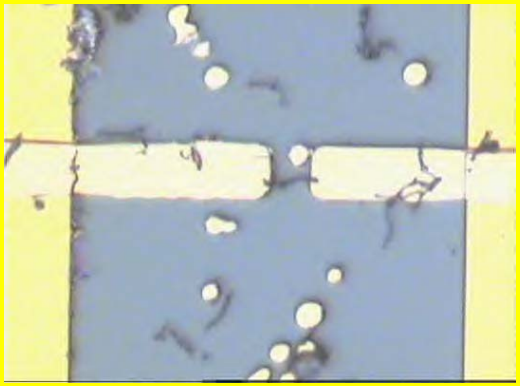
Electrodes on SiO_2 at 2x magnification

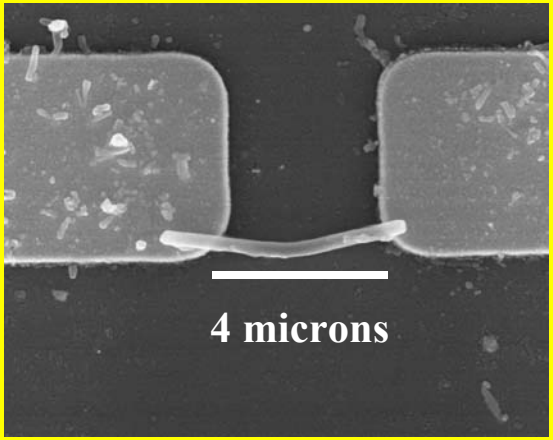
Dielectrophoretic Trapping Procedure

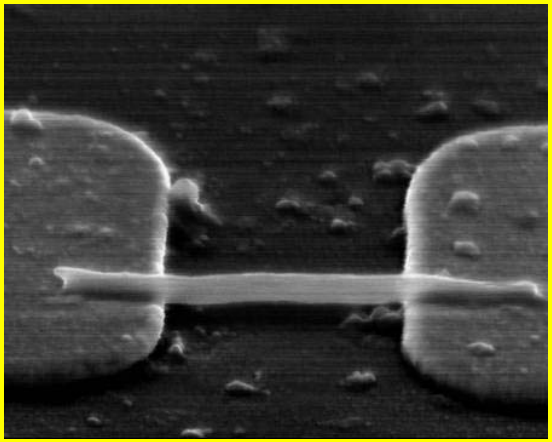
6) Trap CNT between gold electrodes using a dielectrophoretic trapping approach

Experimental Setup and Initial Results









Multi-walled CNT Trapped Between Electrodes

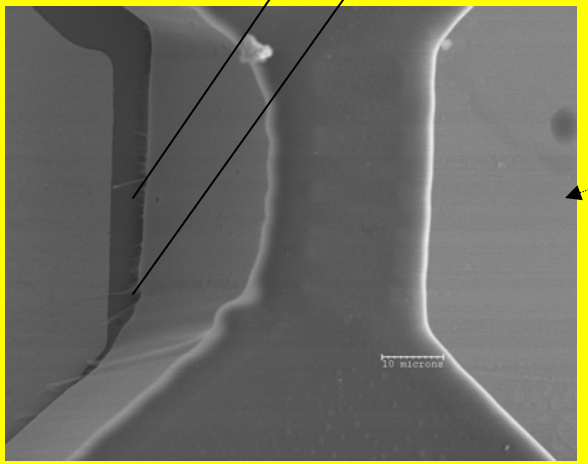
SU-8 Interface

7) Pattern SU-8 Reservoirs Around Tube Ends

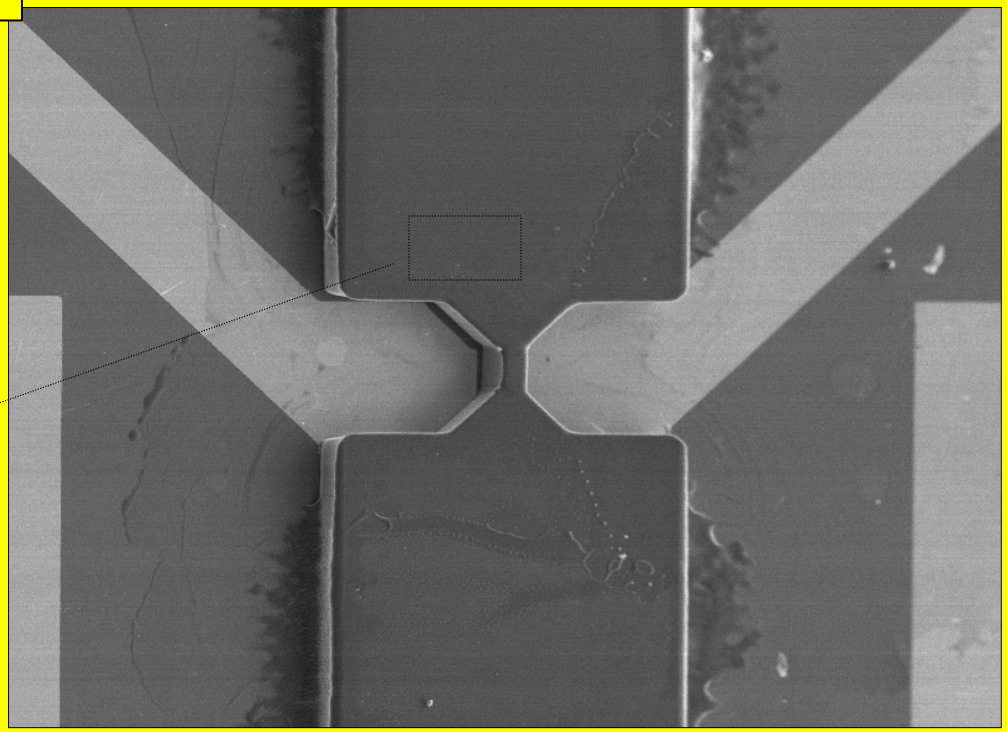
Use of Scanning Electron Microscope (SEM) to Visualize SU-8 interface and carbon nanotube

Gold electrode

Carbon nanotubes



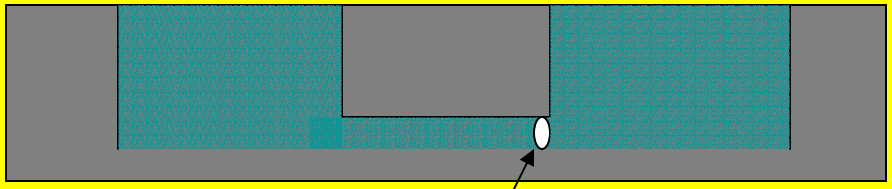
Trapped CNT under SU-8 wall



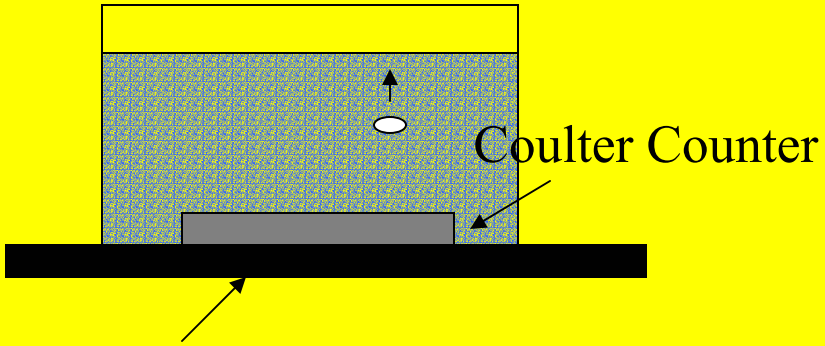
SU-8 Reservoirs formed around the tube ends

Issues and Hopeful Solutions

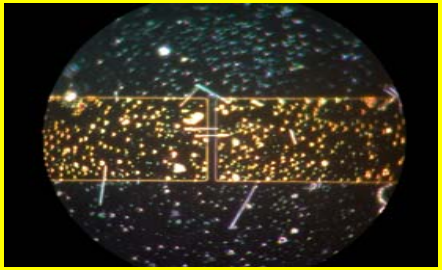
1) Assumed Problem filling the tubes

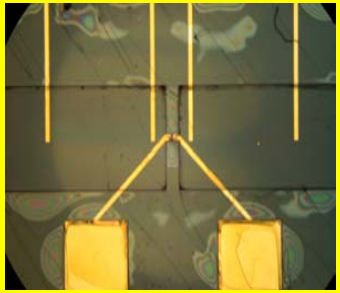


Air Bubble

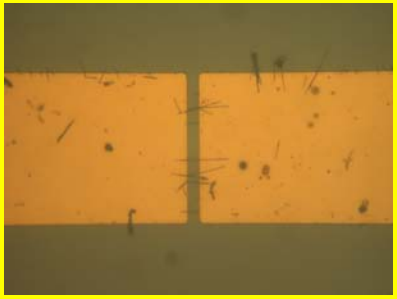


2) Adhesion Between SU-8 and Substrate





Etch away oxide layer with HF



3) Surface Tension Issues

Surfactant - detergent

Other Issues

- “Over” Etching and Undercutting of Au electrodes: Isotropic Wet Etching vs. Liftoff
- Optimization of SU-8 Processing: Modification of exposure and baking time
- CNT Trapping: concentration of tubes, voltage and frequency modifications for different chips
- Electrical measurements of CNTs before and after trapping and in attempt to sense tube filling

If the Future is Not Now, How Soon is it?

-Groundwork is set for the creation of a functional microfabricated device in the near future

-Develop better optical and electrical sensing techniques

-Down the Road: Minimizing Coulter Counter to create breakthroughs in biosensor and chemical applications

THANK YOU!!!!!!