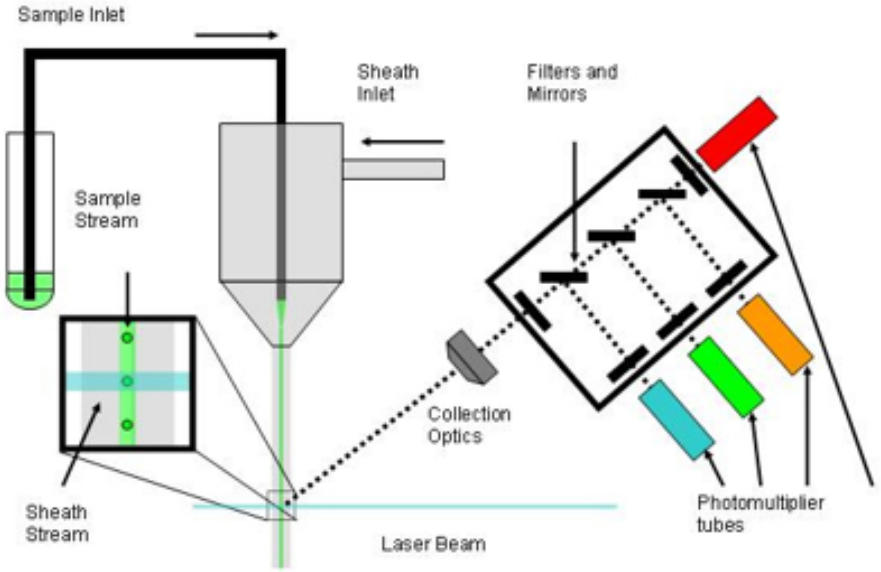
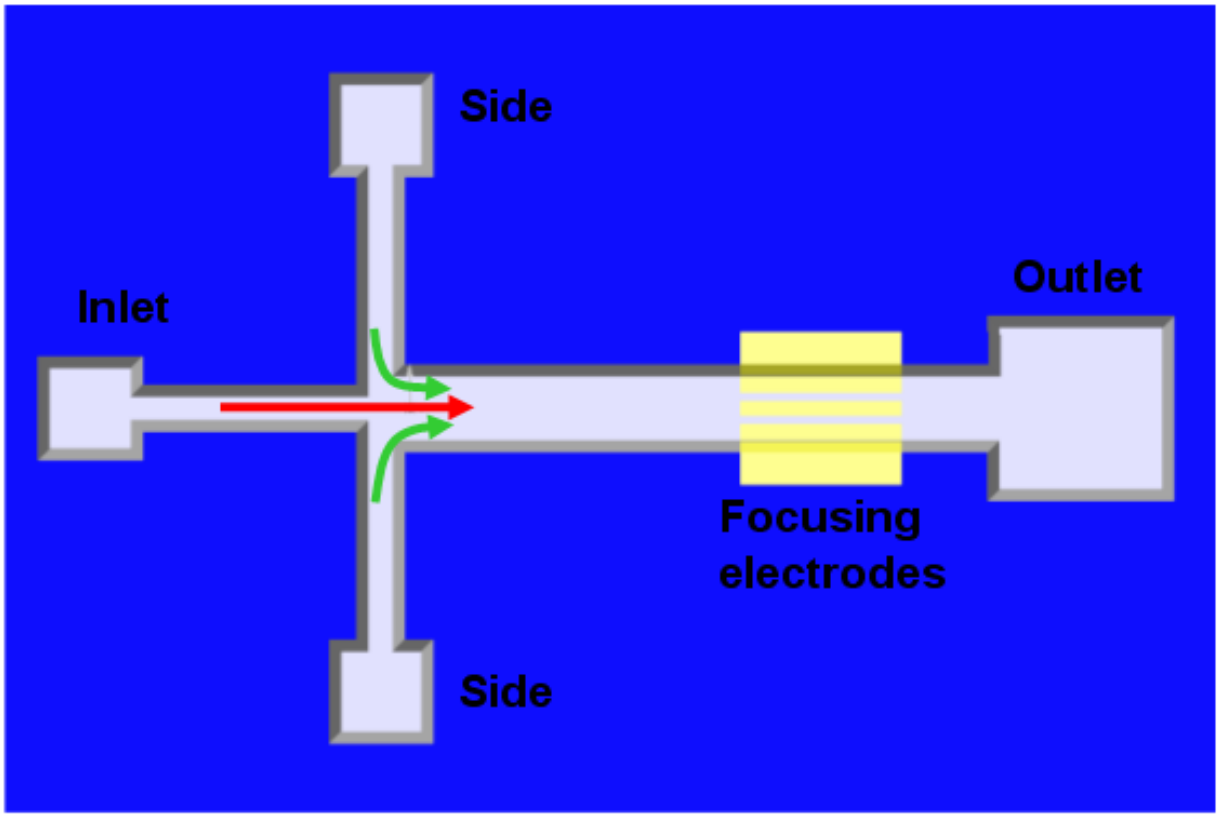
Project Description & Process Flow

Flow Cytometry

Flow cytometry is an important bioanalytical technique that is used for sorting and counting of cells, measurements of physical and chemical characteristics of cells etc.

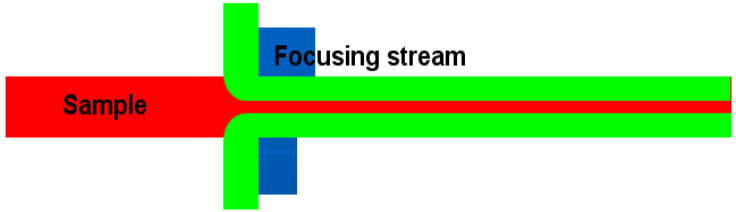


Flow Cytometer /Molecular Focusing on a Chip

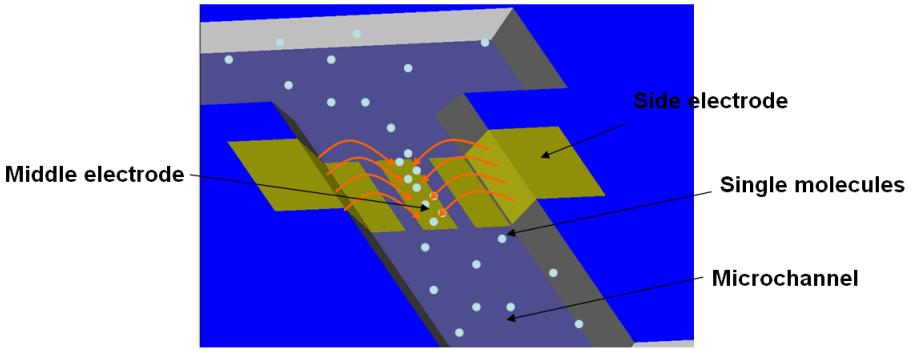


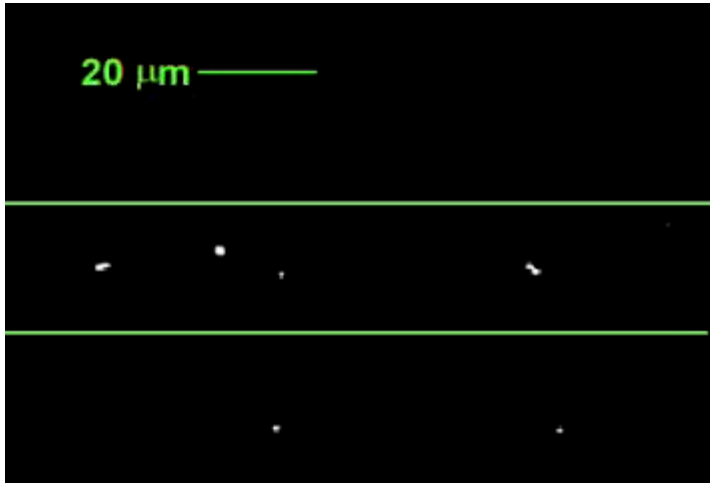
Hydrodynamic Focusing and Electrokinetic Focusing

Hydrodynamic Focusing:



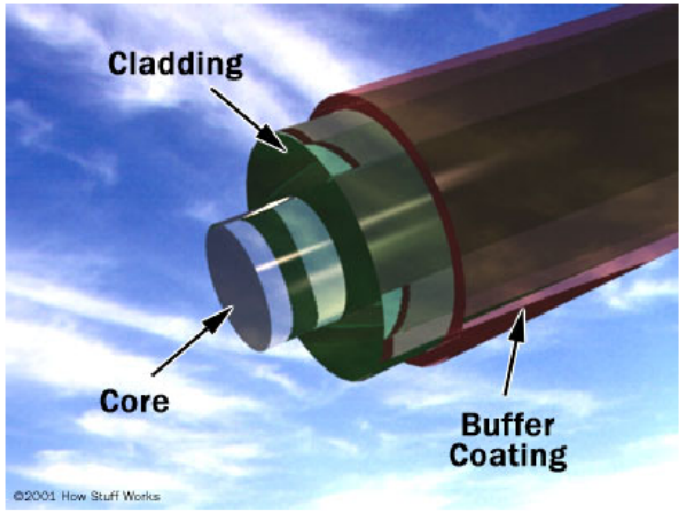
Electrokinetic focusing:

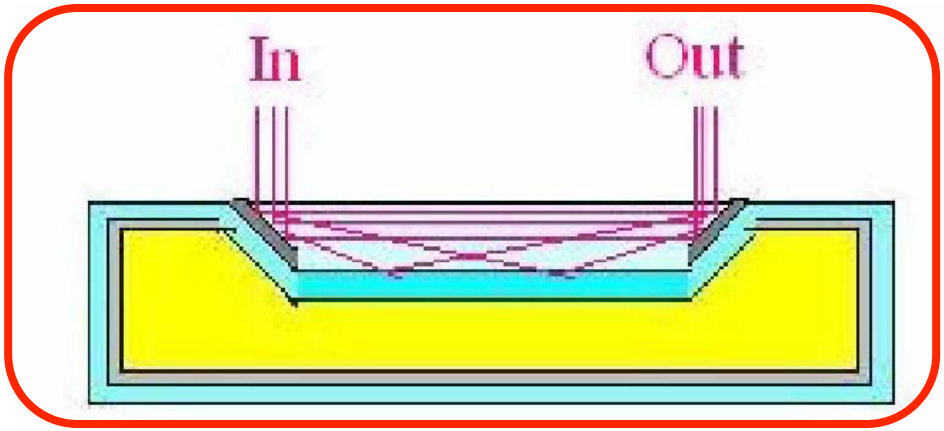


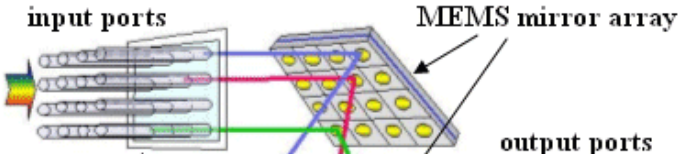


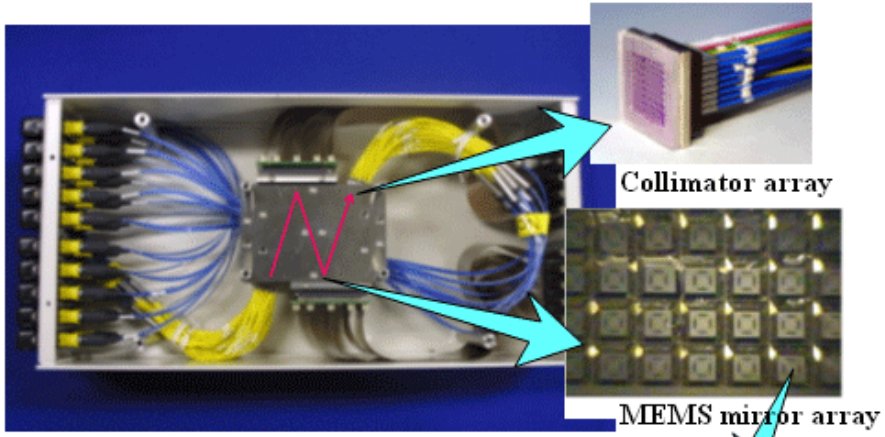
Optical Waveguide on a Chip

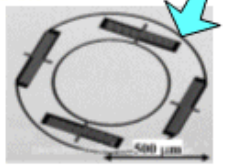
Optical waveguides are widely used, especially in the form of optical fibers, for long distance, high data rate telecommunications.



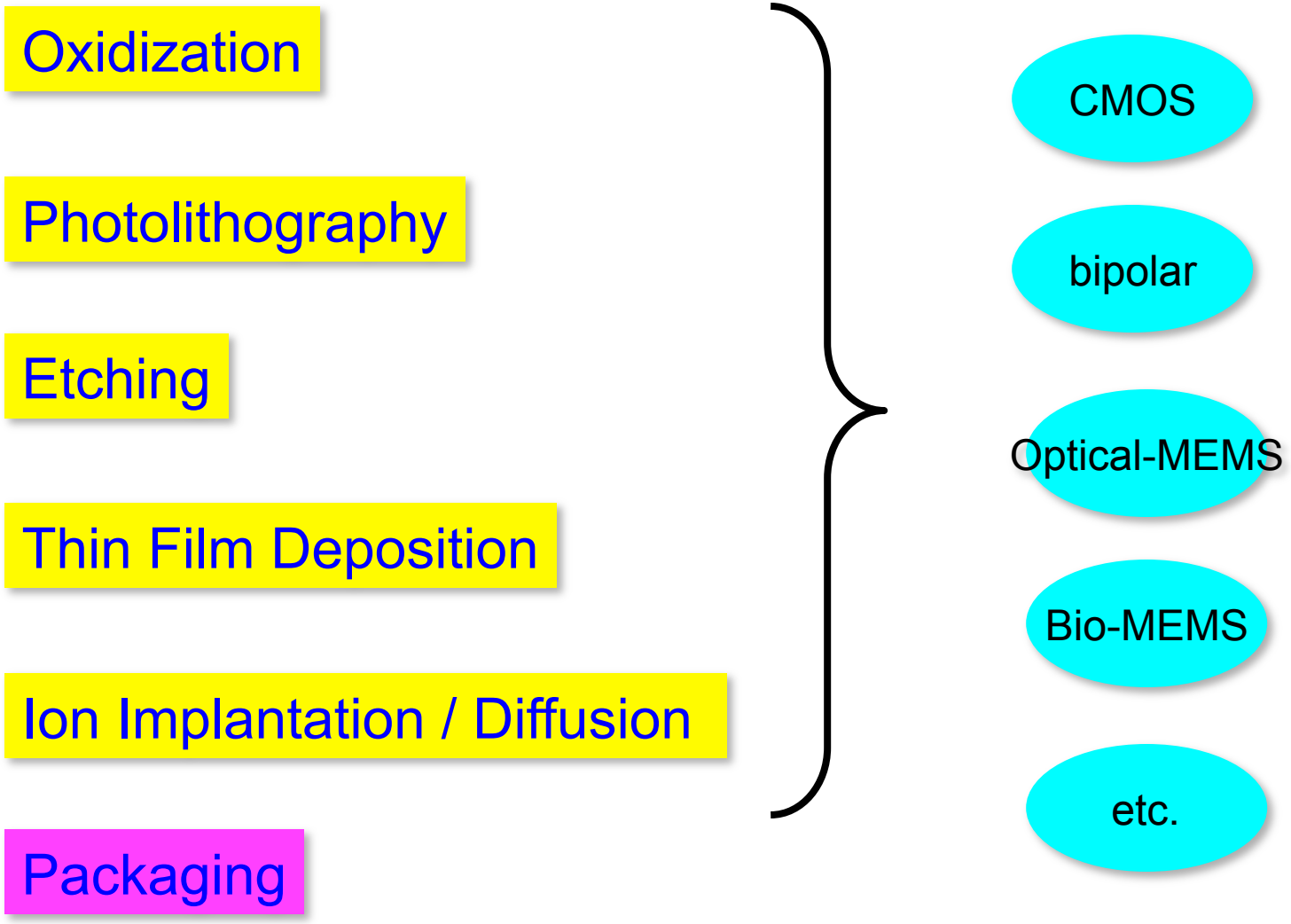






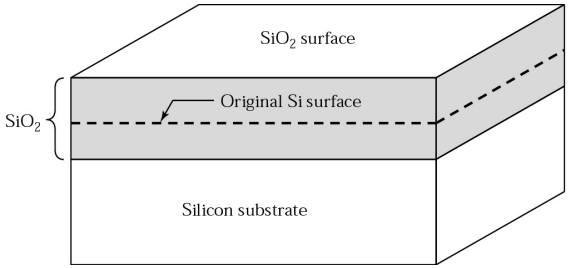


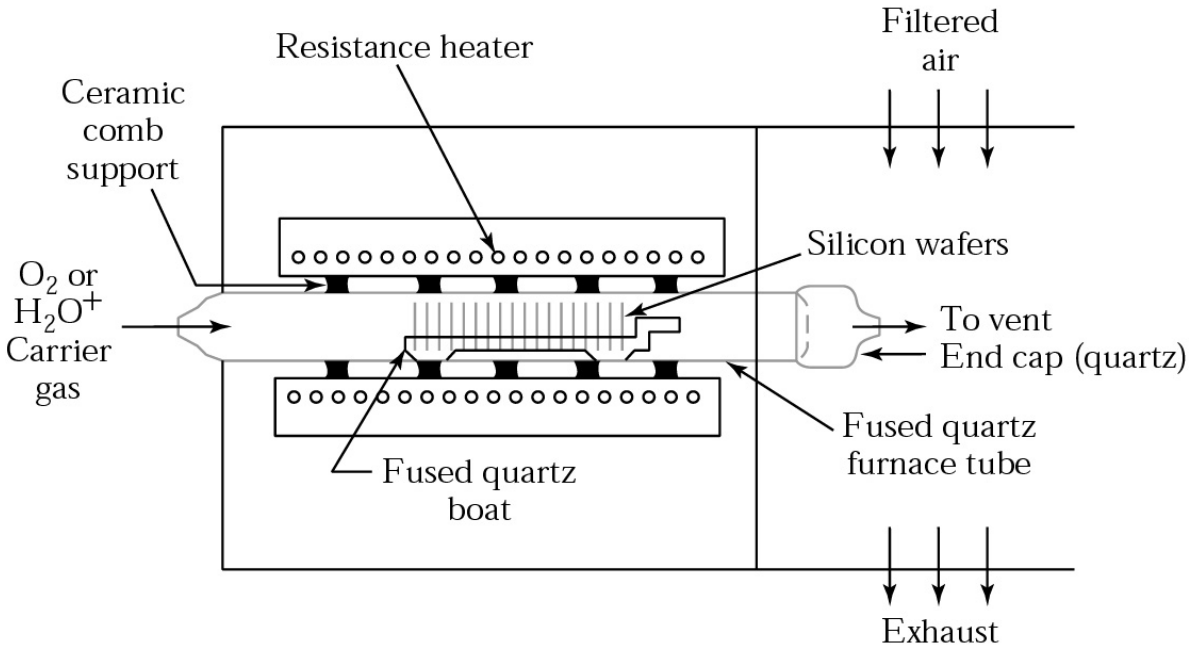
Basic Microfabrication Steps



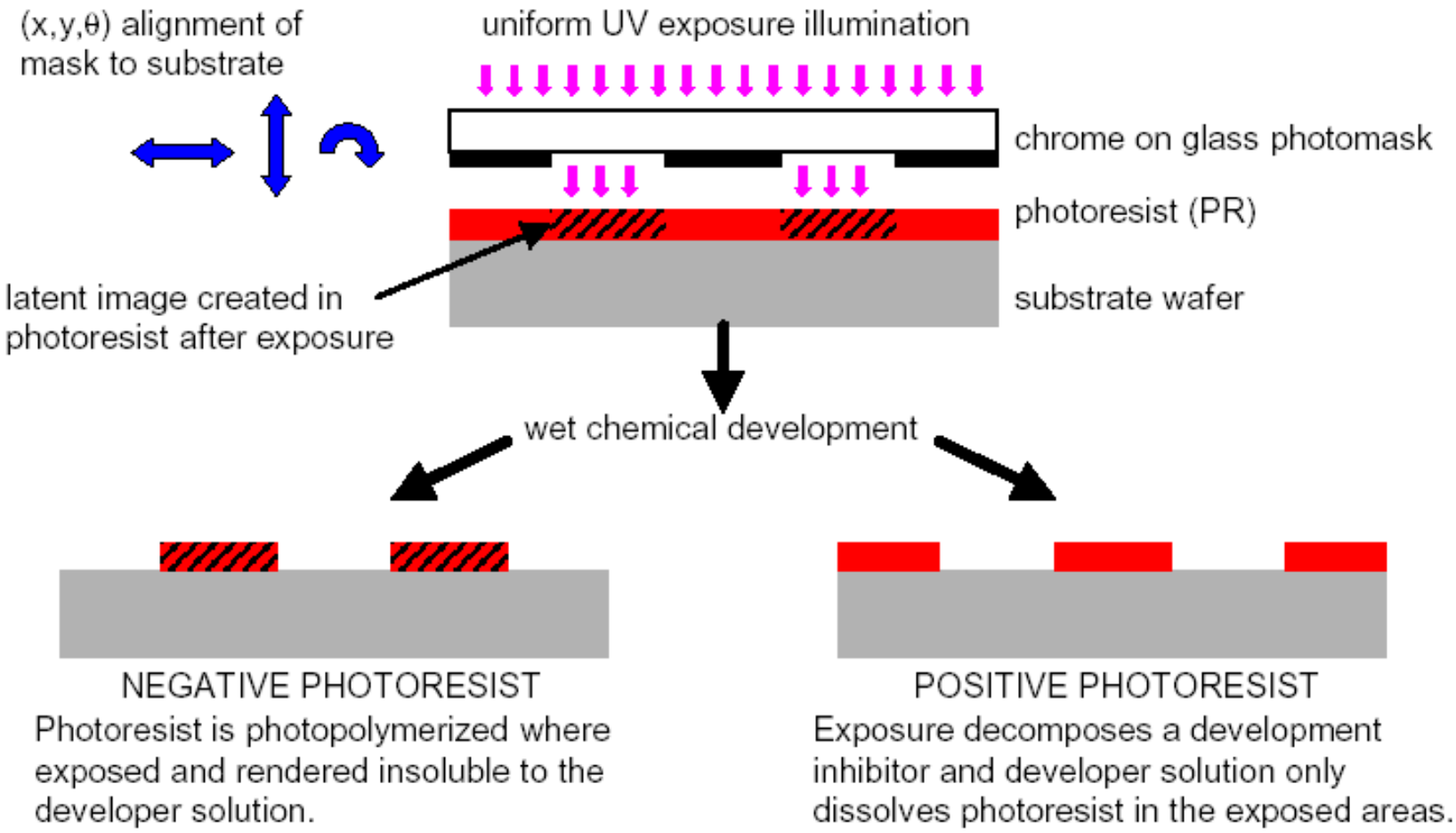
Thermal Oxidization

- Dry Oxidization : Si (solid) + O_2 (gas) → SiO_2 (solid)
- Wet Oxidization: Si (solid) + $2H_2O$ (gas) → SiO_2 (solid) + $2H_2$ (gas)

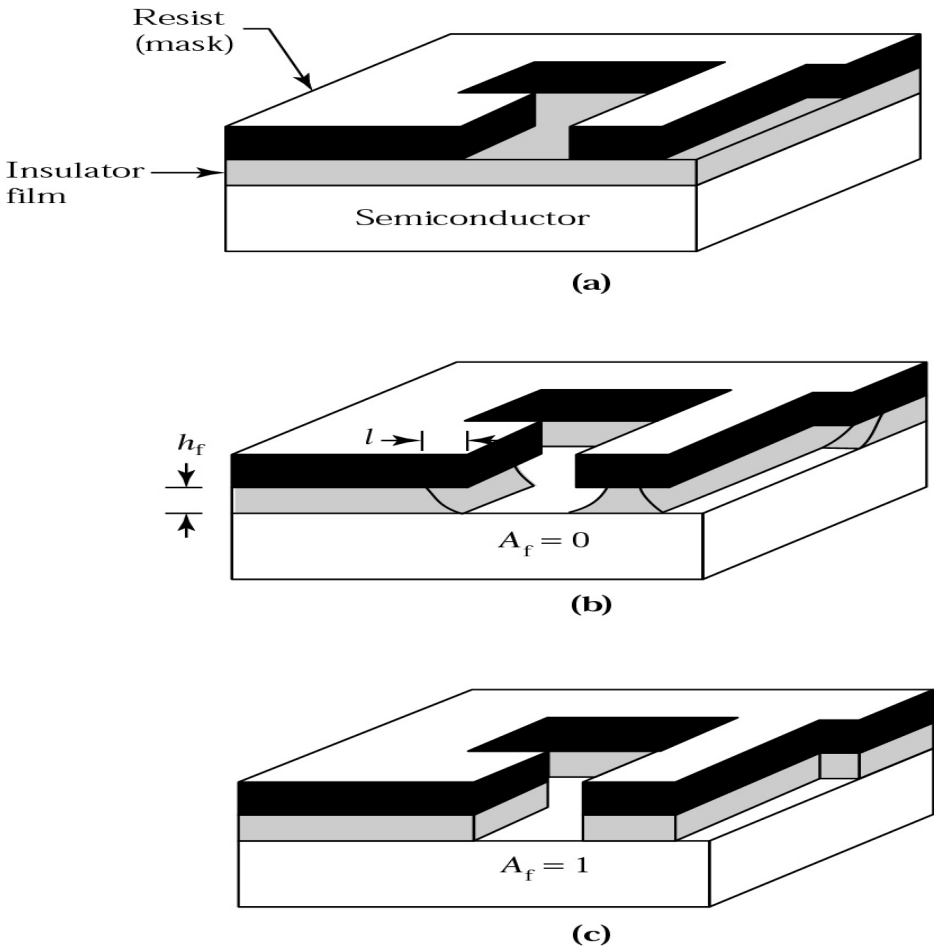




Photolithography

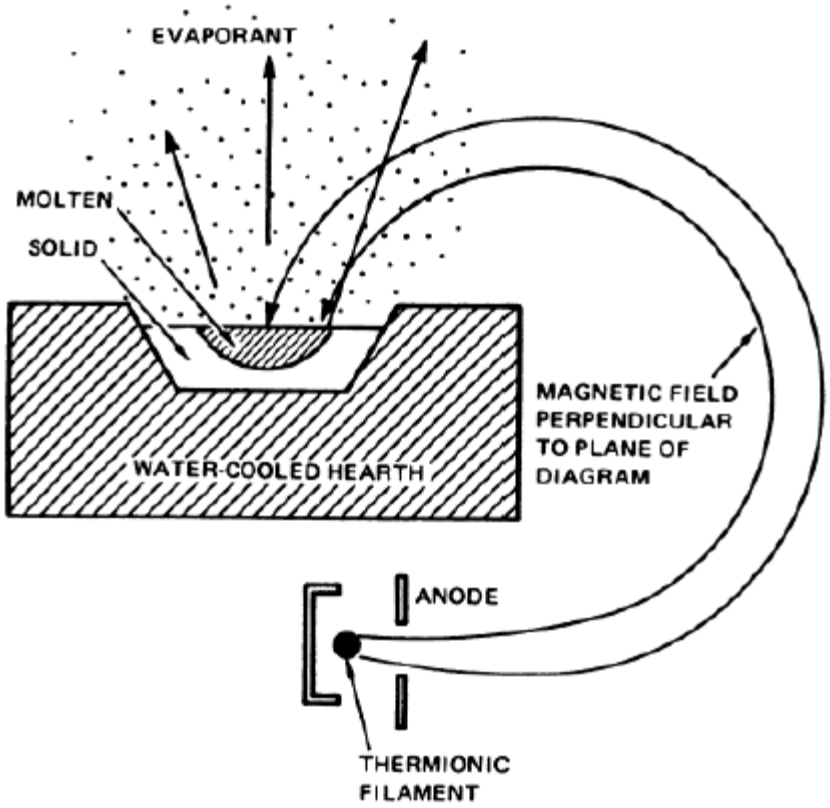


Etching



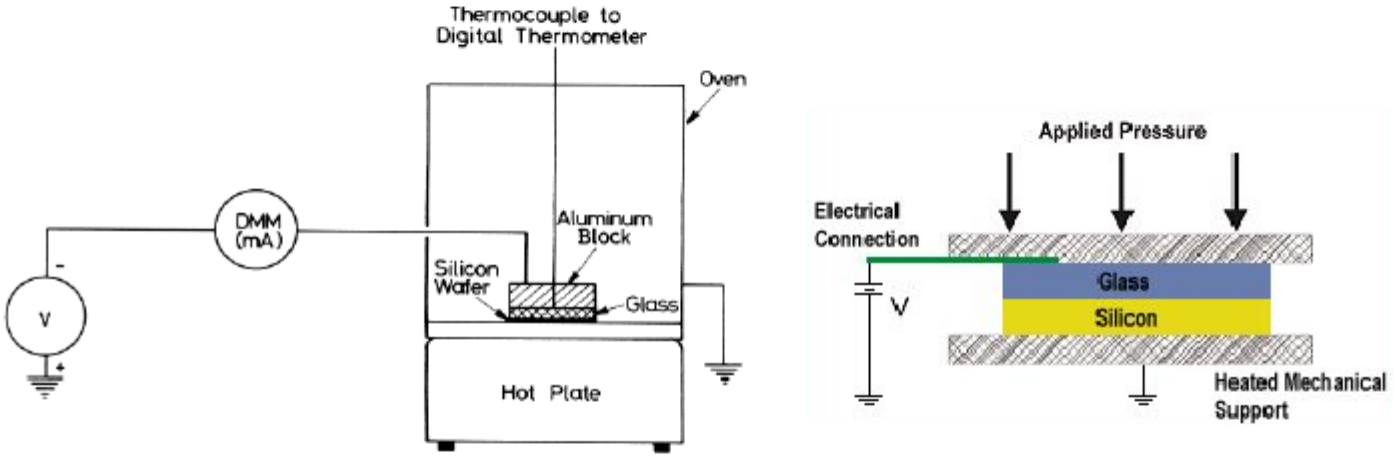
- Wet etch vs Dry Etch
- Etch Selectivity
- Etch Rate
- Degree of Anisotropy

Thin Film Deposition : Evaporation



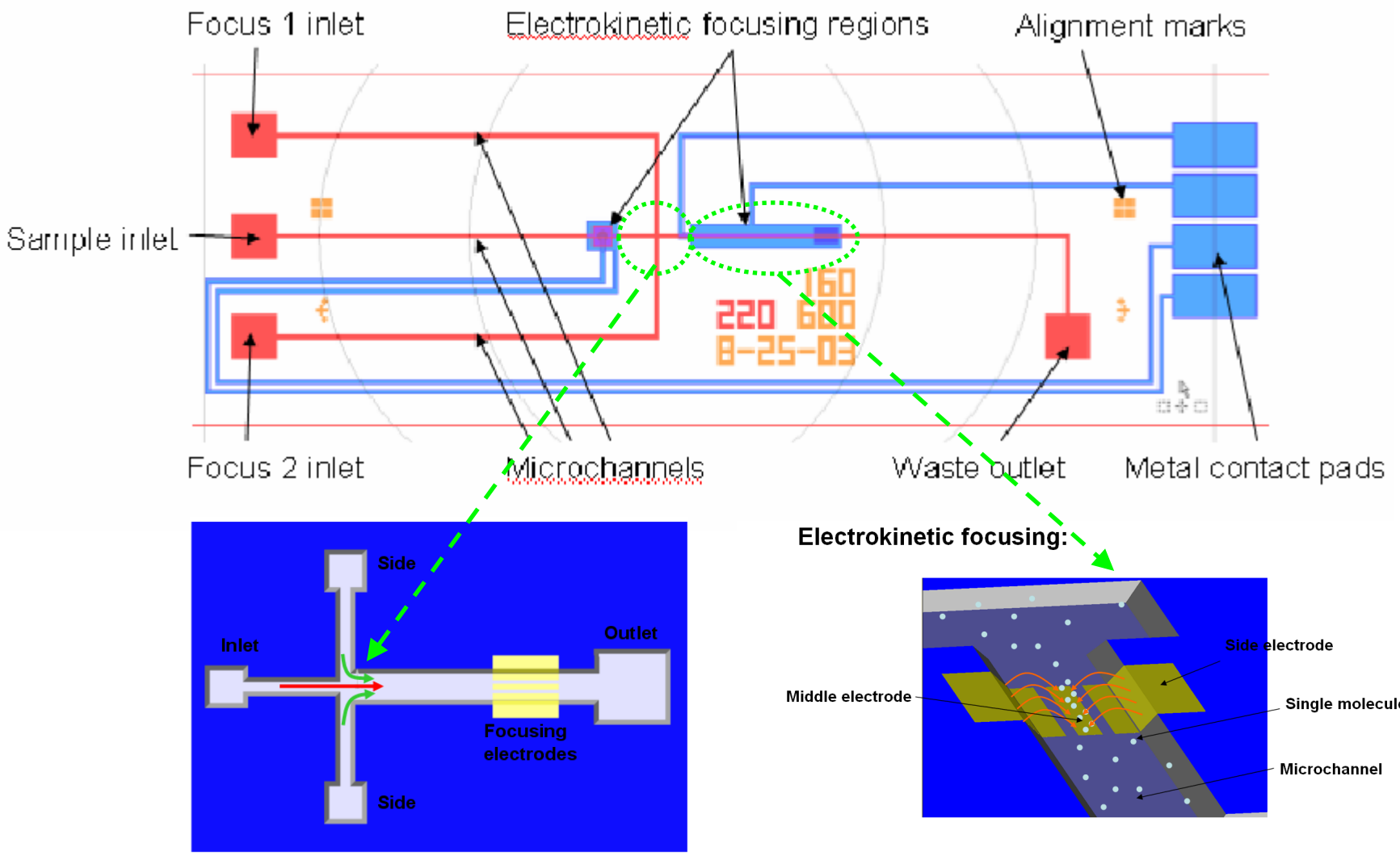
- Focused beam of electrons are used to locally heat the source
- Can be used to heat/evaporate even high melting point materials

Packaging: Anodic Bonding



- High voltage (300 -1000 V) generates large electrostatic forces
- High temperature (300-600 C) facilitates bonding
- Bonds SiO_2 to Si or metal
  - Use Pyrex 7740 or Borofloat glass to match thermal expansion coefficient

Layout of Flow Cytometer (FC)



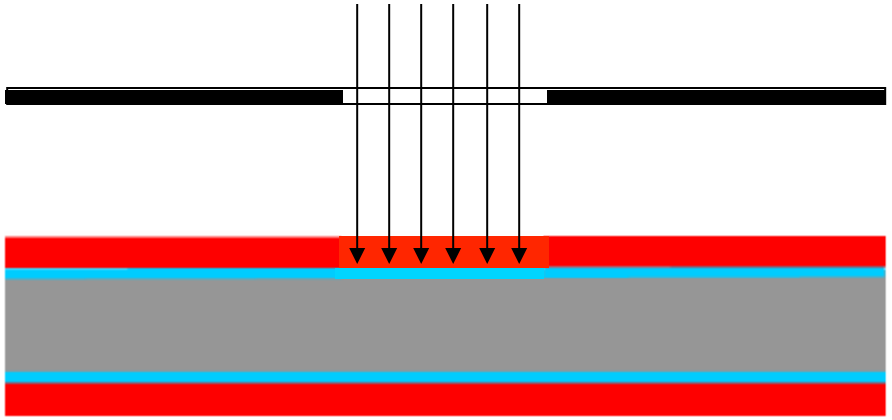
Process Flow for Flow Cytometer (FC)

1. Oxidation of silicon substrate (Lab done by staff)

- Grow 0.5~1μm oxide on silicon surface

2. Patterning the oxide with mask #1 (Lab #2_FC)

- 2μm PR 1813 used as mask
- Buffered HF (BOE) used for wet etching
- Wafer backside also protected by PR 1813 (manually applied)



(positive PR)

3. Substrate bulk etching (Lab #3_FC)

- Concentrated KOH used for wet etching
- Temperature control required
- Channel width: 120 ~ 150μm, depth: ~ 20μm

4. Second oxidation (Lab #4_FC)

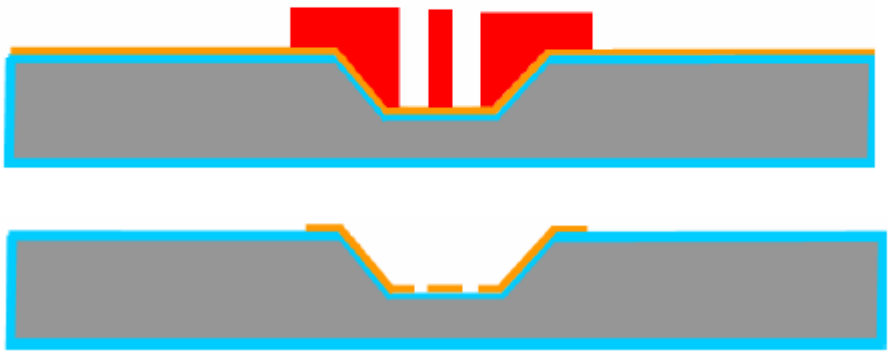
- Grow 0.5μm oxide for electrode isolation purpose

5. Metallization by thermal evaporation (Lab #5_FC)

- 2500Å aluminum film deposited as electrodes
- 10 ~ 20 μm PR SJR5740 photoresist deposition on fresh aluminum

6. Patterning metal by aluminum etchant (Lab #6_FC)

- Photolithography using electrodes mask
- PAN etchant used to remove unwanted aluminum
- Electrodes spacing: 50μm



7. Removal of oxide on after patterning with mask #3 (Lab #7_FC)

- 10μm PR SJR5740 used as mask (Al attacked by BOE)
- Buffered HF used as etchant

8. Anodic bonding with pre-drilled glass plate (Lab #8_FC)

- Pyrex 7740 glass used to seal the microchannels

Process Flow for Flow Cytometer (FC)

Silicon oxidation
Lab # 2_WG

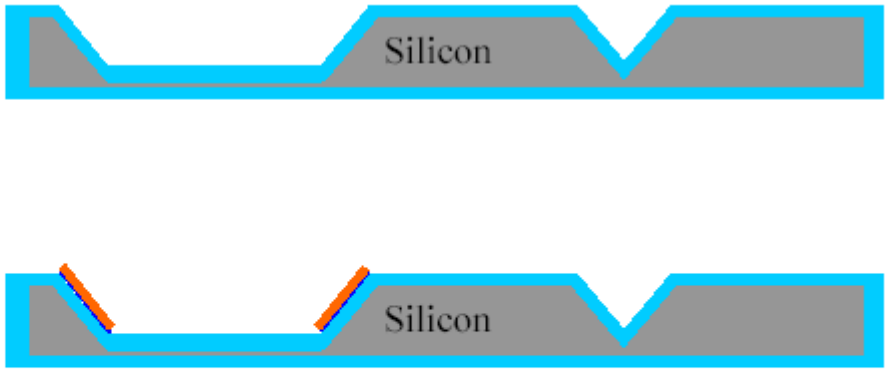
Photoresist deposition (back and front)
Lab # 3_WG

Front side lithography
Lab # 3_WG

Buffered Oxide etch
Lab # 3_WG

Anisotropic silicon KOH etch
Lab # 4_WG

Cladding Layer grown (Thick SiO_2 - wet oxide)
Lab # 5_WG
Shadow Mask Aluminum Patterning
Lab # 6_WG



SU-8 Fill Waveguide Complete
Lab # 7_WG

SU-8 is negative PR