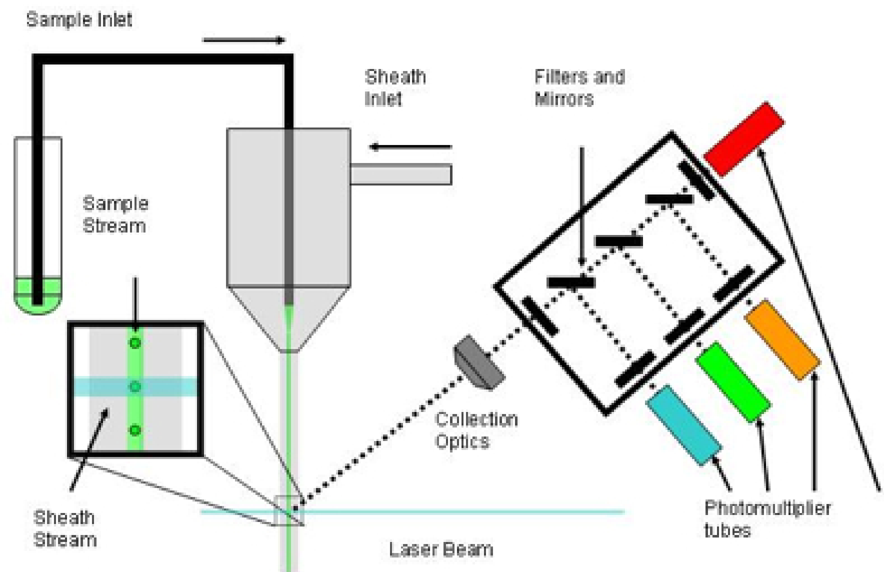
Lecture 3

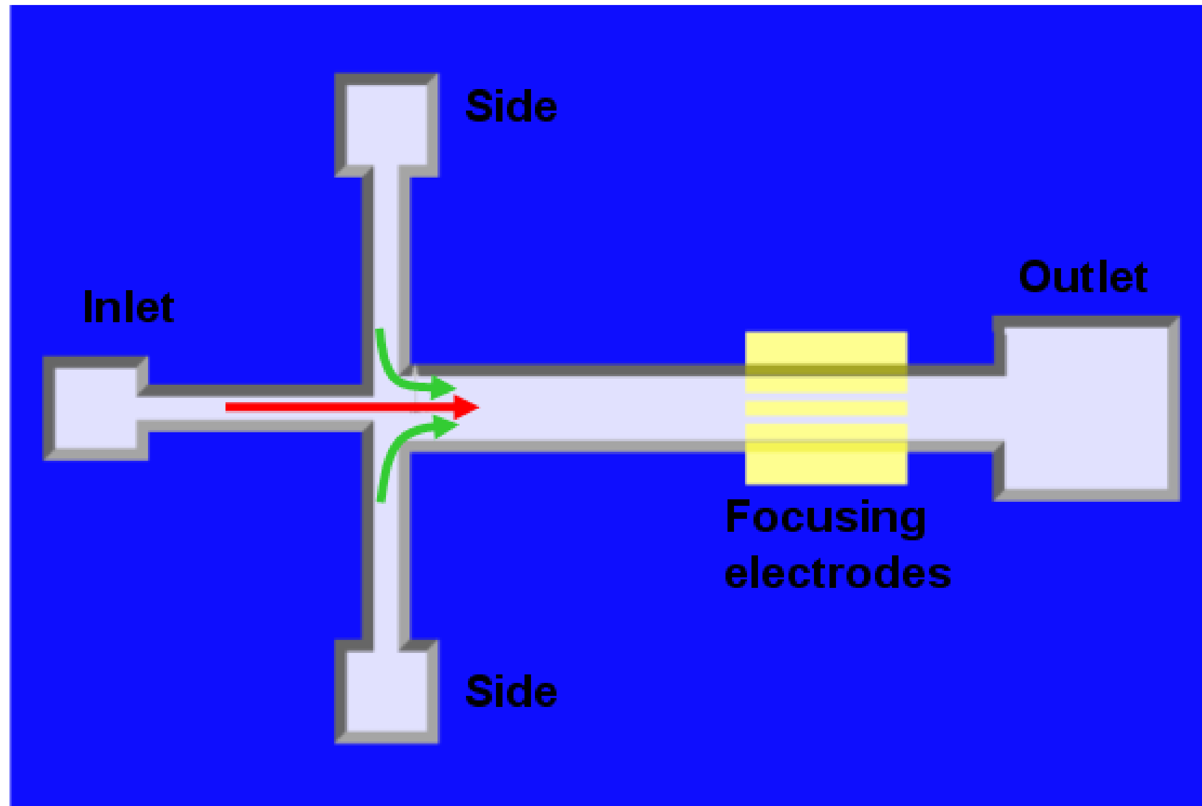
# Project Description & Process Flow

# 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.

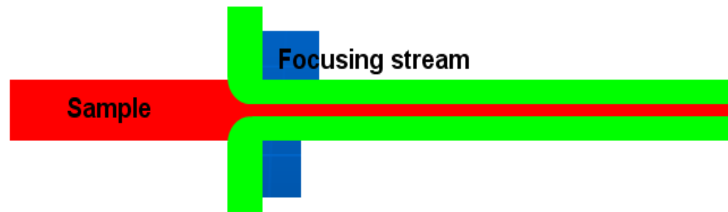


# Flow Cytometer /Molecular Focusing on a Chip

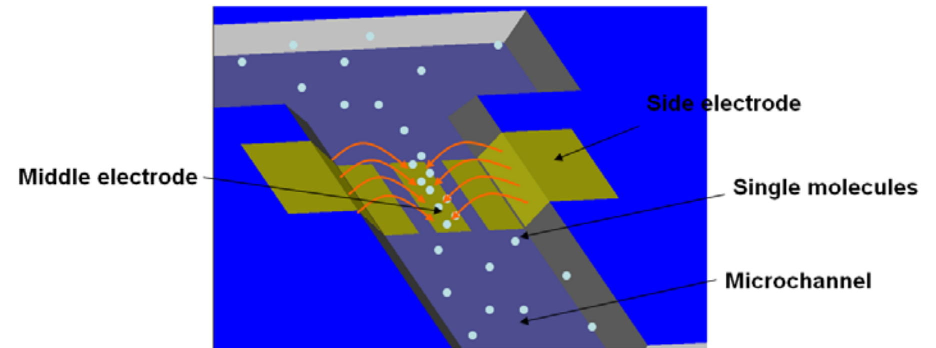


# Hydrodynamic Focusing and Electrokinetic Focusing

Hydrodynamic Focusing:

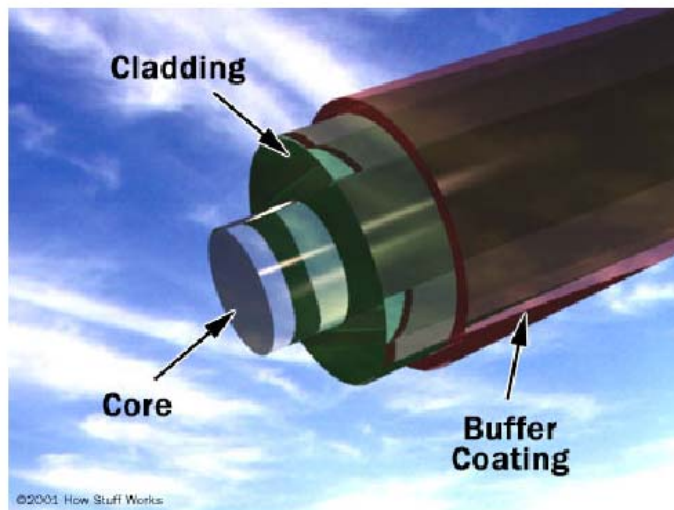


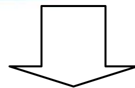

Electrokinetic focusing:

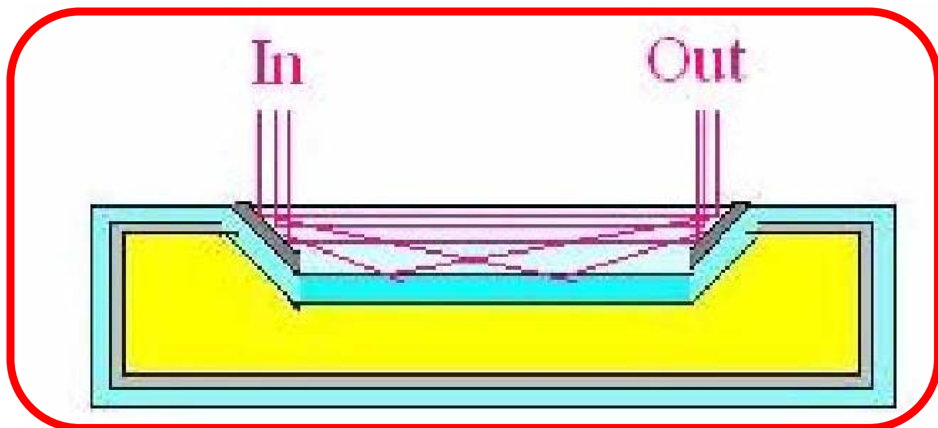


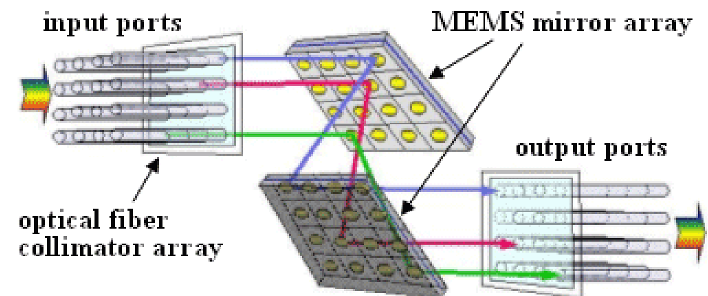
# Optical Waveguide on a Chip

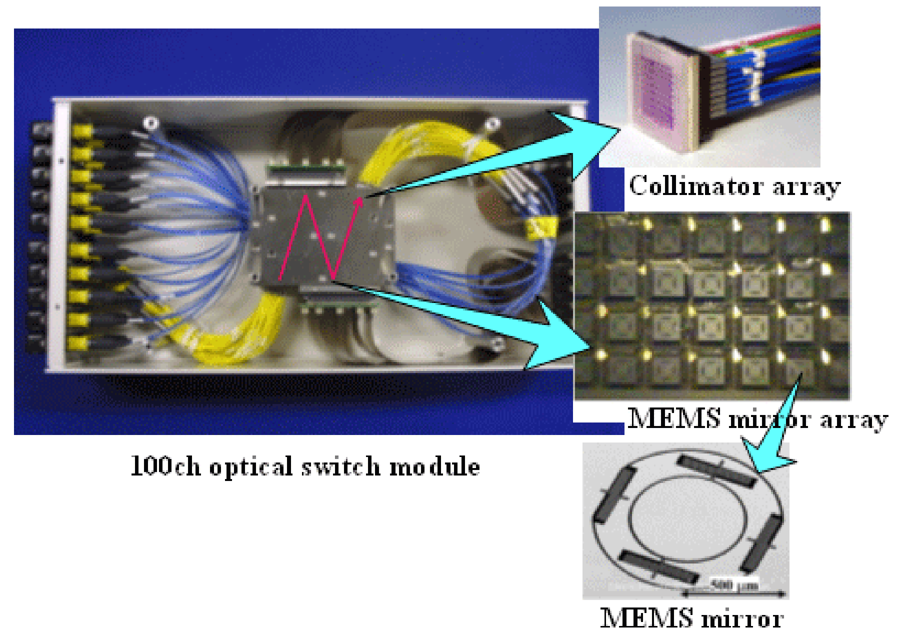
**Optical waveguides** are widely used, especially in the form of optical fibers, for long distance, high data rate telecommunications.



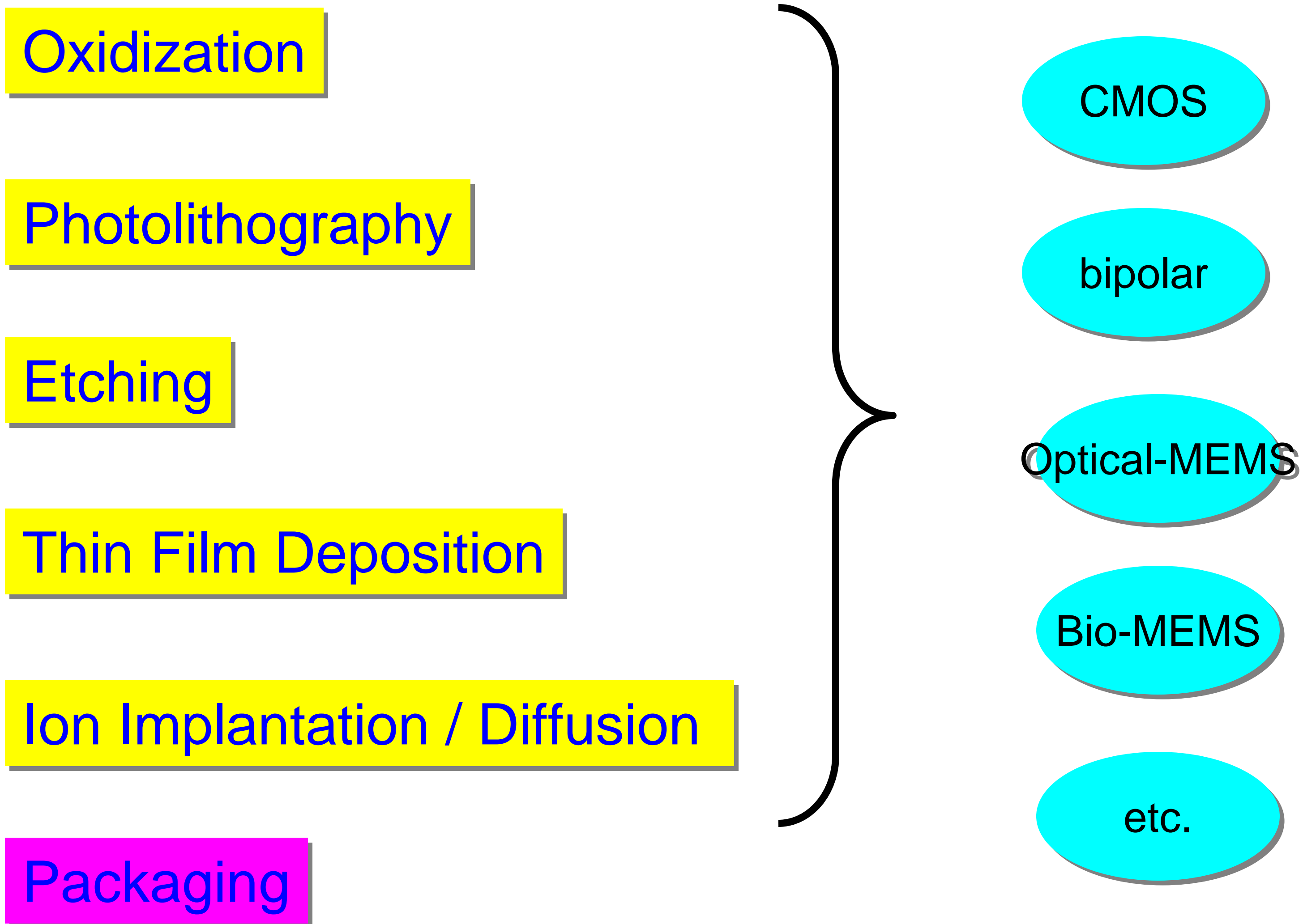





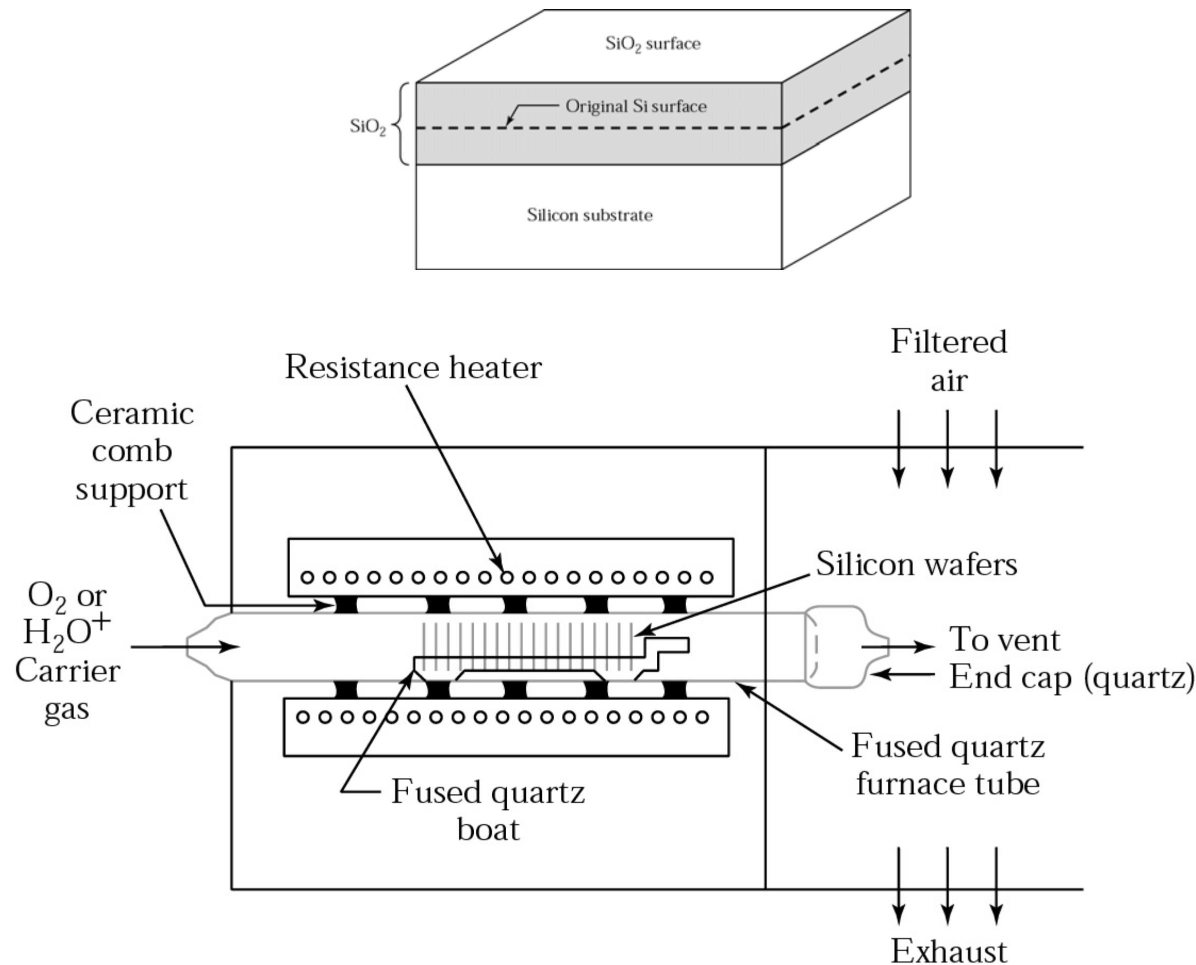



# Basic Microfabrication Steps

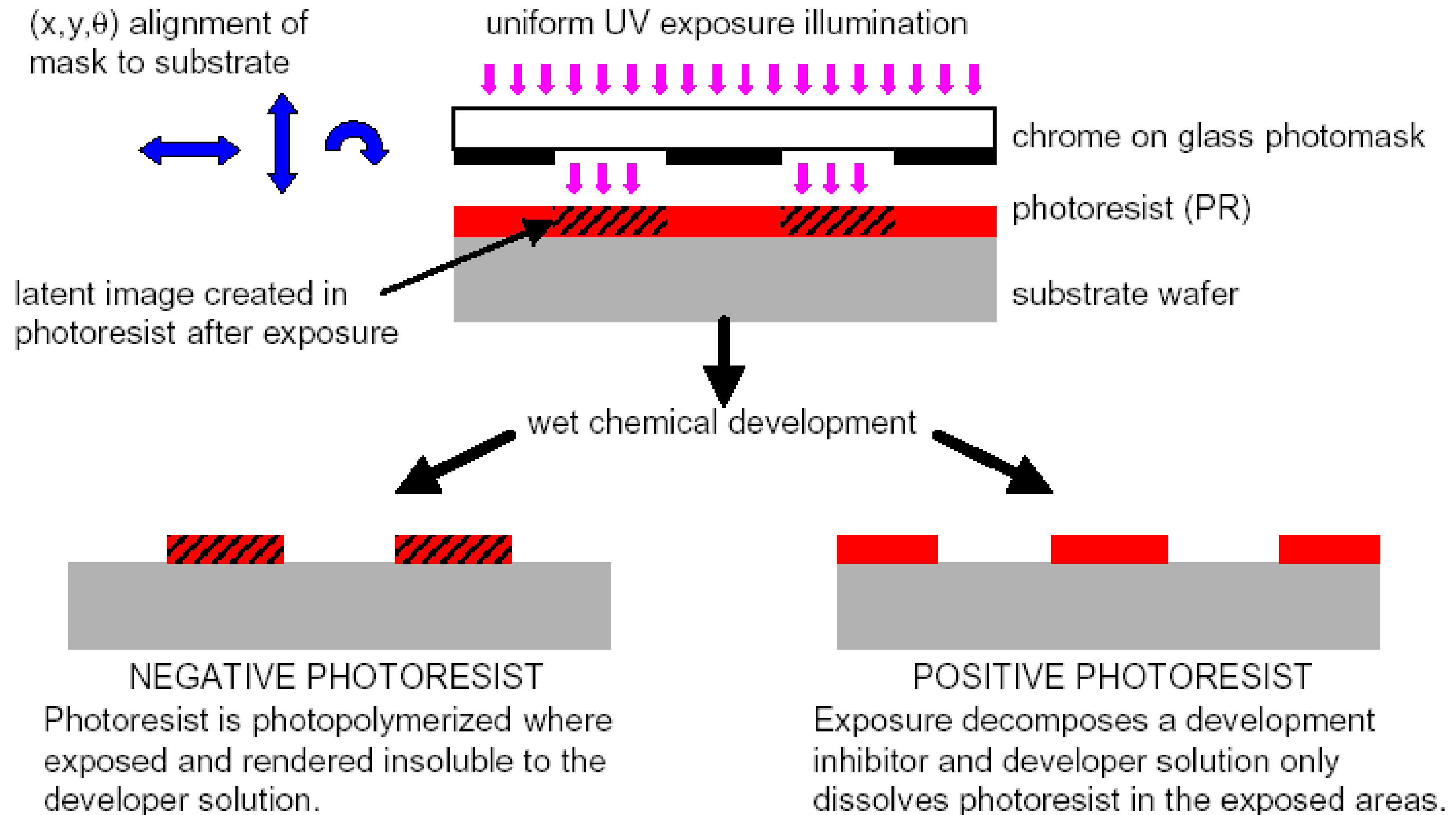


# Thermal Oxidization

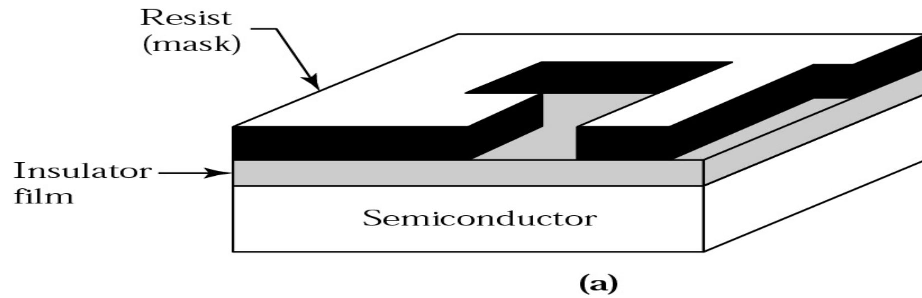
- Dry Oxidization : Si (solid) + $O_2$ (gas) → $SiO_2$ (solid)
- Wet Oxidization: Si (solid) + $2H_2O$ (gas) → $SiO_2$ (solid) + $2H_2$ (gas)

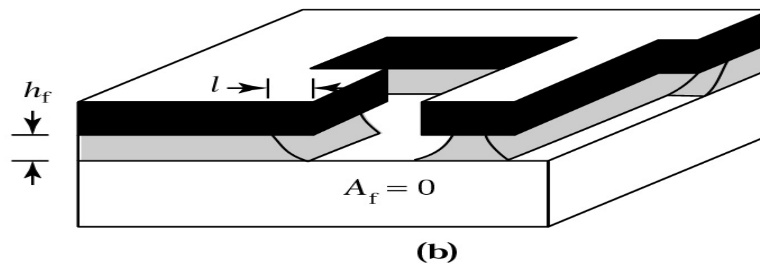


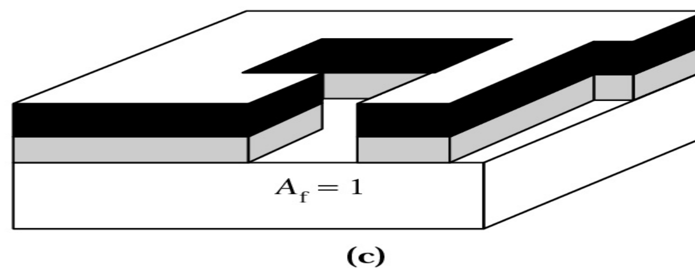
# Photolithography



# Etching

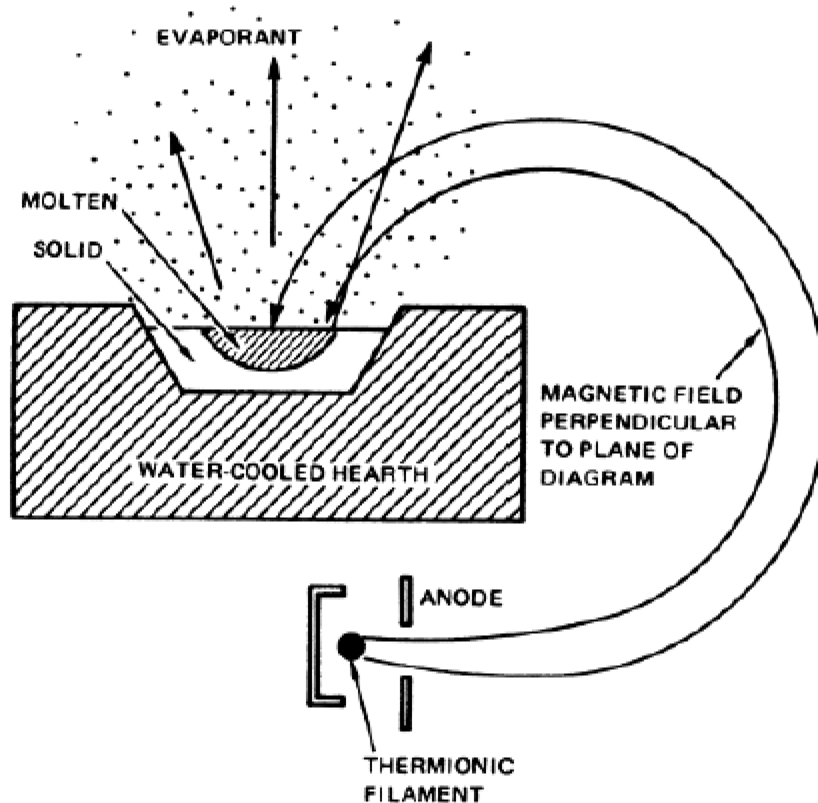



- Wet etch vs Dry Etch
- Etch Selectivity
- Etch Rate
- Degree of Anisotropy

# 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

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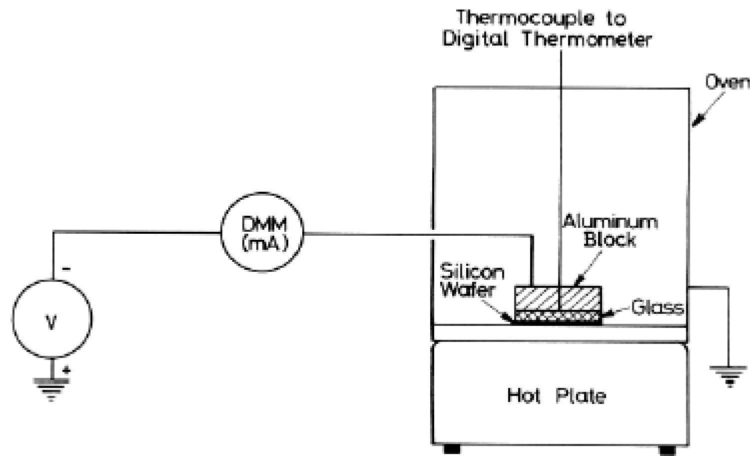
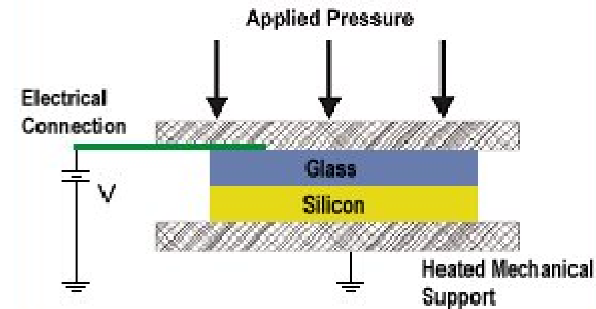
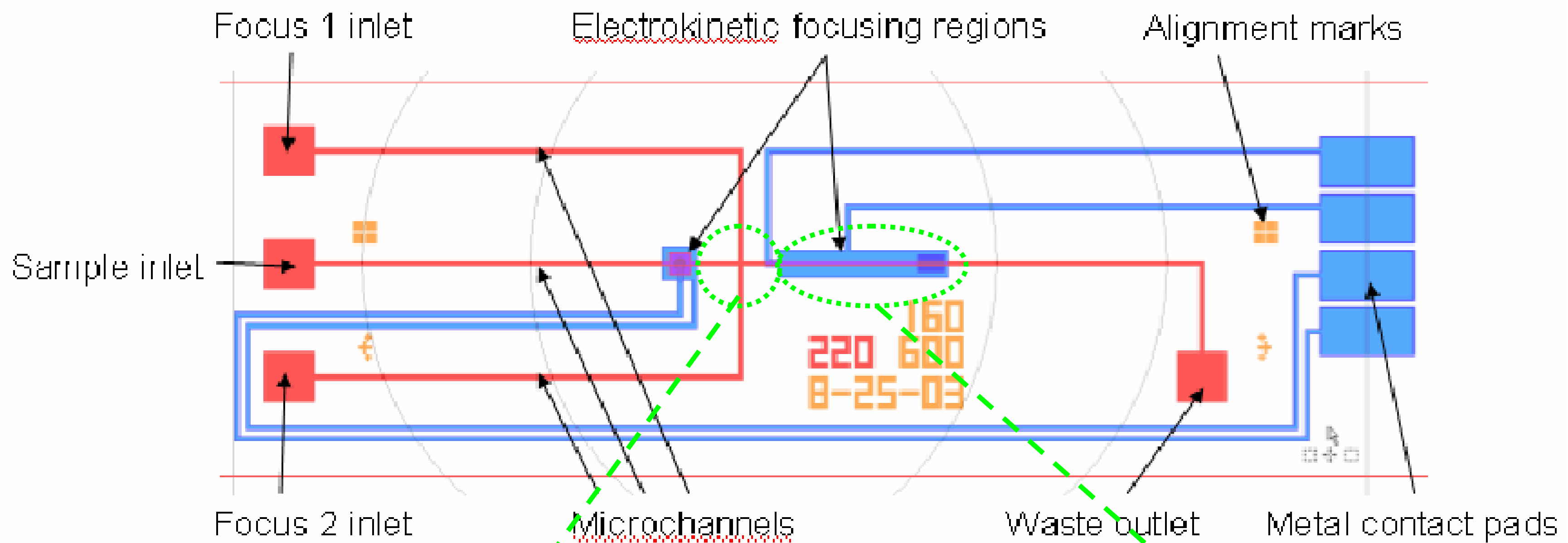
# Packaging: Anodic Bonding

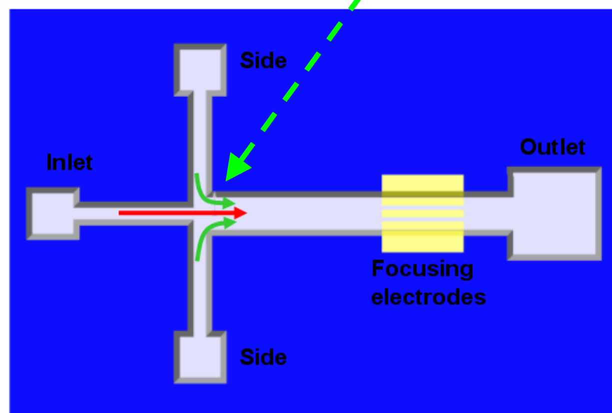


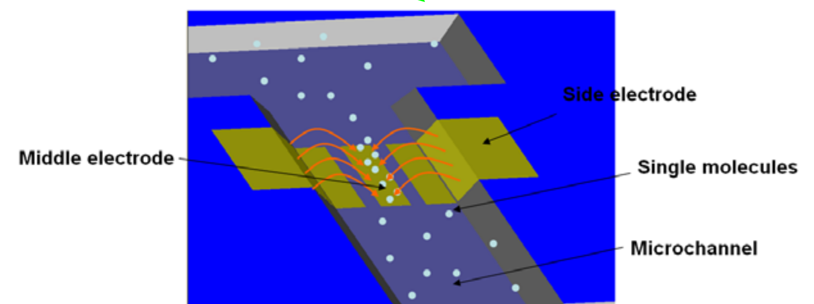

- High voltage (300 -1000 V) generates large electrostatic forces
- High temperature (300-600 C) facilitates bonding
- Bonds $SiO_2$ to Si or metal
  - Use Pyrex 7740 or Borofloat glass to match thermal expansion coefficient

# Layout of Flow Cytometer (FC)




Electrokinetic focusing:



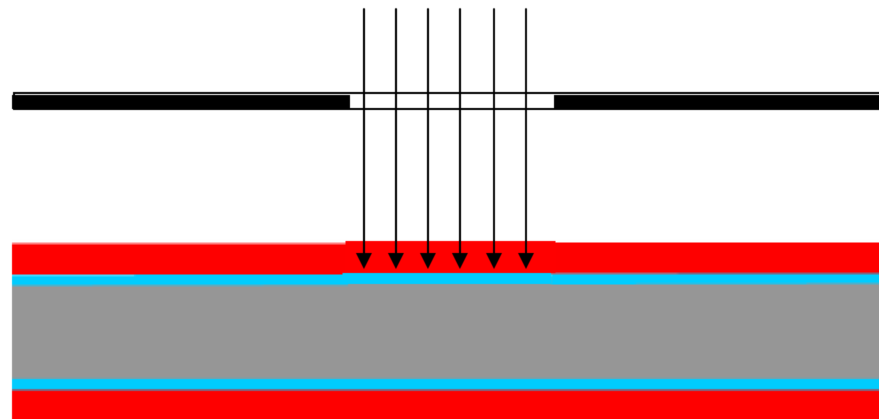
# Process Flow for Flow Cytometer (FC)

**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)



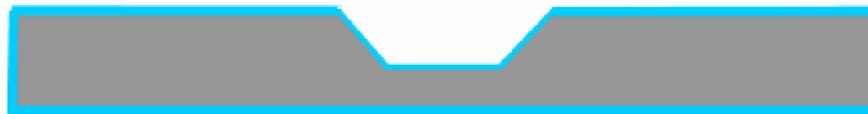
(positive PR)

**3. Substrate bulk etching (Lab #3_FC)**

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

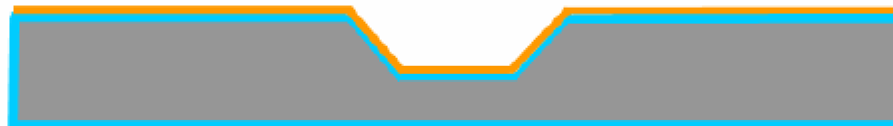
**4. Second oxidation (Lab #4_FC)**

- 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



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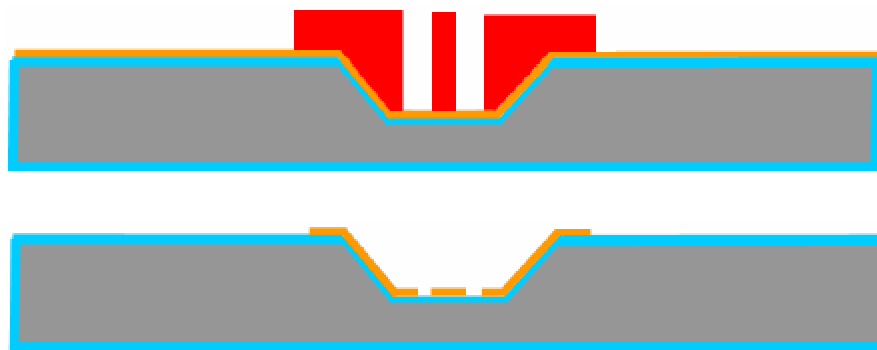
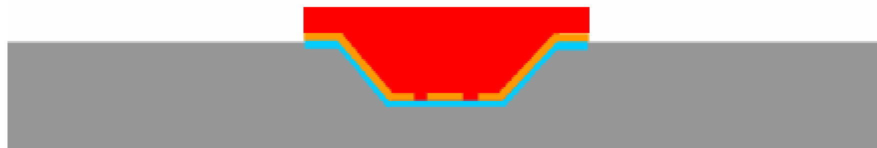
6. **Patterning metal by aluminum etchant (Lab #6_FC)**

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



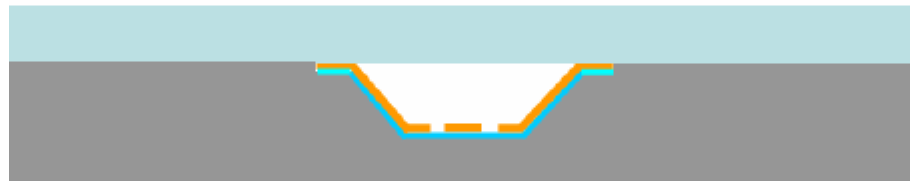
7. **Removal of oxide on after patterning with mask #3 (Lab #7_FC)**

- 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



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# 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