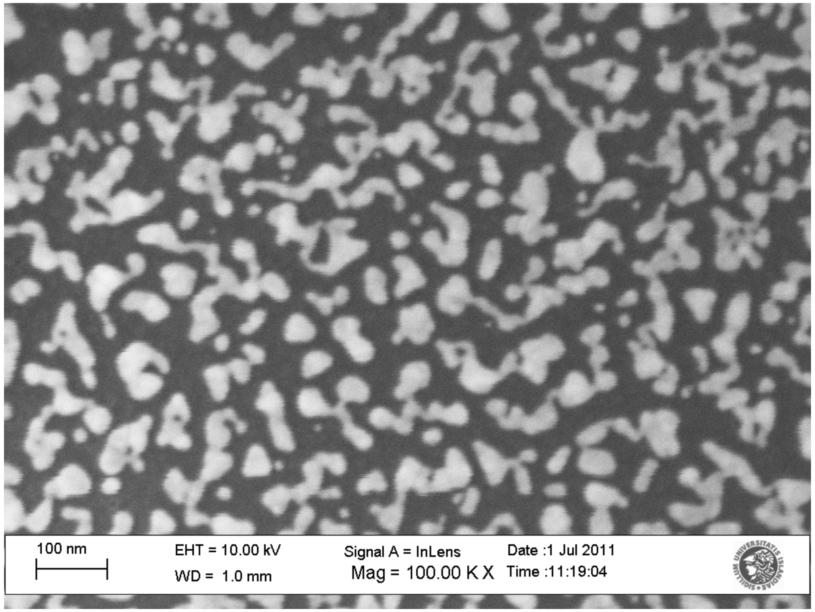
Preparation of Nanostructures

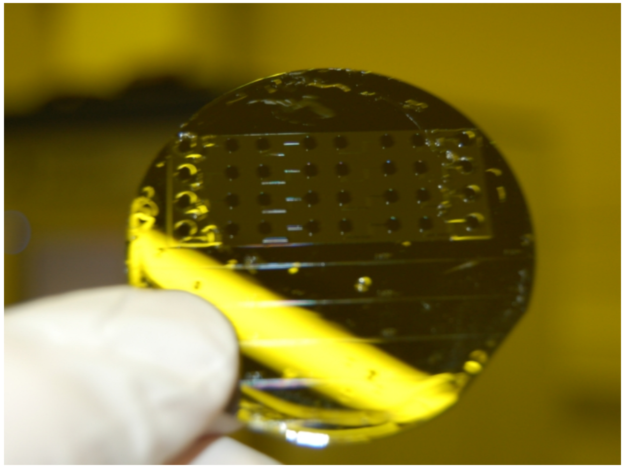


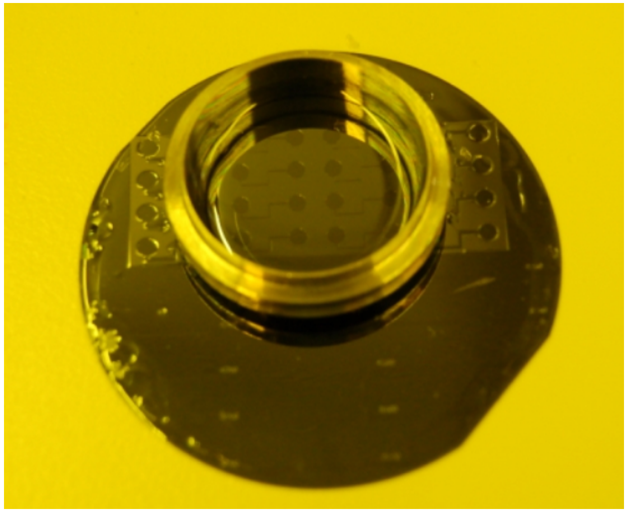
SEM picture of 7nm thick gold on a polymer substrate

Guðmundur Kári Stefánsson
19th November 2012

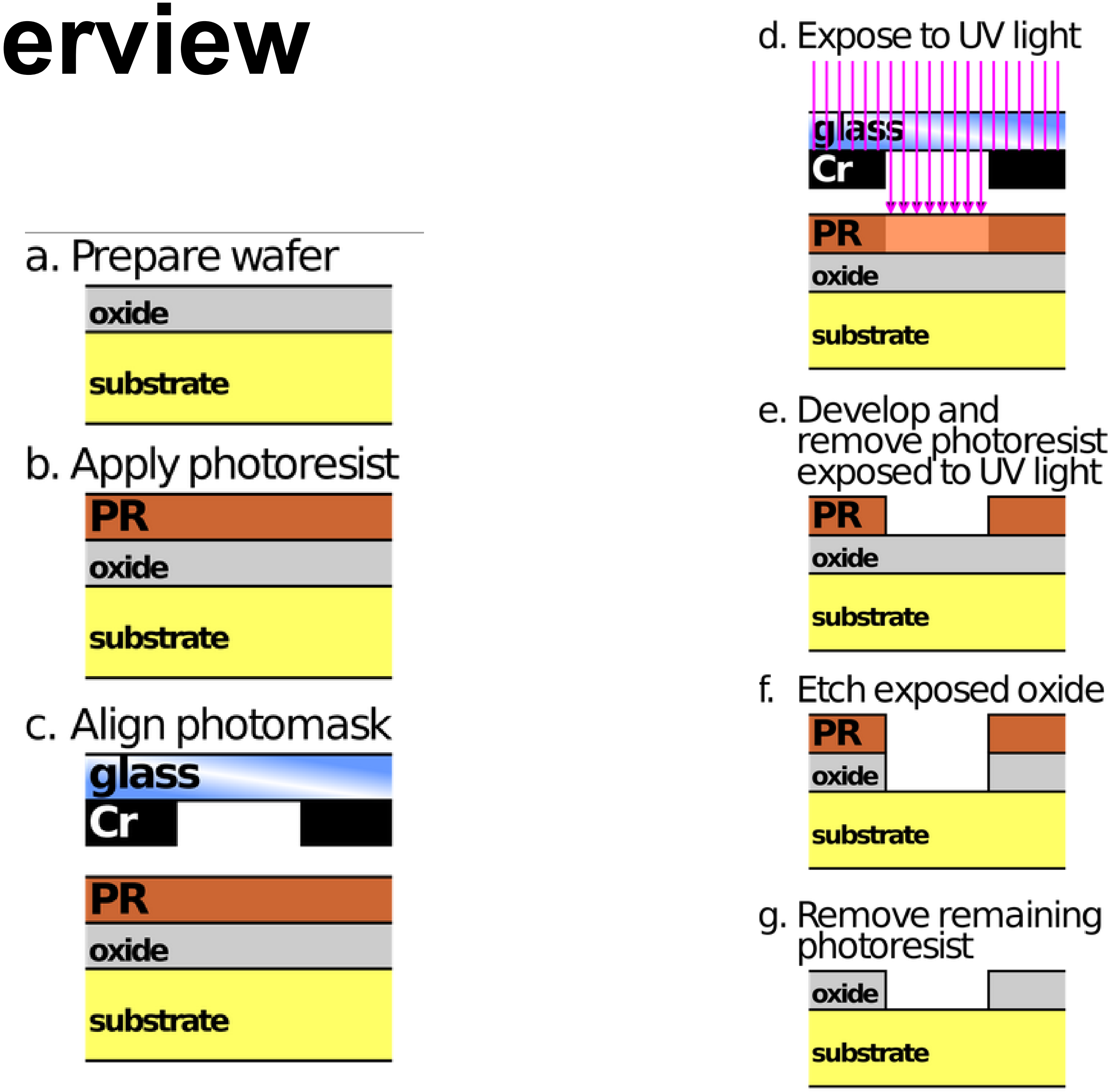
HÁSKÓLI ÍSLANDS

- Patterning techniques
- Equipment
- Applications





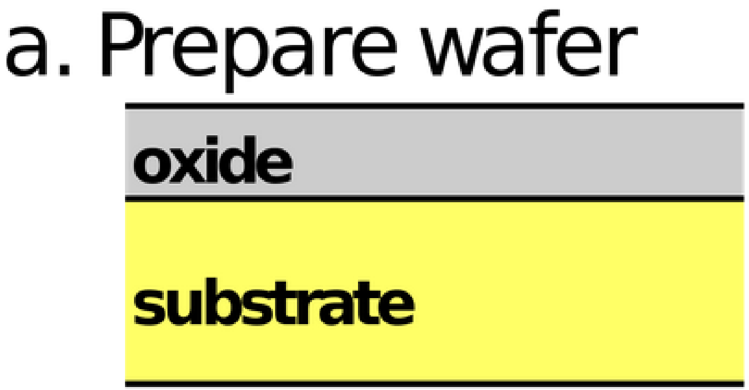
Overview

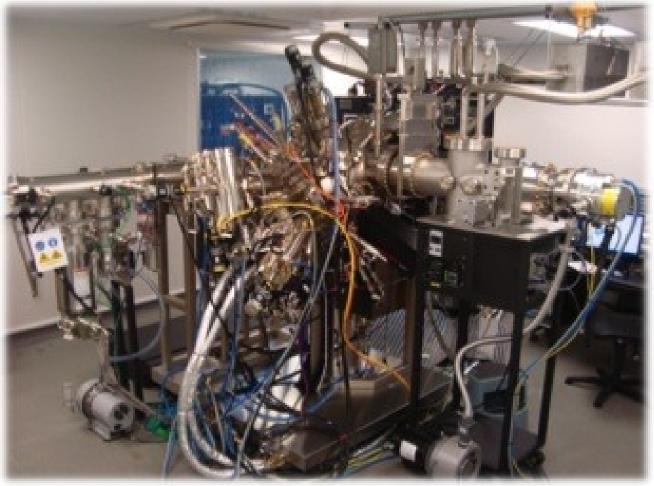


a. Prepare wafer
oxide
substrate
b. Apply photoresist
PR
oxide
substrate
c. Align photomask
glass
Cr
PR
oxide
substrate
d. Expose to UV light
glass
Cr
PR
oxide
substrate
e. Develop and remove photoresist exposed to UV light
PR
oxide
substrate
f. Etch exposed oxide
PR
oxide
substrate
g. Remove remaining photoresist
oxide
substrate

Preparing the substrate

- Substrate
  - Si, Ge, GaAs/AlGaAs, InGaAs/InP
- Molecular Beam Epitaxy (MBE)
  - A technique to grow crystalline layers
  - High purity (>99.999999%)
  - Growth rate: 0.001 - 2 monolayers/sec
- Presence of an oxide layer

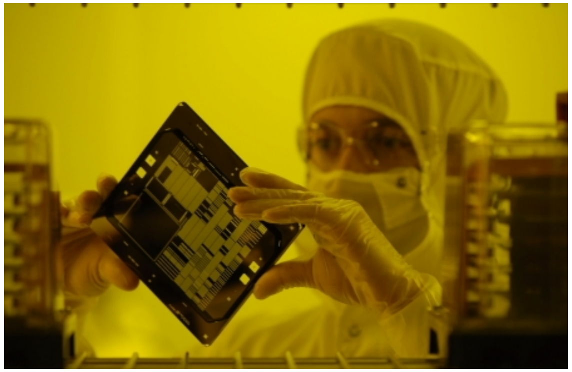




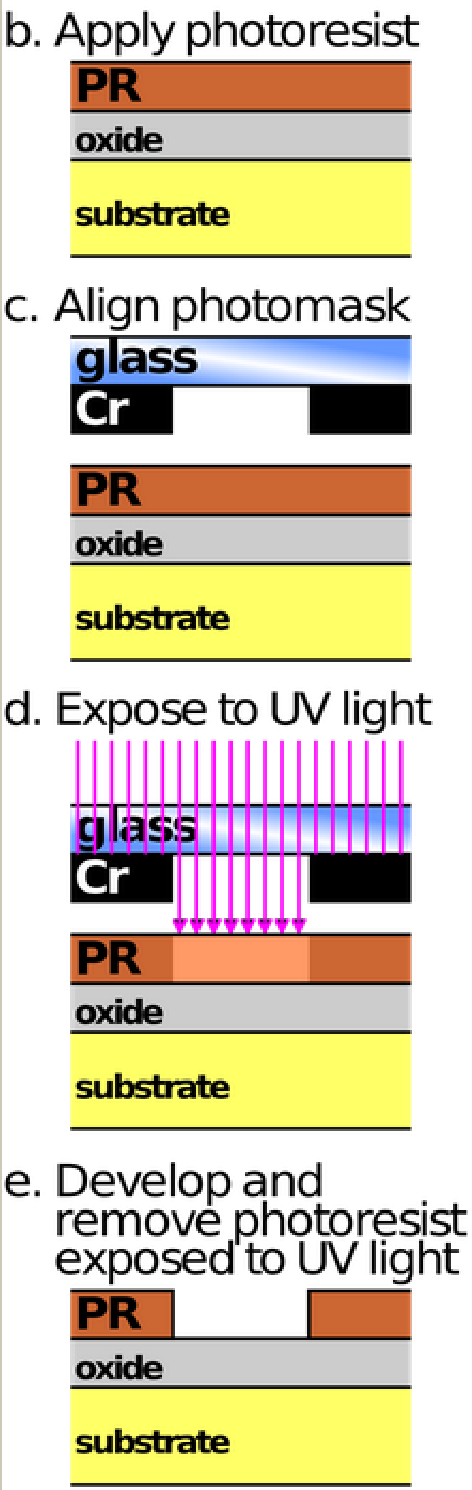
Expensive epitaxy equipment

Lithography

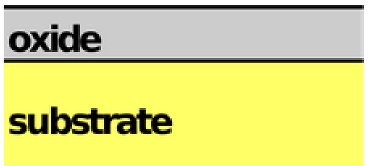
- Transfer of patterns to a UV-sensitive material
- Two main types
  - **<u>Optical lithography -></u>**
    - Range: ~100nm
    - Fast, relatively cheap
  - E-beam lithography
    - Range: ~5-10nm
    - More expensive
- Photoresist:
  - "+": Breaks down if illuminated
  - "-": Hardenes if illuminated



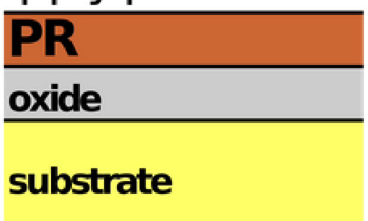
A patterned mask



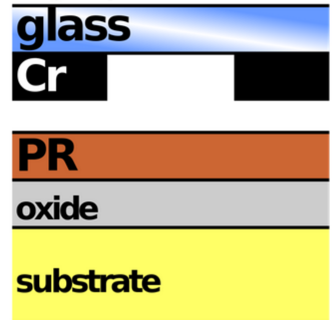
a. Prepare wafer



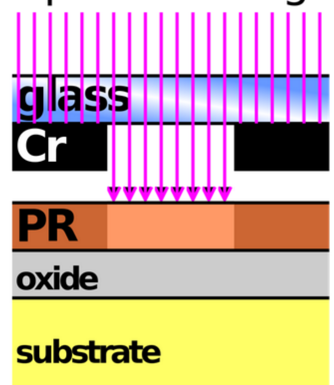
b. Apply photoresist



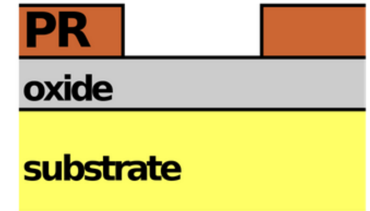
c. Align photomask



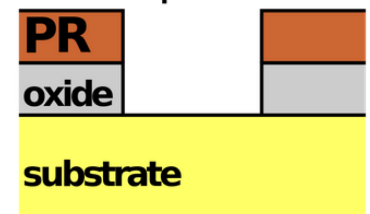
d. Expose to UV light



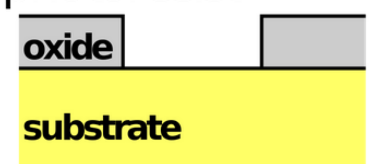
e. Develop and remove photoresist exposed to UV light



f. Etch exposed oxide



g. Remove remaining photoresist



Spinner

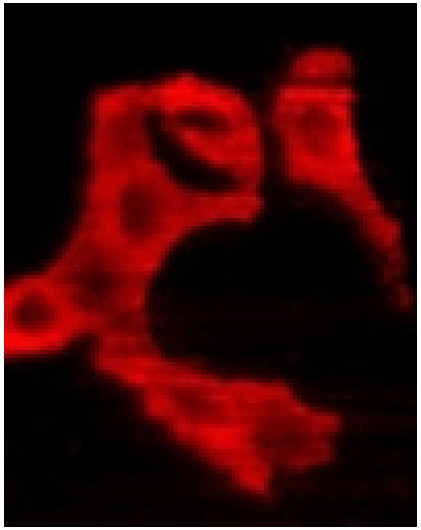
Mask aligner

RIE equipment

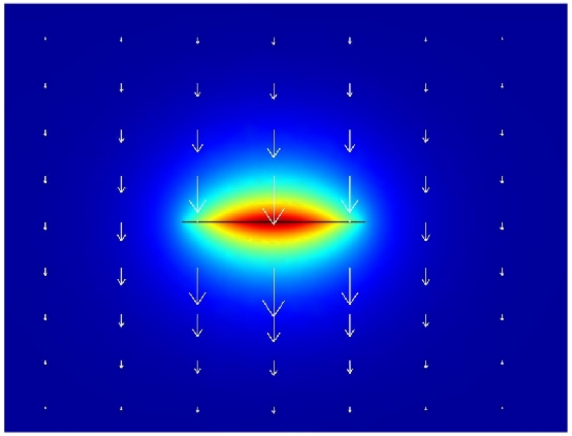
Applications

- Many applications
- Combine with metal deposition
  - Elaborate multilayer devices

- **Research with KL group**
  - Microfluidics
  - LRSPP Waveguides
  - Fluorescent materials – OLED



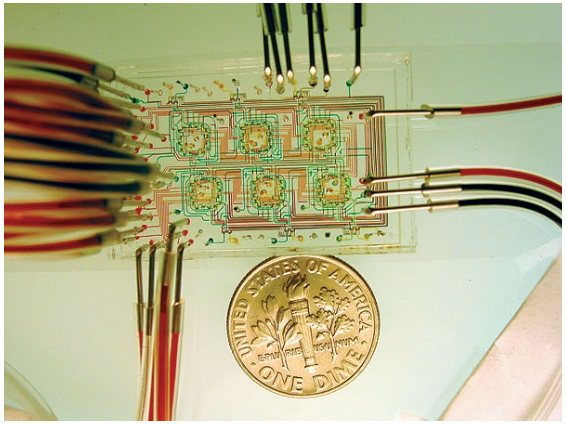
Cell imaging



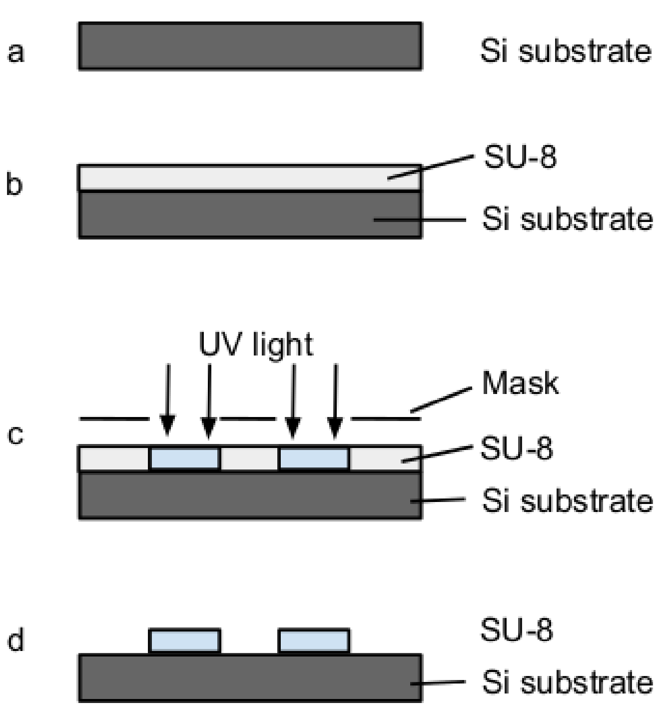
Simulations of LRSPP in a gold waveguide

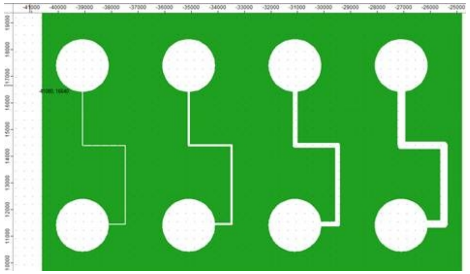
Microfluidics

- Control and manipulation of fluids in a sub-millimeter scale
  - Small volumes: uL, nL, pL, fL
- Organic materials
  - SU-8 master mold
  - PDMS circuits
- Integration with optical circuits
  - Biosensing



Microfluidic circuits - “lab on a chip”

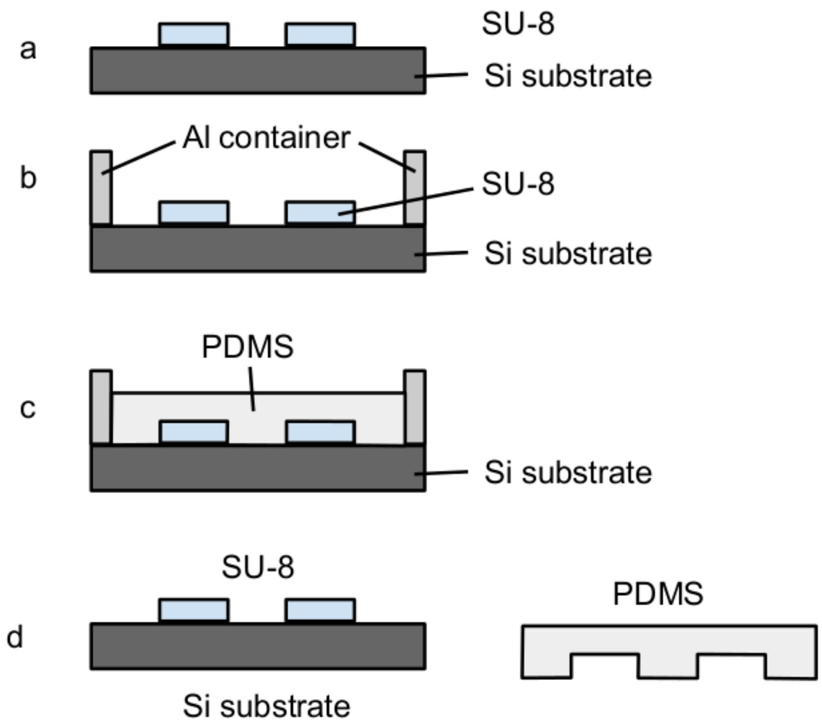


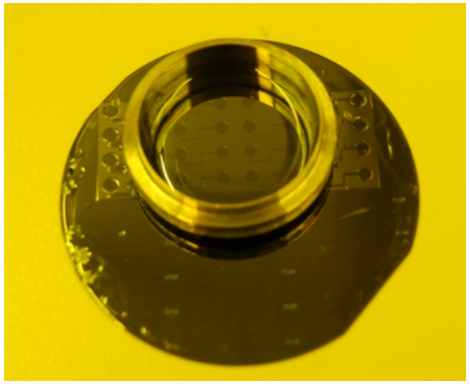


A patterned mask

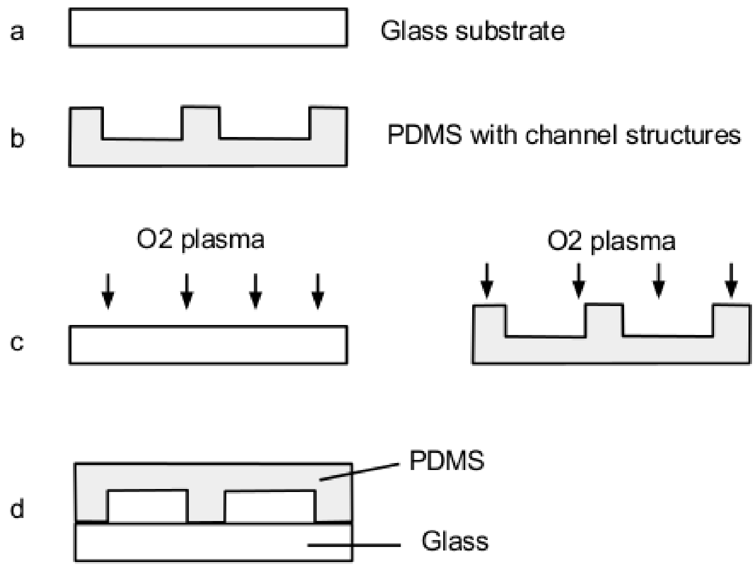
Microfluidics

Shaping the PDMS circuits:





Bonding to a substrate:



A completed microfluidic device