DSE CLASS

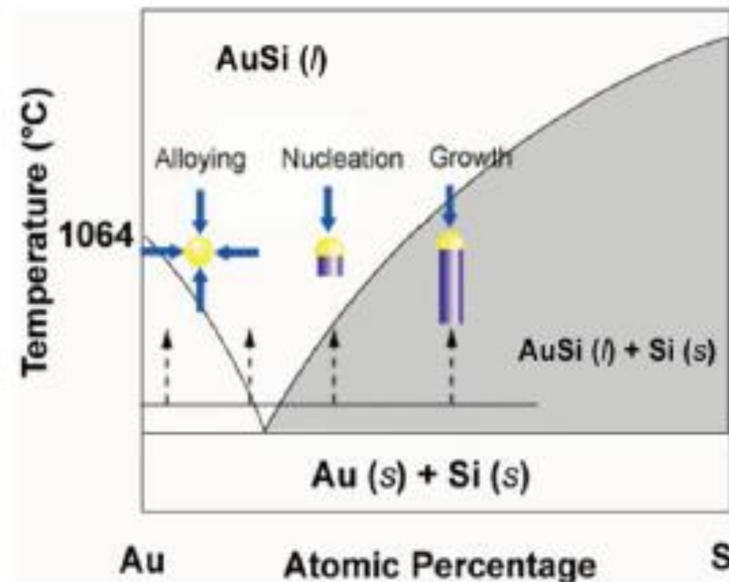
CONDENSED MATTER PHYSICS

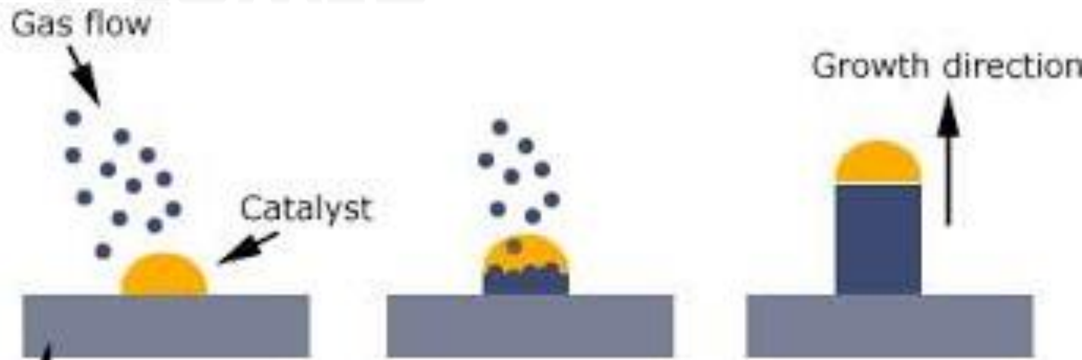
Lecture-13

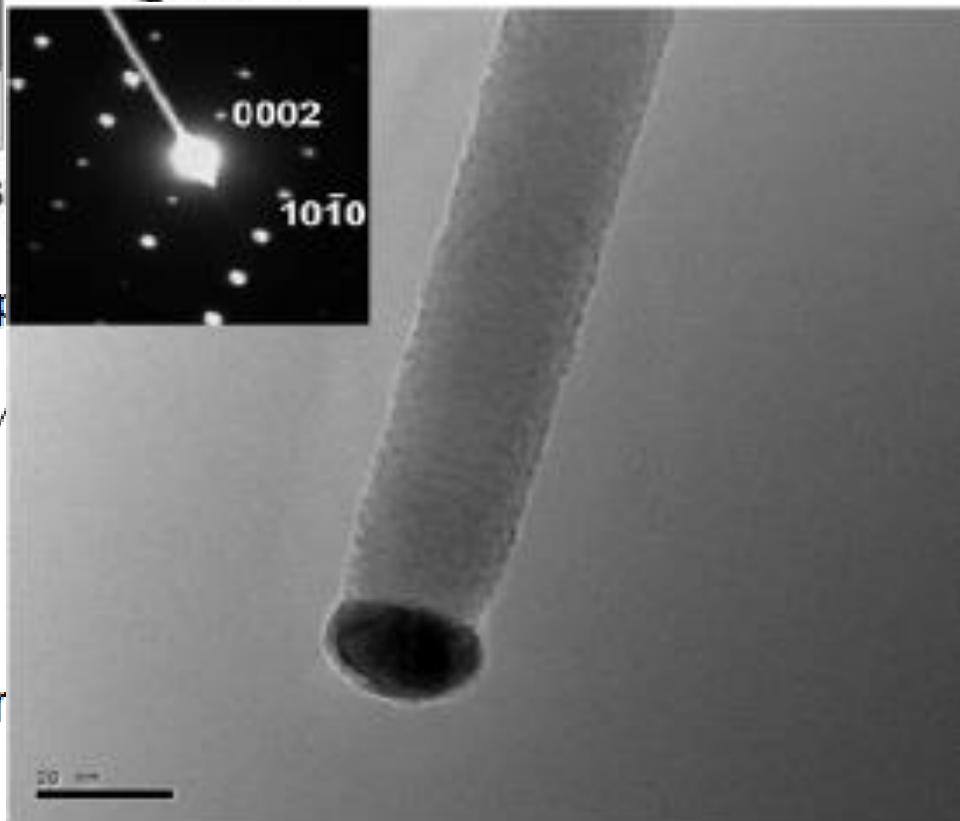
14/1/2021

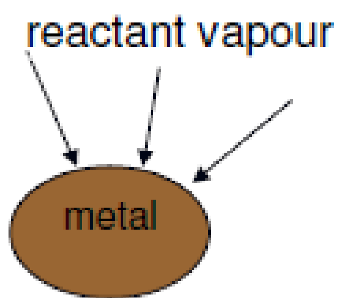
Nanowire Growth

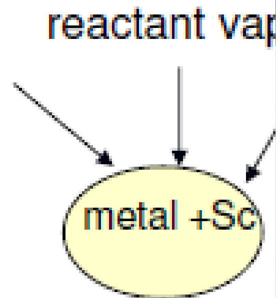
VLS Growth











our

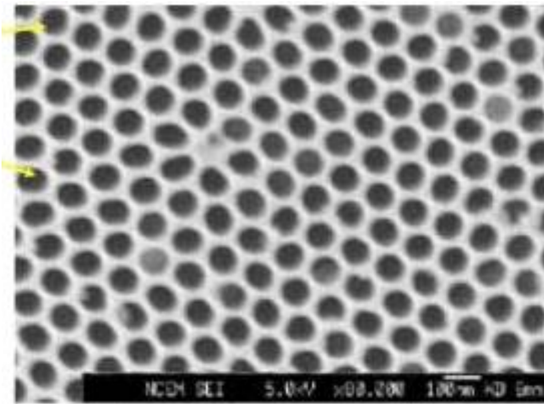
Sc

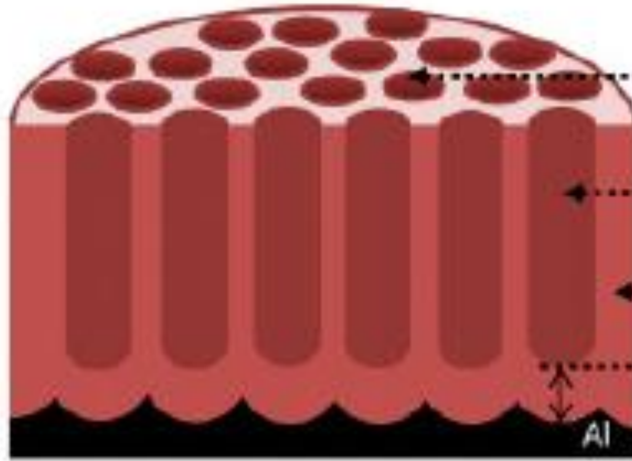
Liquid catalytic nanocluster

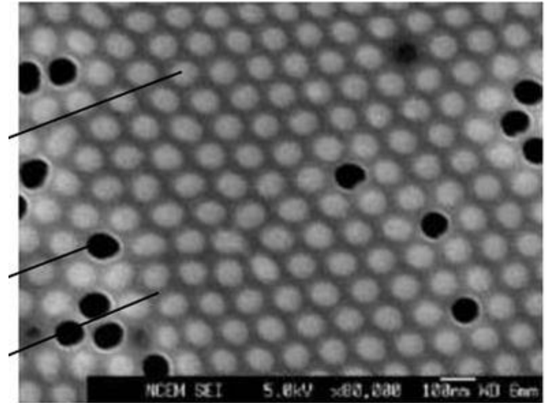
supersatur

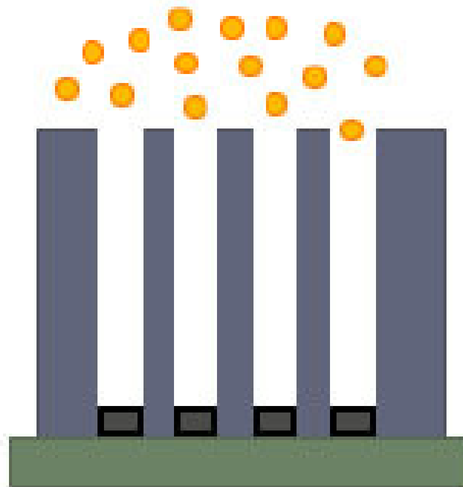
e

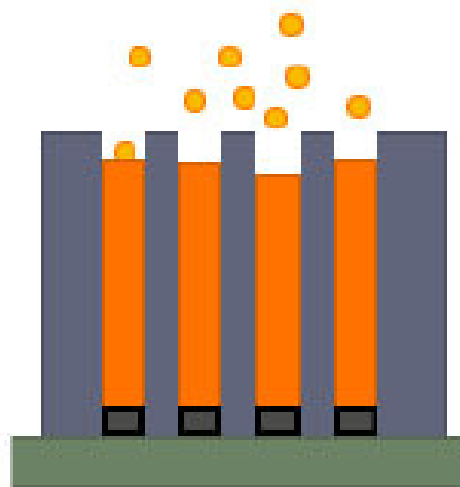
Nanoporous Alumina Template

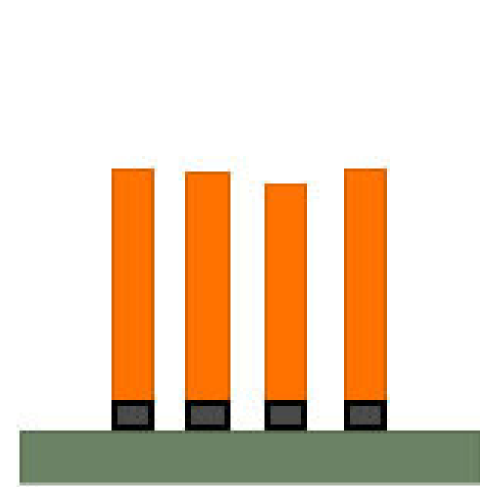




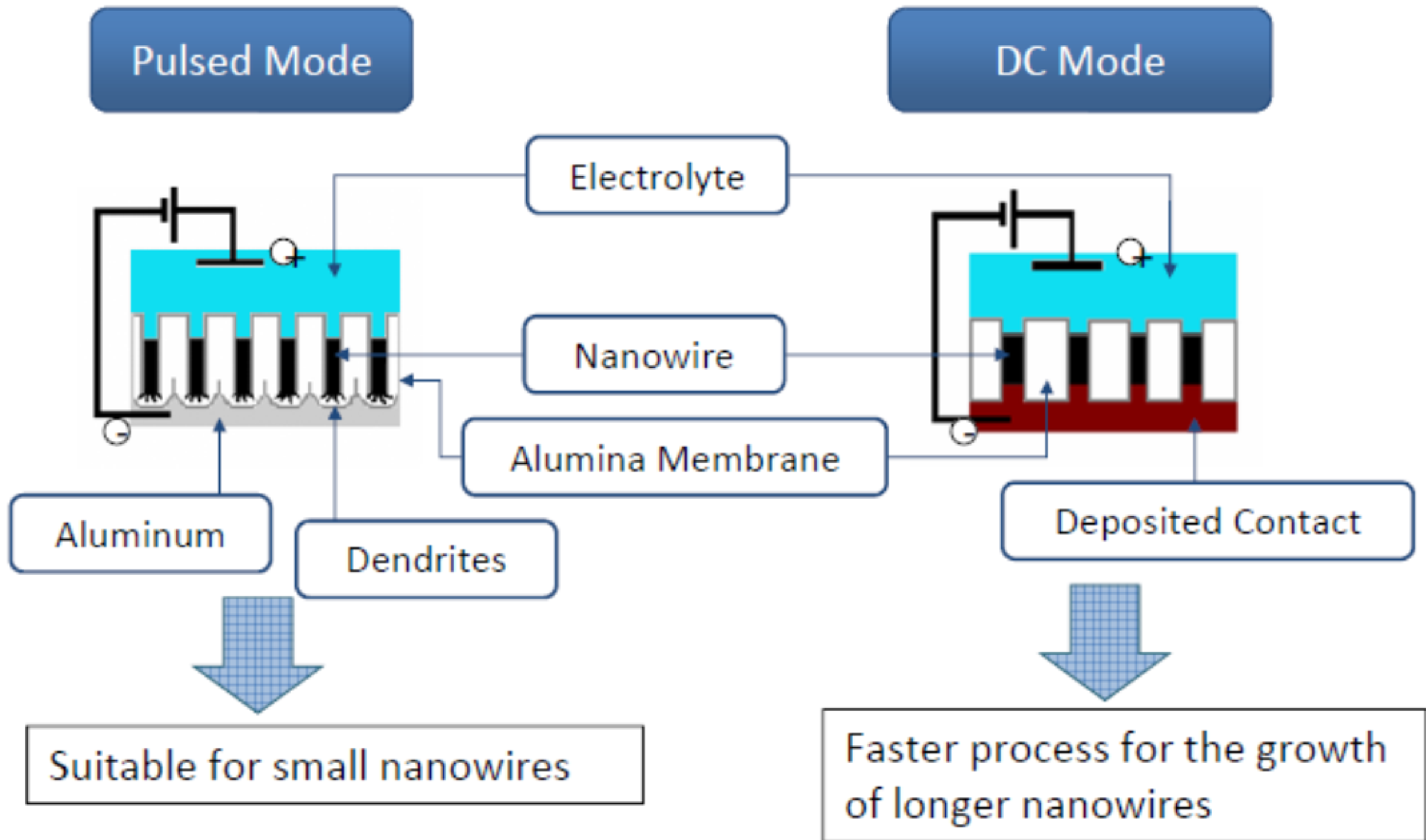








Electrodeposition



Nanoparticle Synthesis

Sol-gel Method:

This method involves two types of materials ‘Sol’ and ‘Gel’

Principle:

- Sol-Gel method involves formation of ‘sols’ in a liquid and then connecting the sol particles to form a network.
- By drying the liquid, it is possible to obtain powders, thin films etc.,

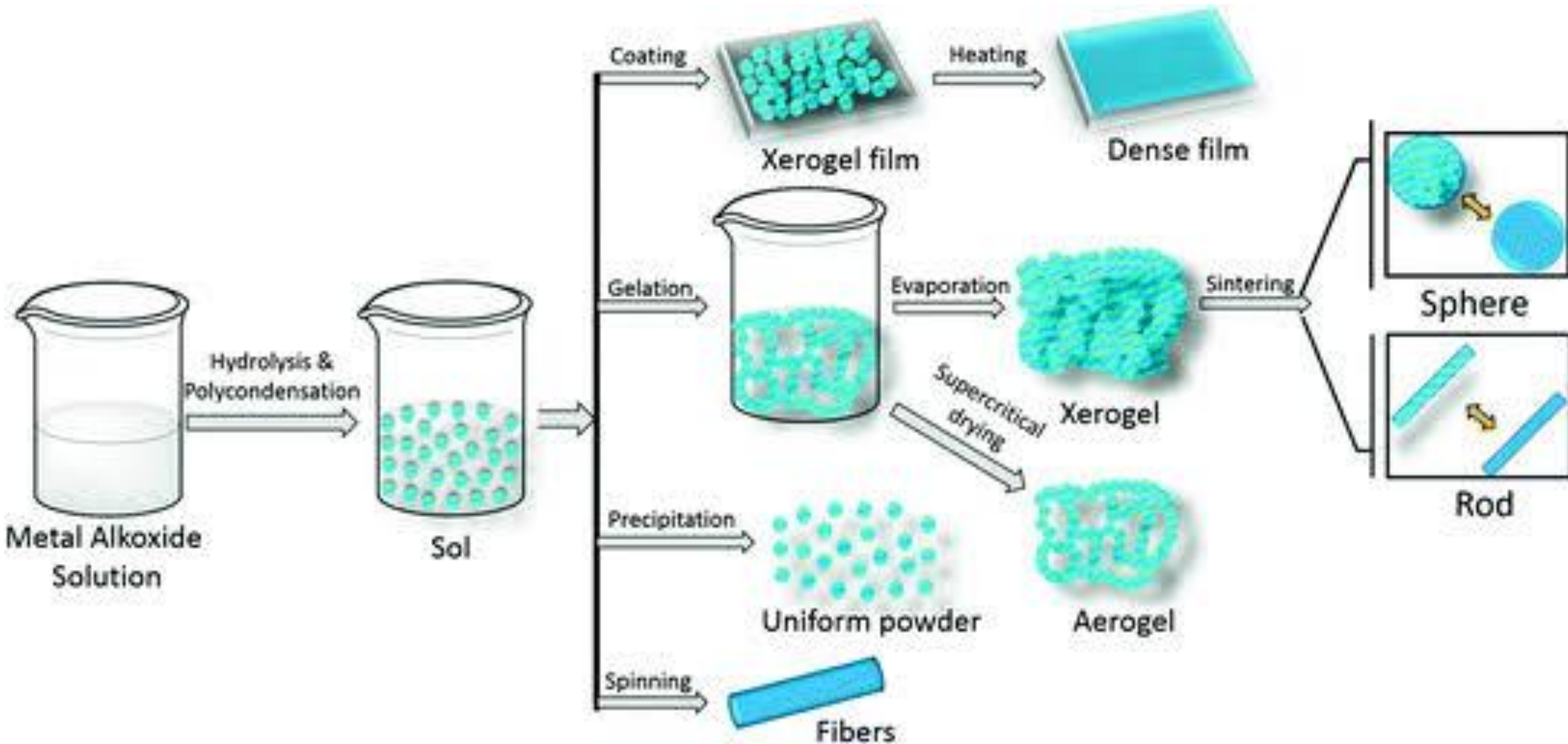
Methods for sol-gel formation:

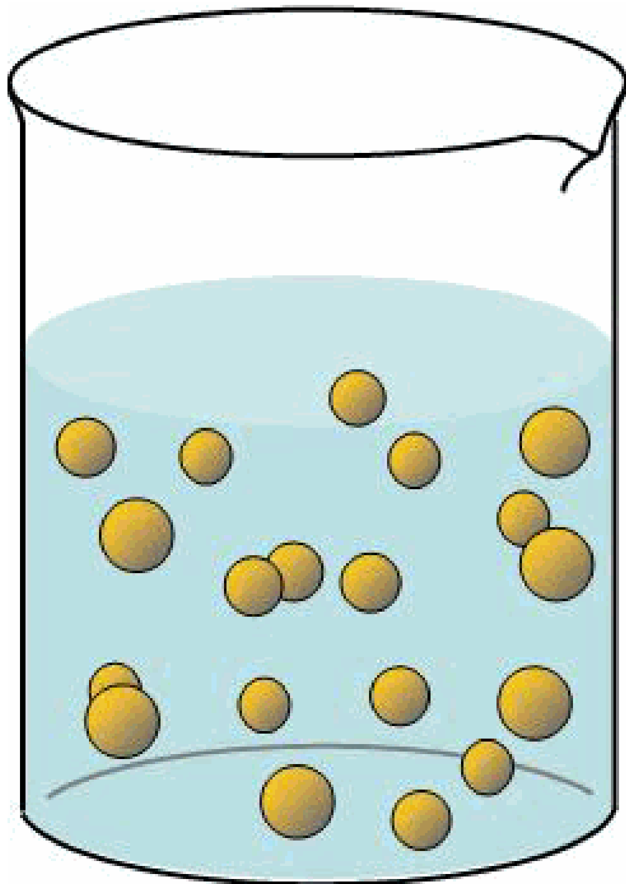
Sol can be obtained by,

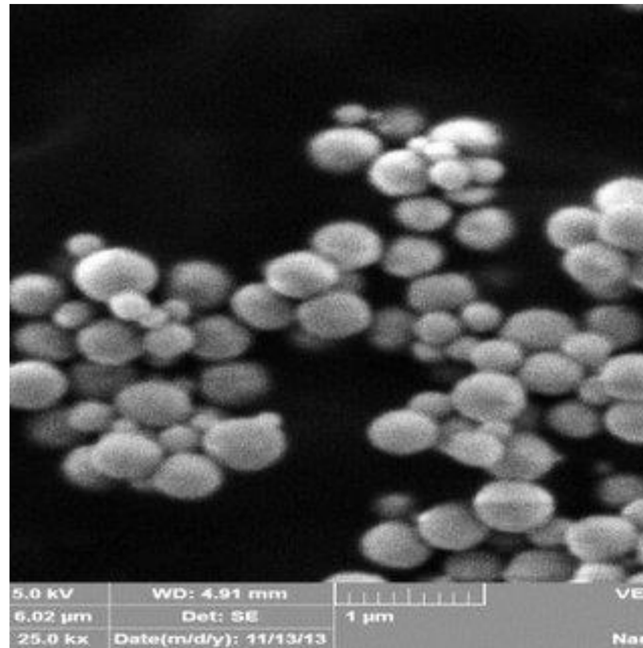
- Hydrolysis
- Condensation and Polymerization of monomers to form particles
- Agglomeration of particles

After the formation of sol, formation of network (gelation) which extends throughout the liquid medium is obtained to form a gel.

Sol-Gel Process



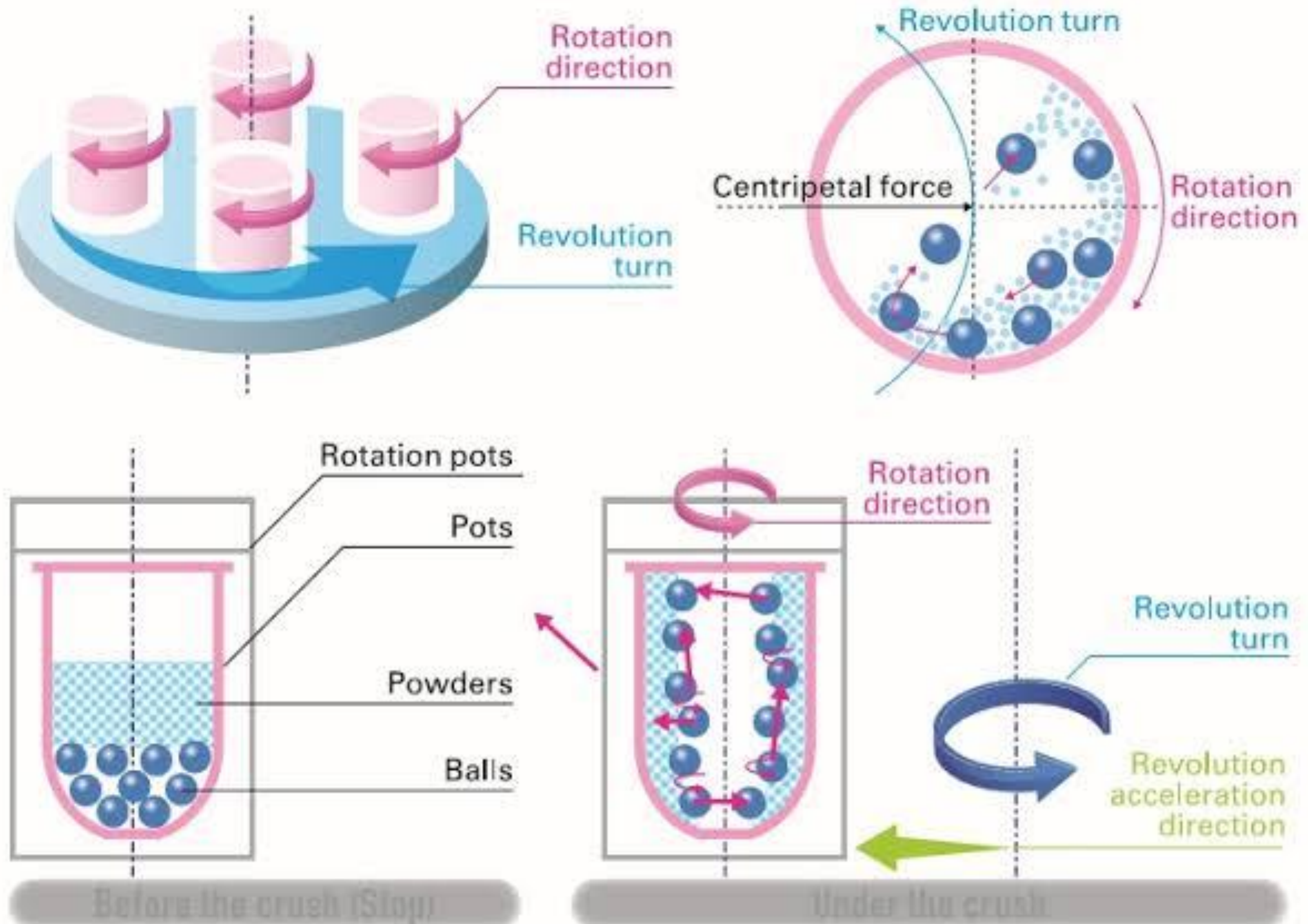




The advantages of using sol-gel processing instead of high temperature processing methods are:

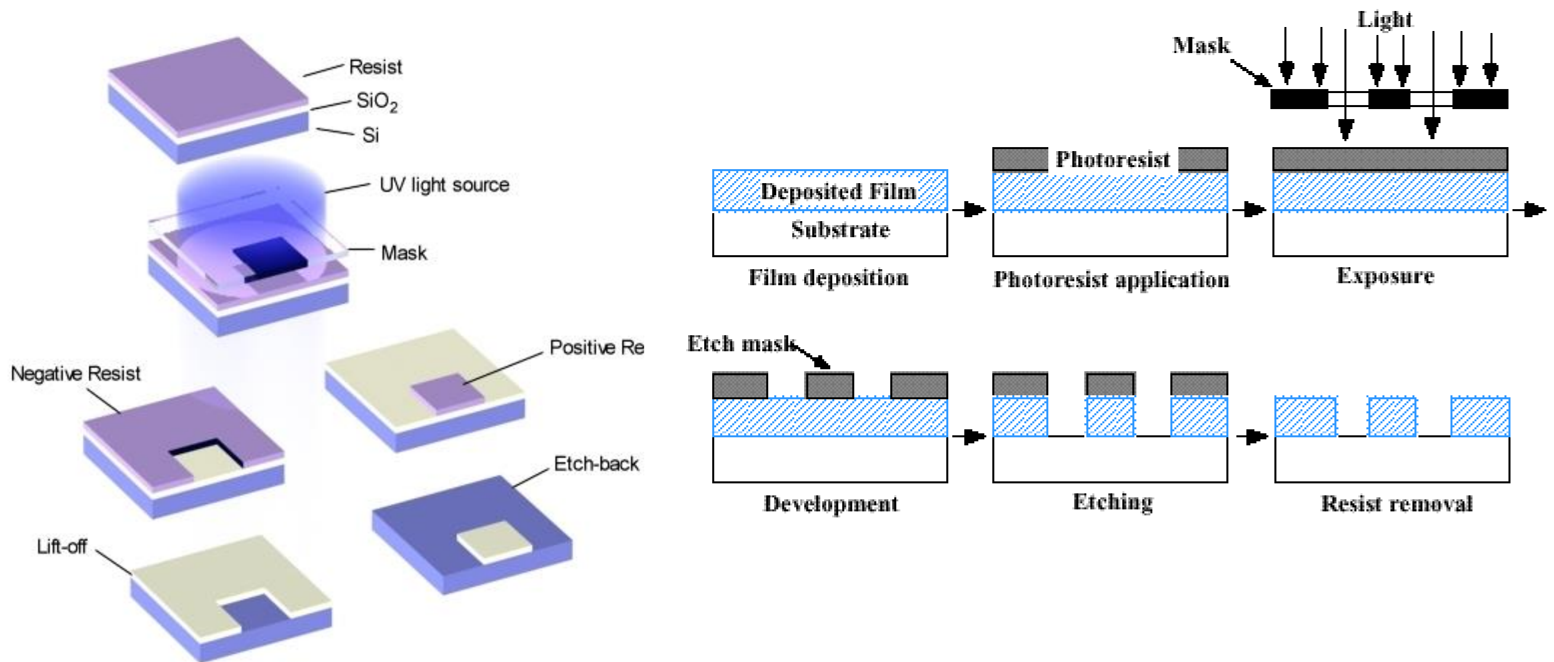
- lower synthesis temperature
- high purity
- novel materials
- low capital costs

Planetary Ball Mill



Lithography

We have discussed various routes for the synthesis and fabrication of variety of nanomaterials; however, the synthesis routes applied have been focused mainly on the chemical methods approaches, or the physical vapor deposition. Now, we will discuss a different approach: top-down approach, fabrication of nanoscale structures with various physical techniques---lithography.



Lithography Process

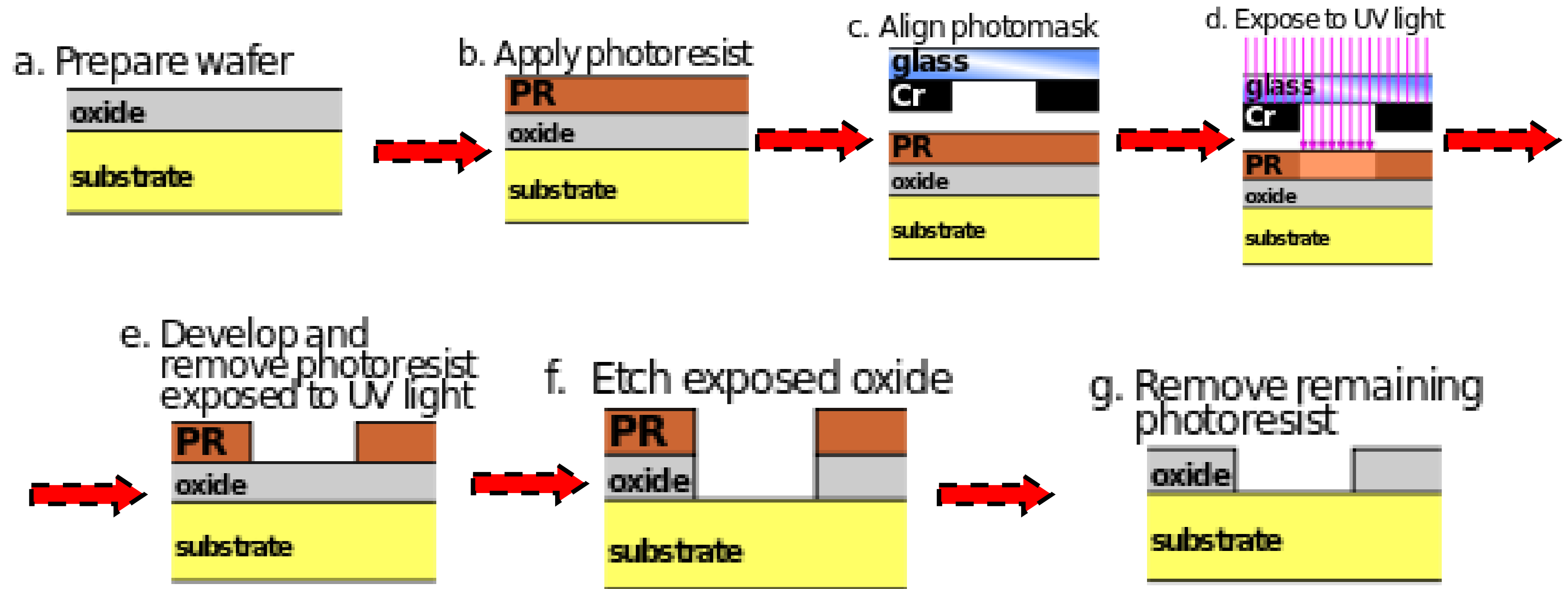
The term is more generally applied to a number of methods for replicating a predetermined master pattern on a substrate.

Basic Steps of Lithography

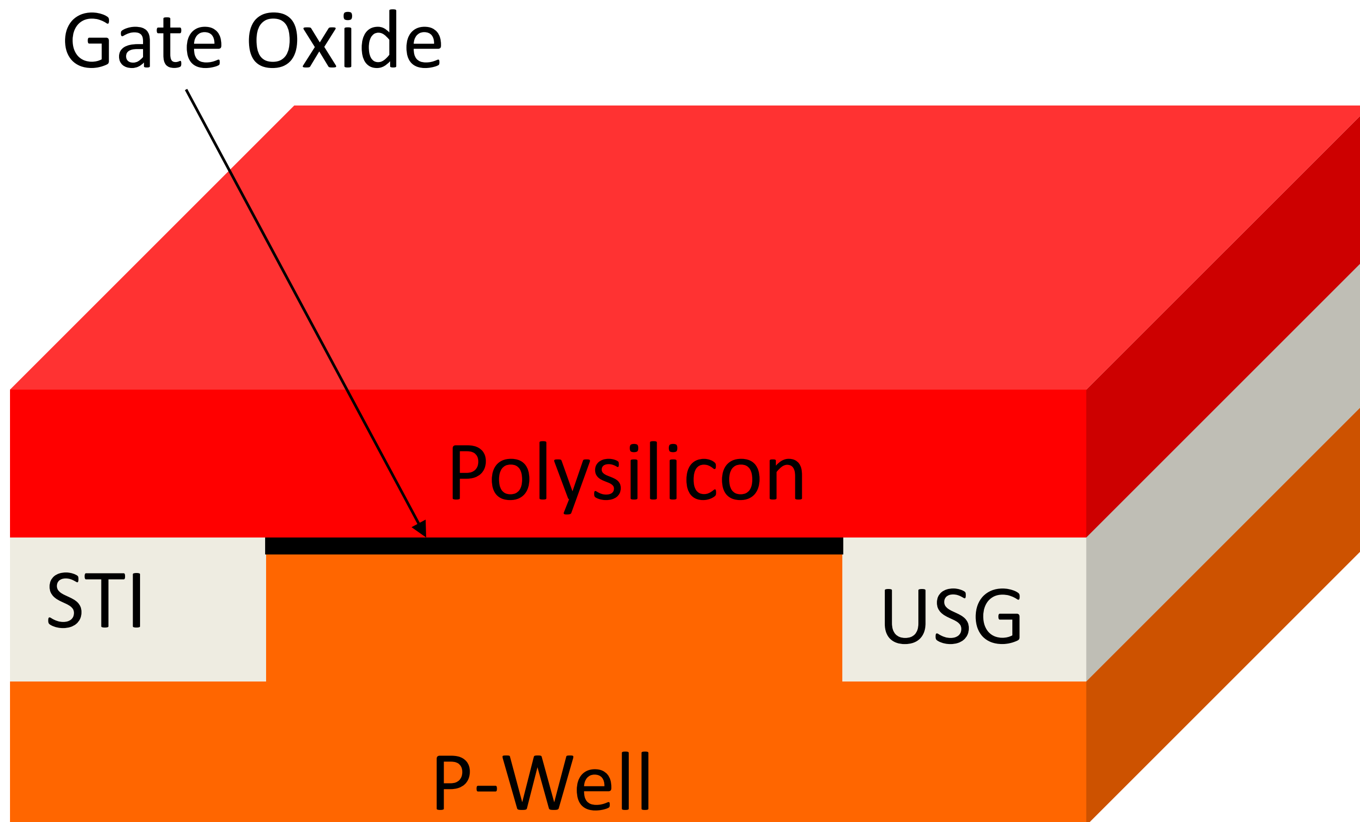
- Spin coat radiation sensitive polymer - Resist
- Expose layer (through mask or direct write)
- Develop
- Etch away or deposit material

Photolithography

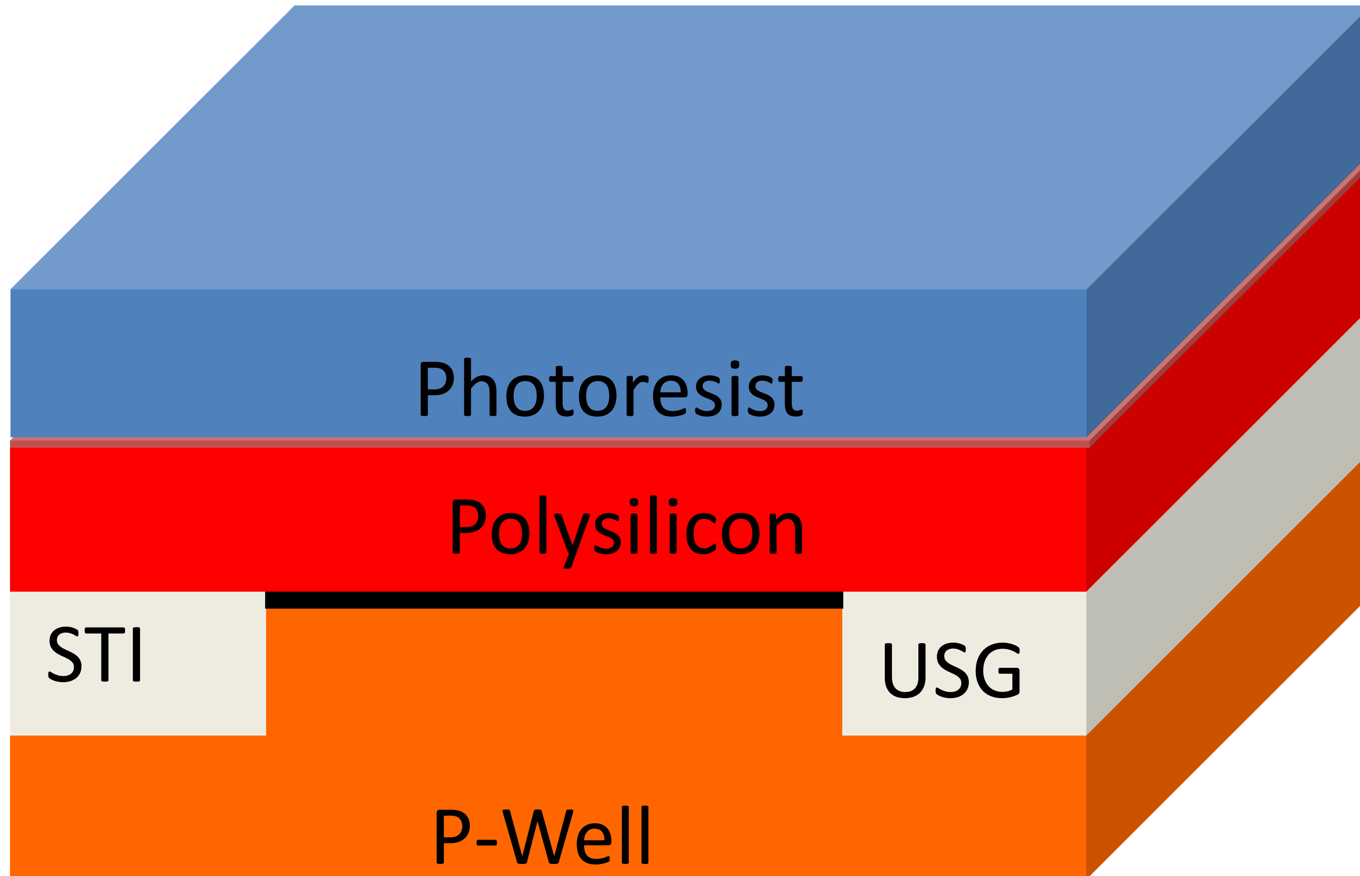
Typical photolithographic process consists of producing a mask carrying the requisite pattern information and subsequently transferring that pattern, using some optical technique into a photoactive polymer or photoresist.



Wafer Clean



Photoresist Coating



Photoresist

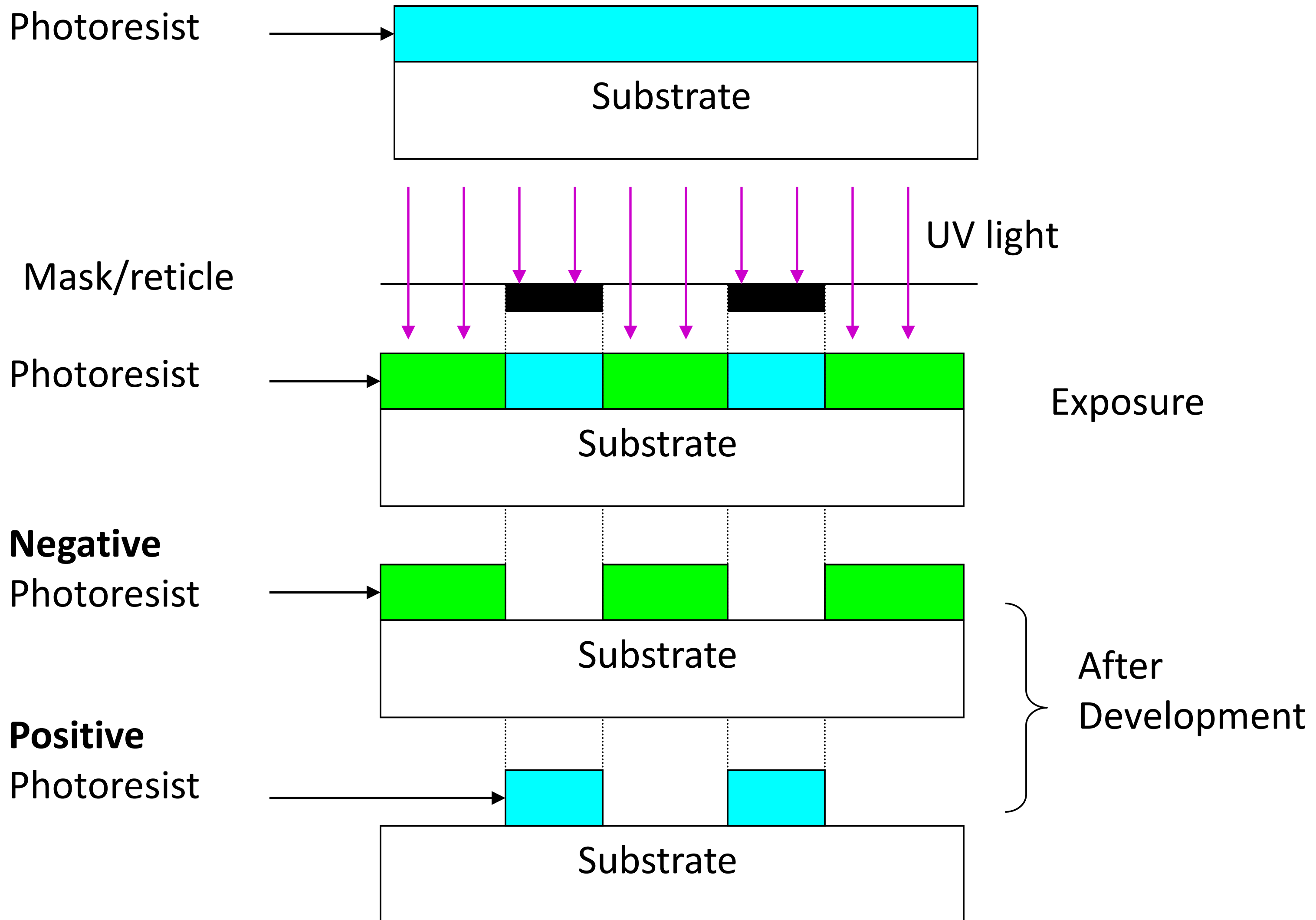
Negative Photoresist

- Becomes insoluble after exposure
- When developed, the unexposed parts dissolved.
- Cheaper

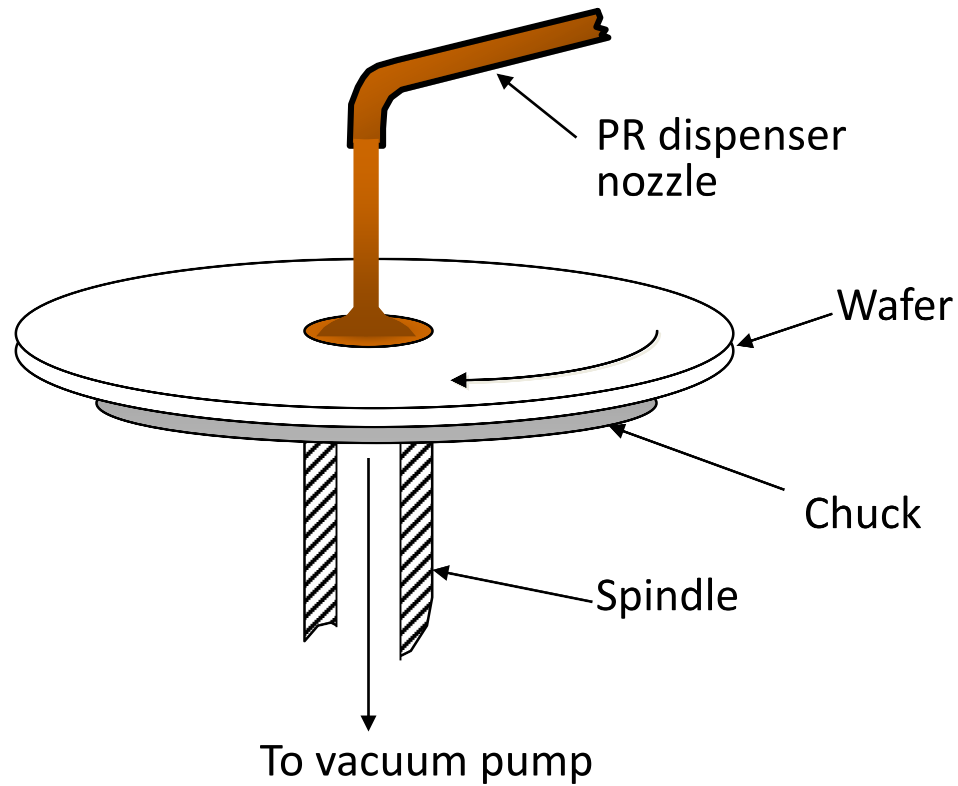
Positive Photoresist

- Becomes soluble after exposure
- When developed, the exposed parts dissolved
- Better resolution

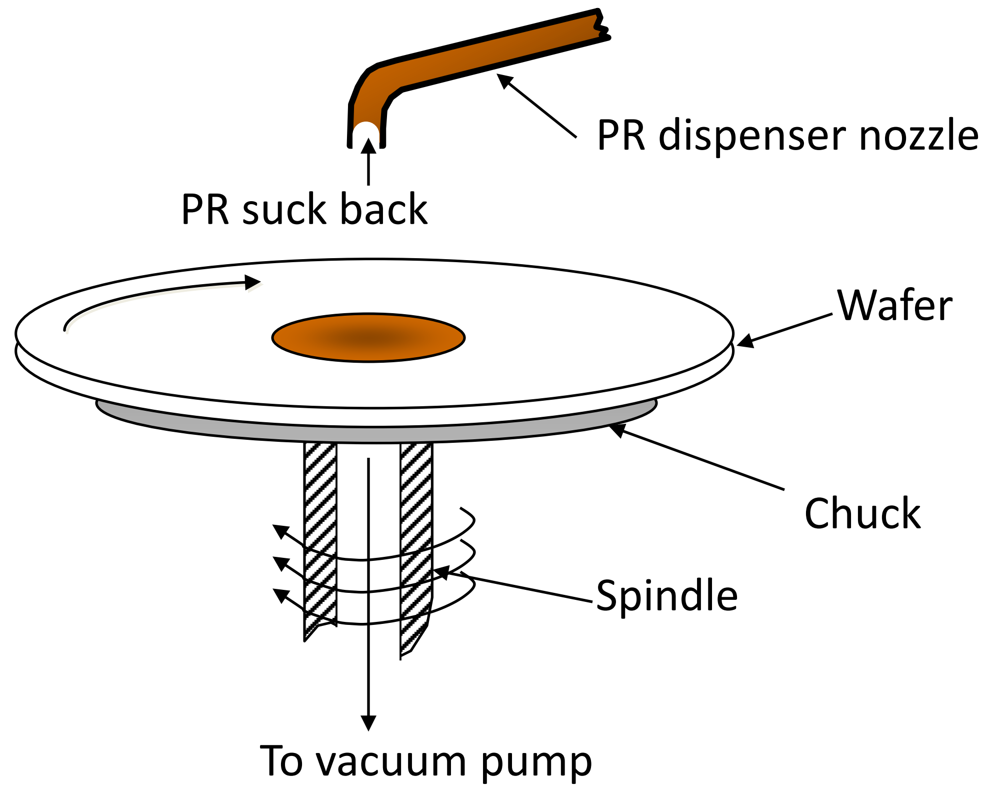
Negative and Positive Photoresists



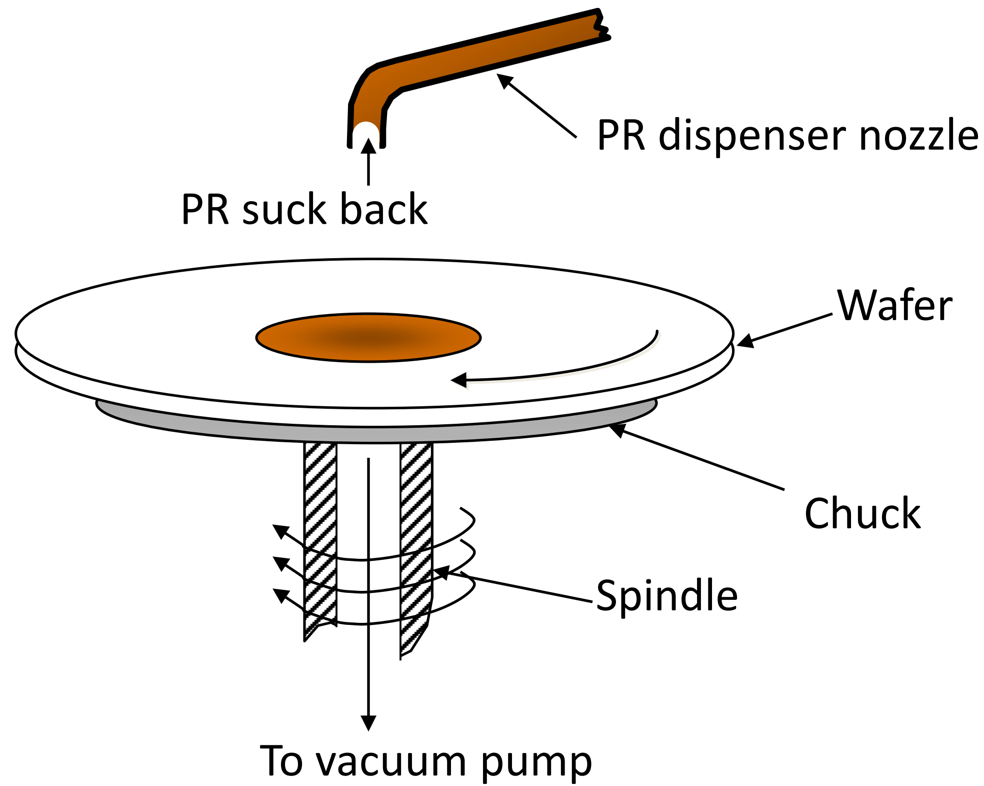
Photoresist Applying

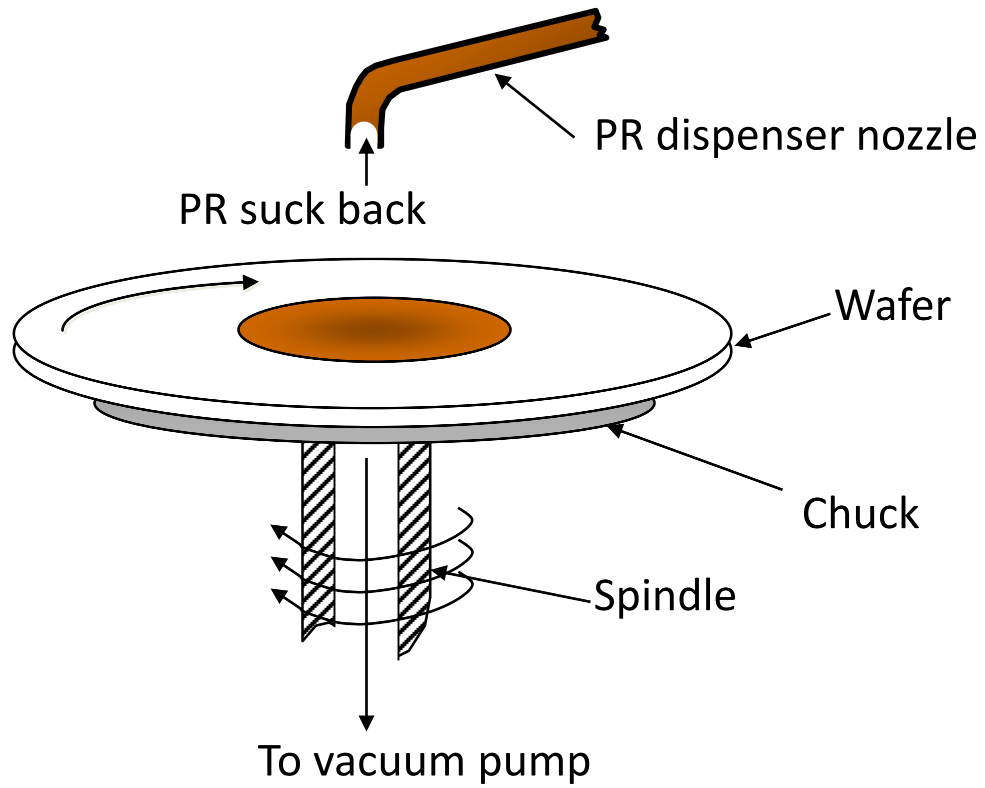


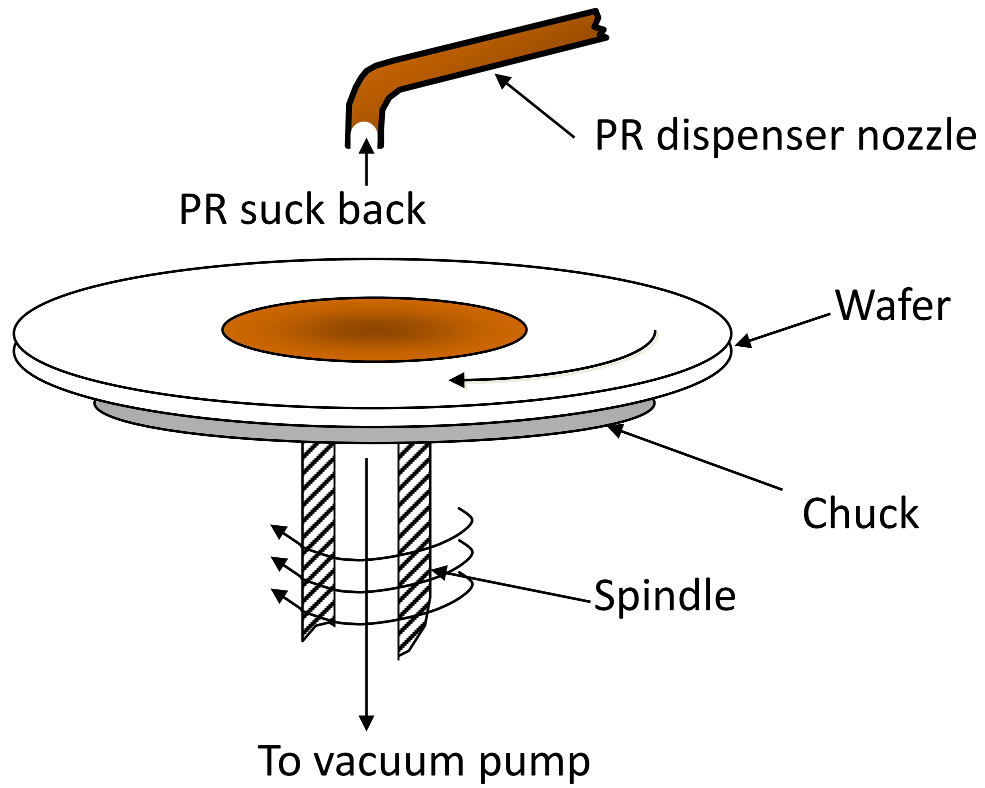
Photoresist Suck Back

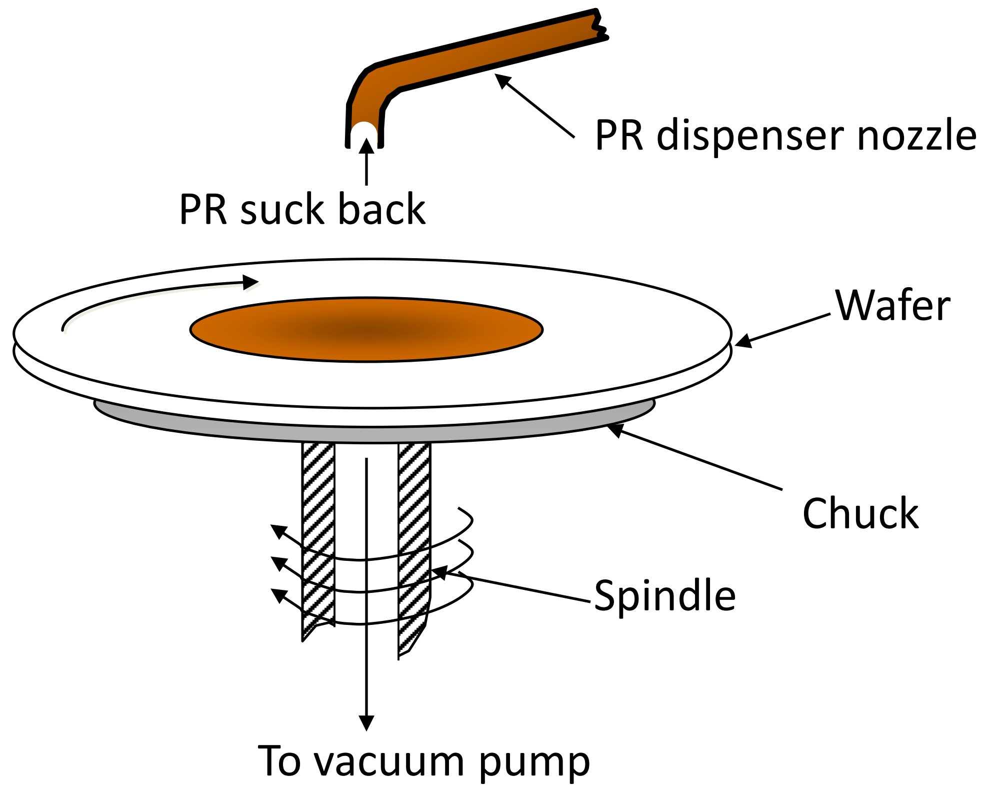


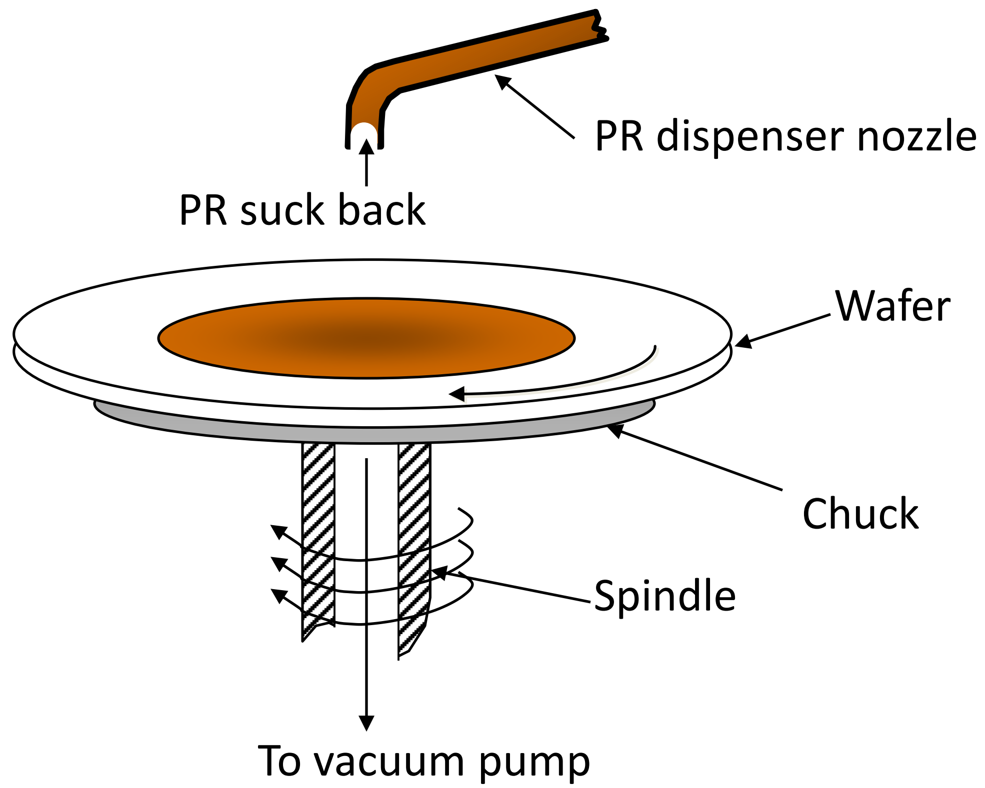
Photoresist Spin Coating

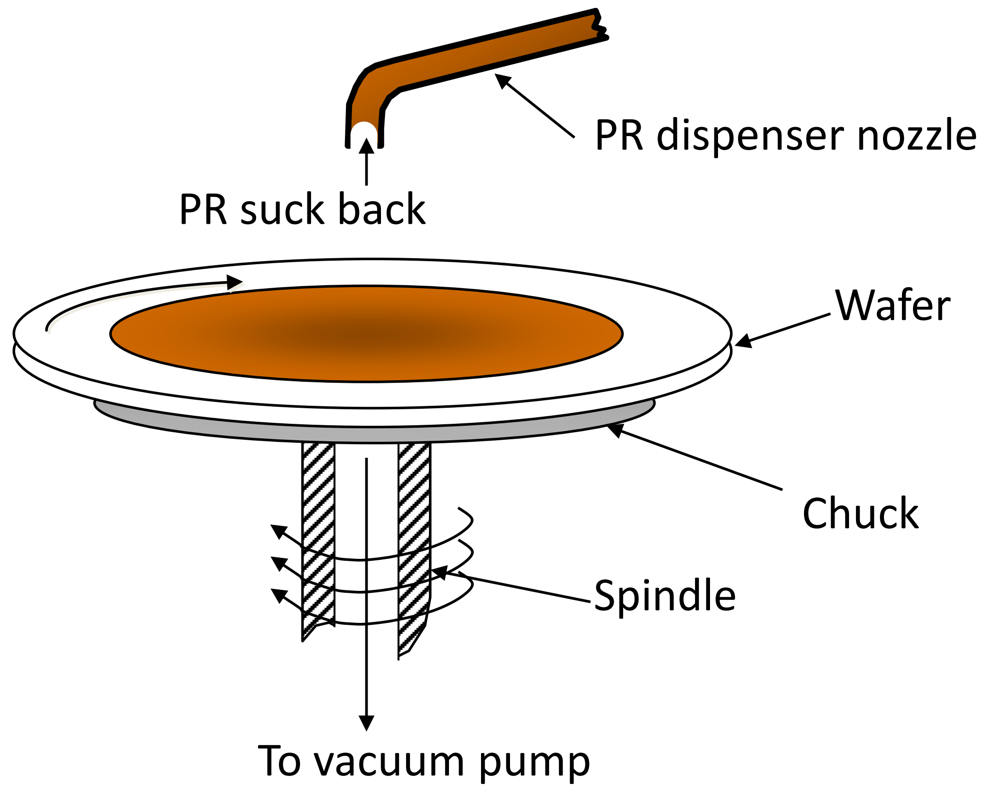


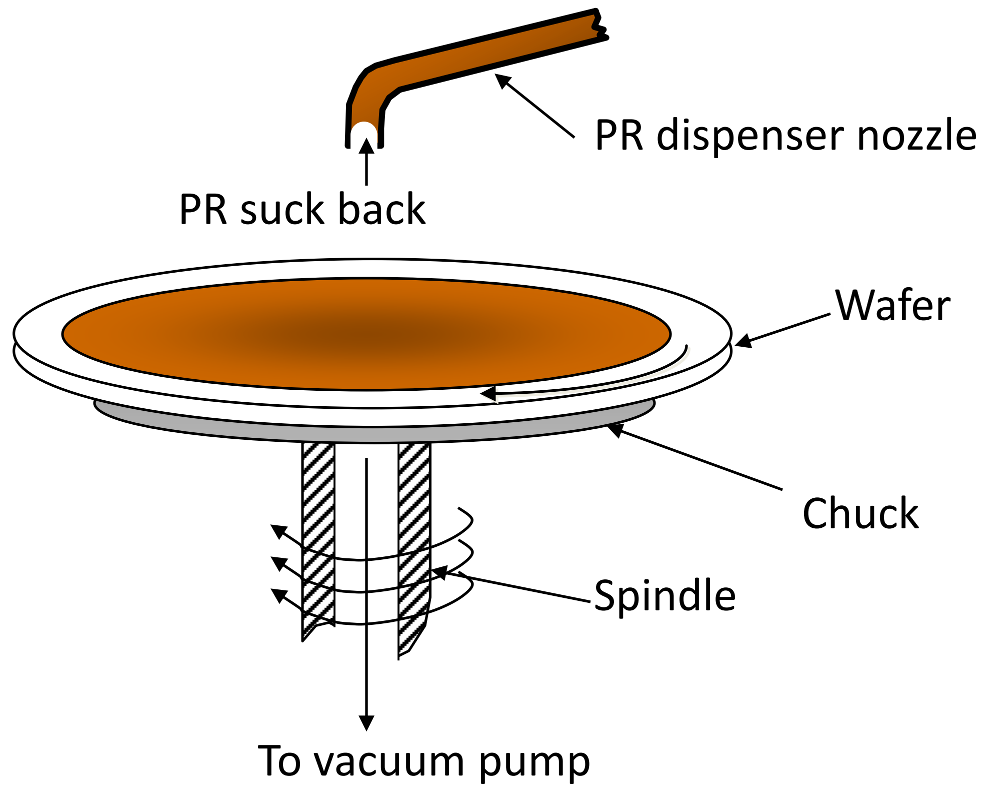

PR dispenser nozzle
PR suck back
Wafer
Chuck
Spindle
To vacuum pump

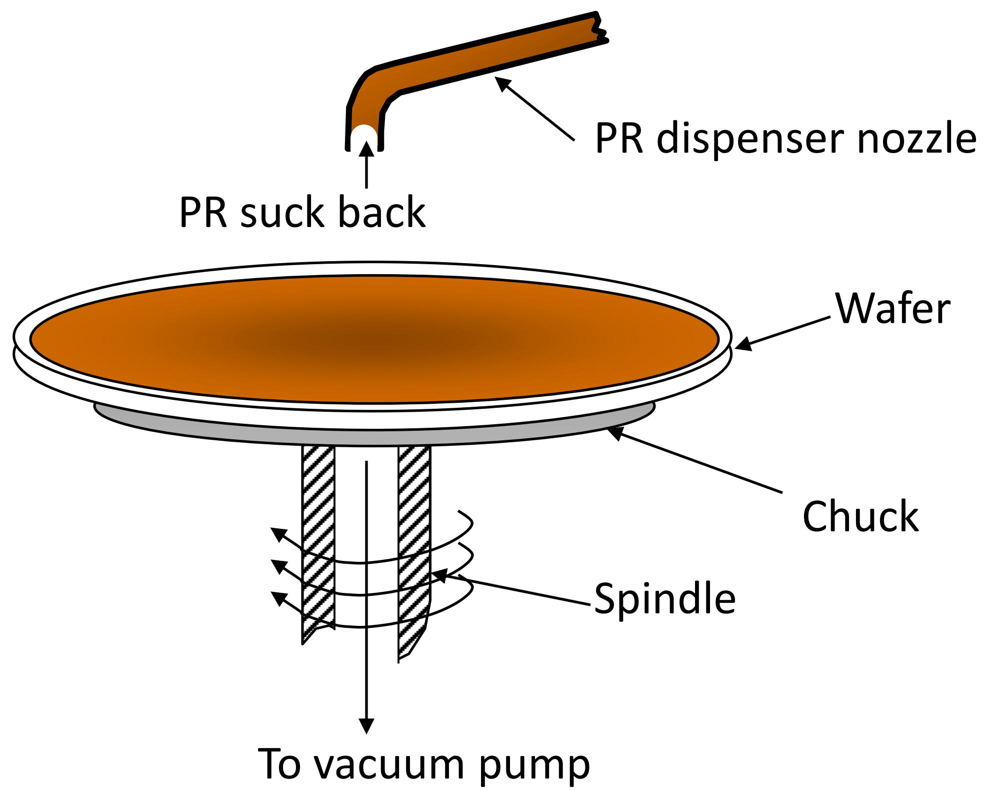

PR dispenser nozzle
PR suck back
Wafer
Chuck
Spindle
To vacuum pump

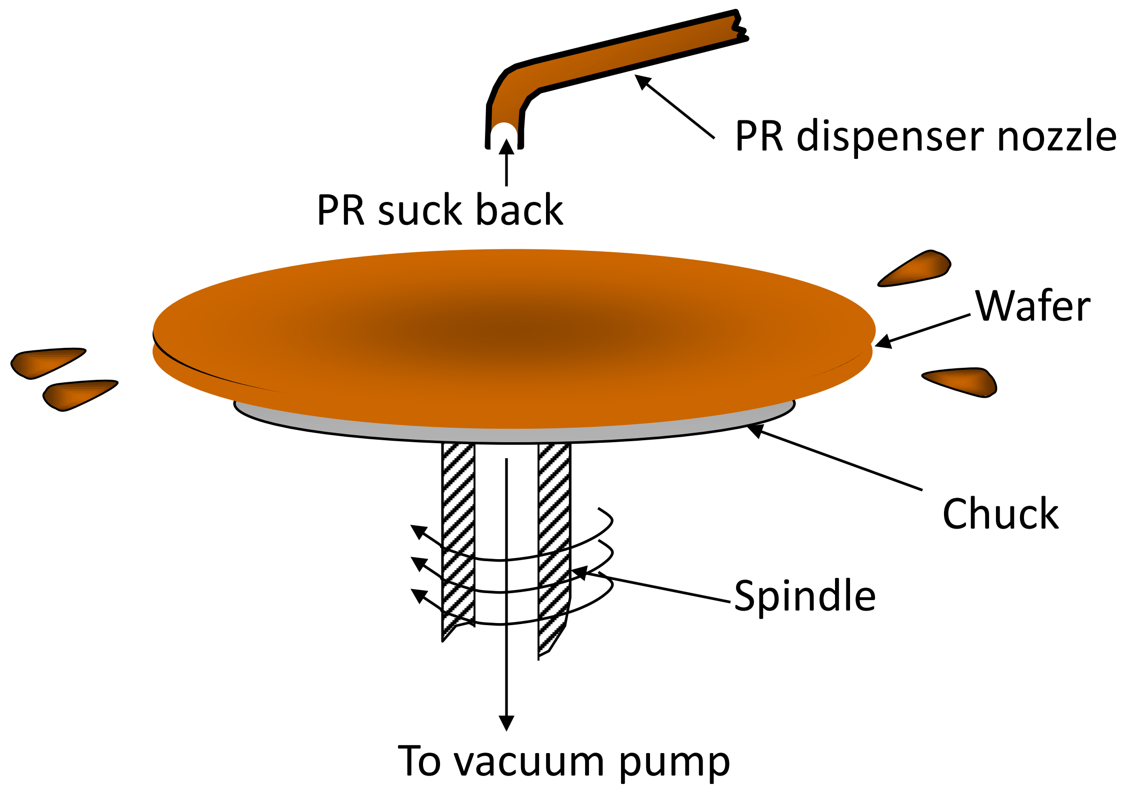

PR dispenser nozzle
PR suck back
Wafer
Chuck
Spindle
To vacuum pump

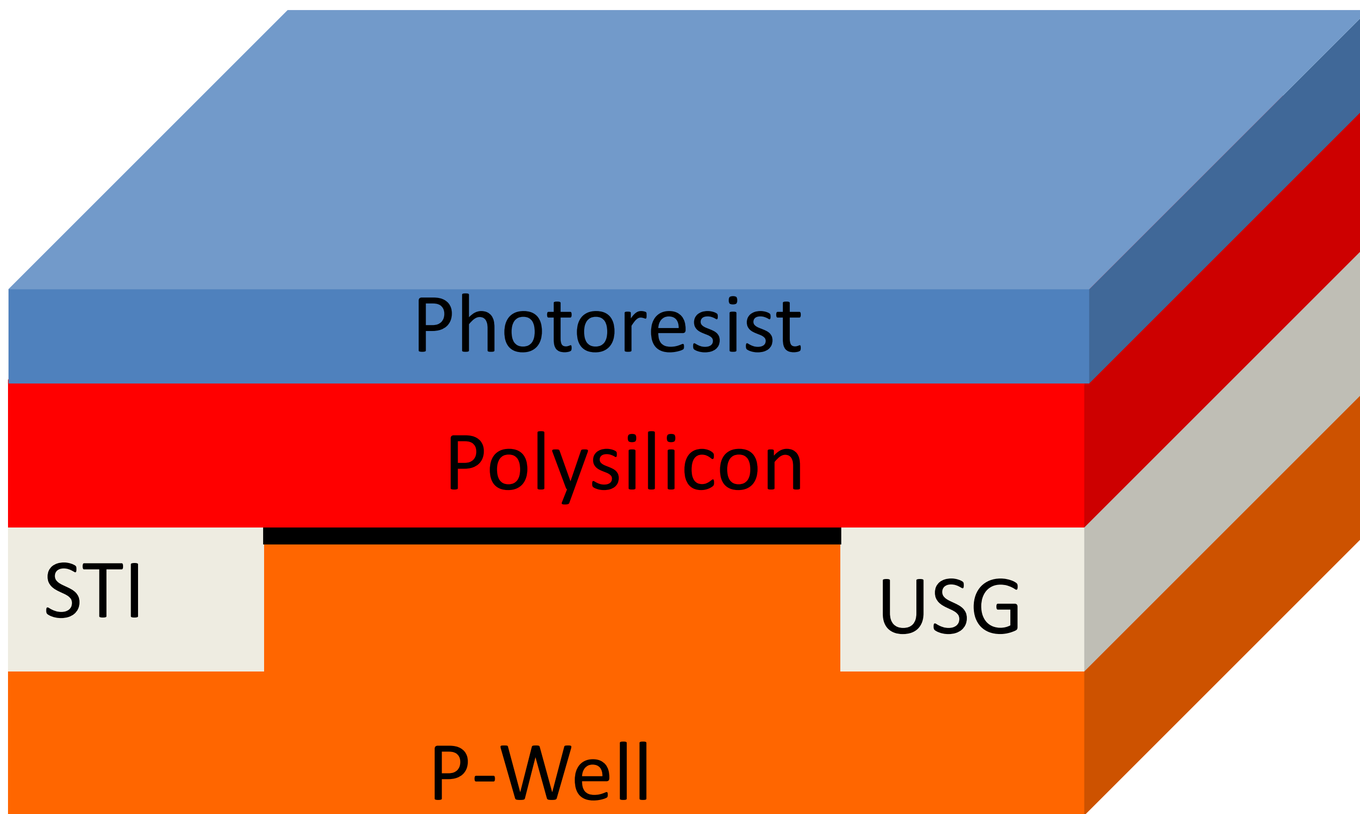

PR dispenser nozzle
PR suck back
Wafer
Chuck
Spindle
To vacuum pump


PR dispenser nozzle
PR suck back
Wafer
Chuck
Spindle
To vacuum pump

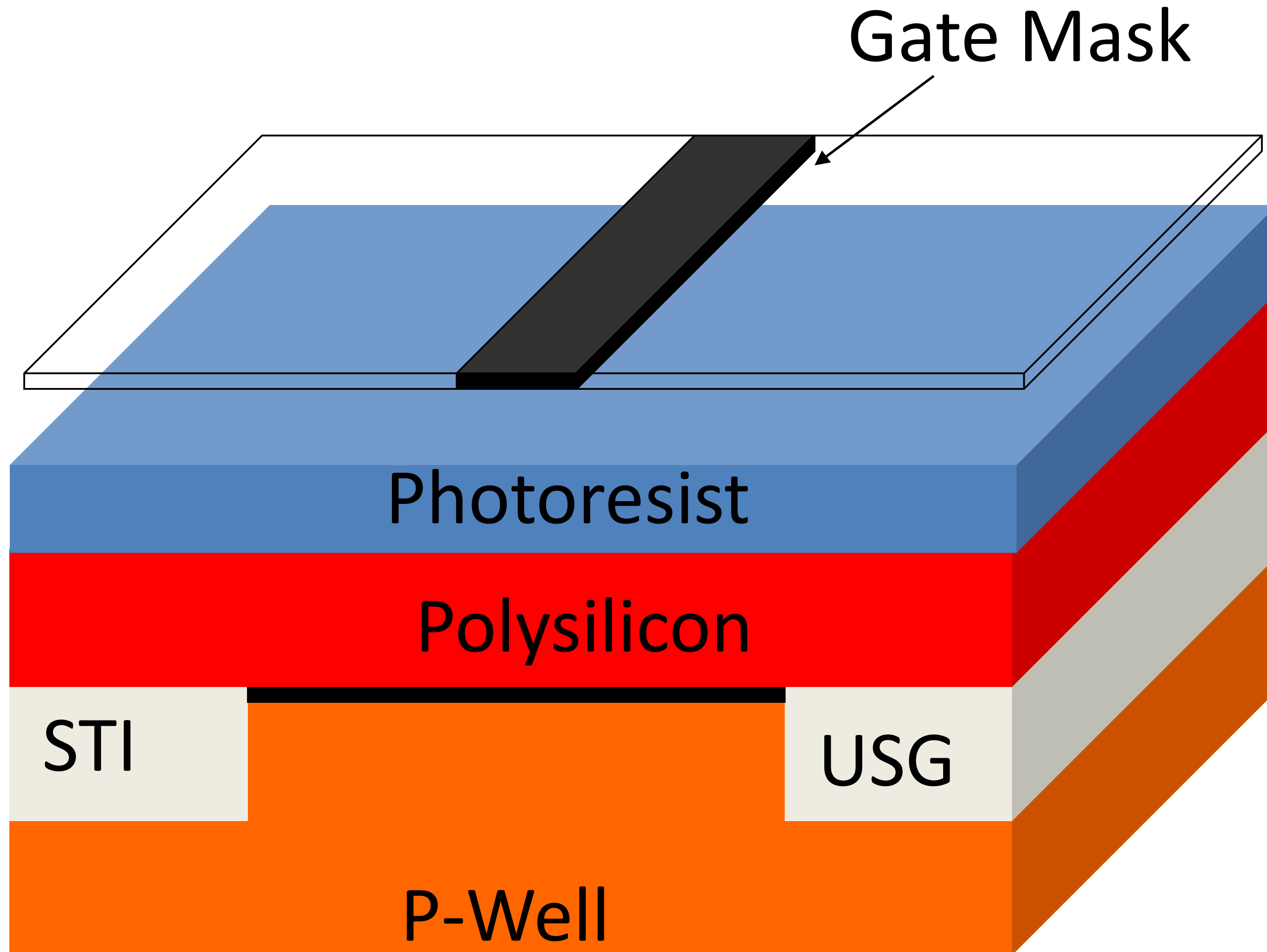

PR dispenser nozzle
PR suck back
Wafer
Chuck
Spindle
To vacuum pump


PR dispenser nozzle
PR suck back
Wafer
Chuck
Spindle
To vacuum pump

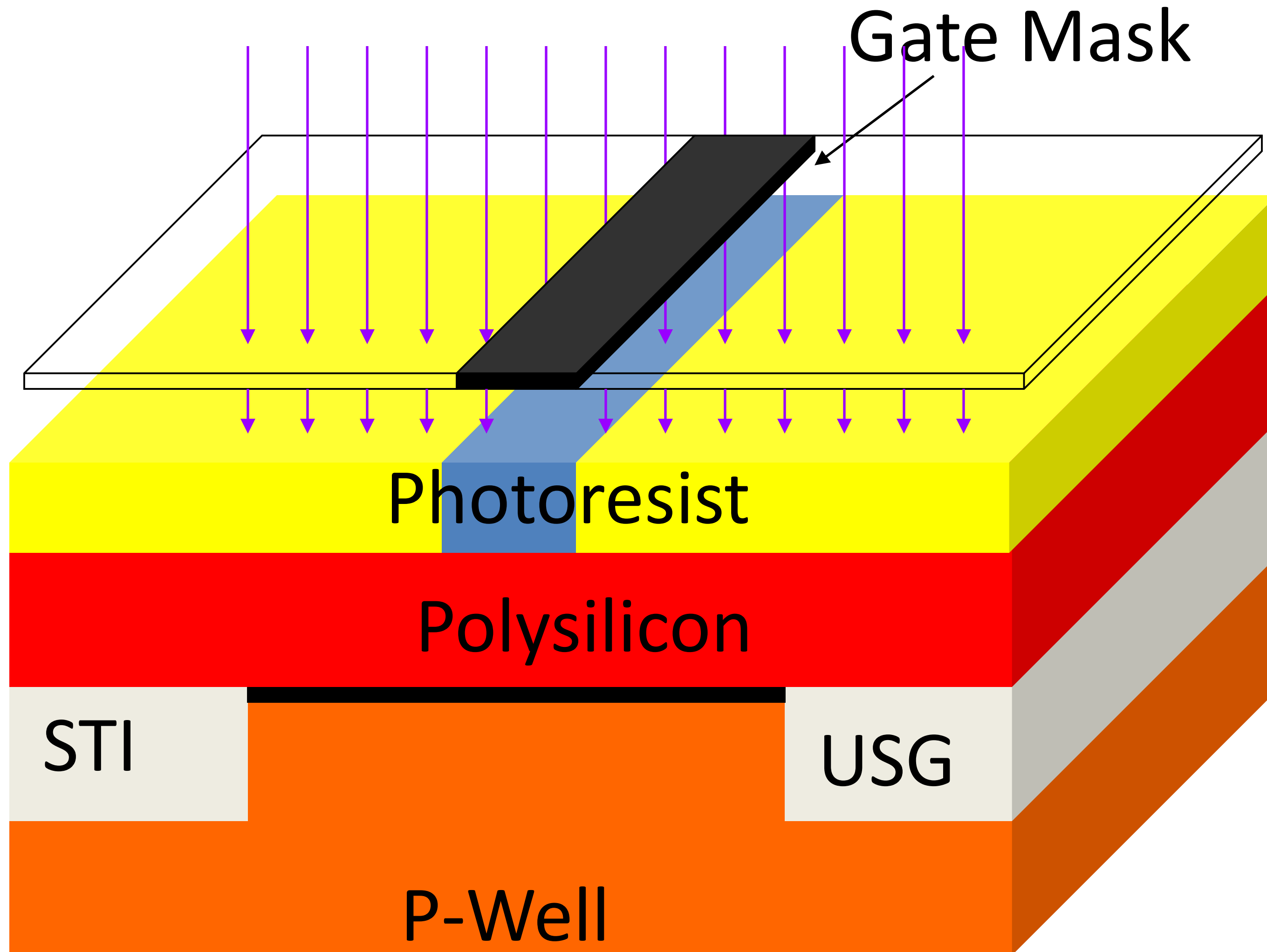

PR dispenser nozzle
PR suck back
Wafer
Chuck
Spindle
To vacuum pump


Photoresist
Polysilicon
STI
USG
P-Well

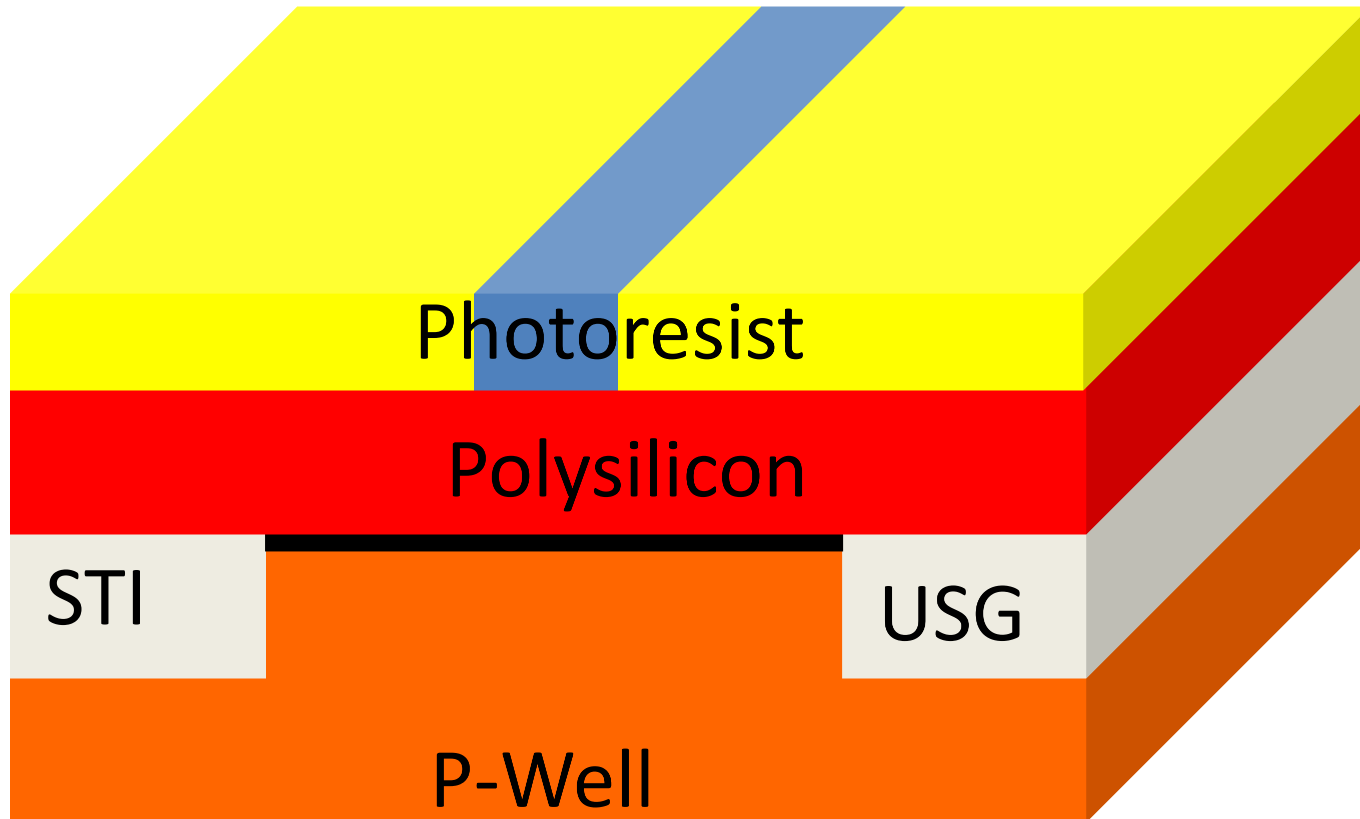
Alignment and Exposure



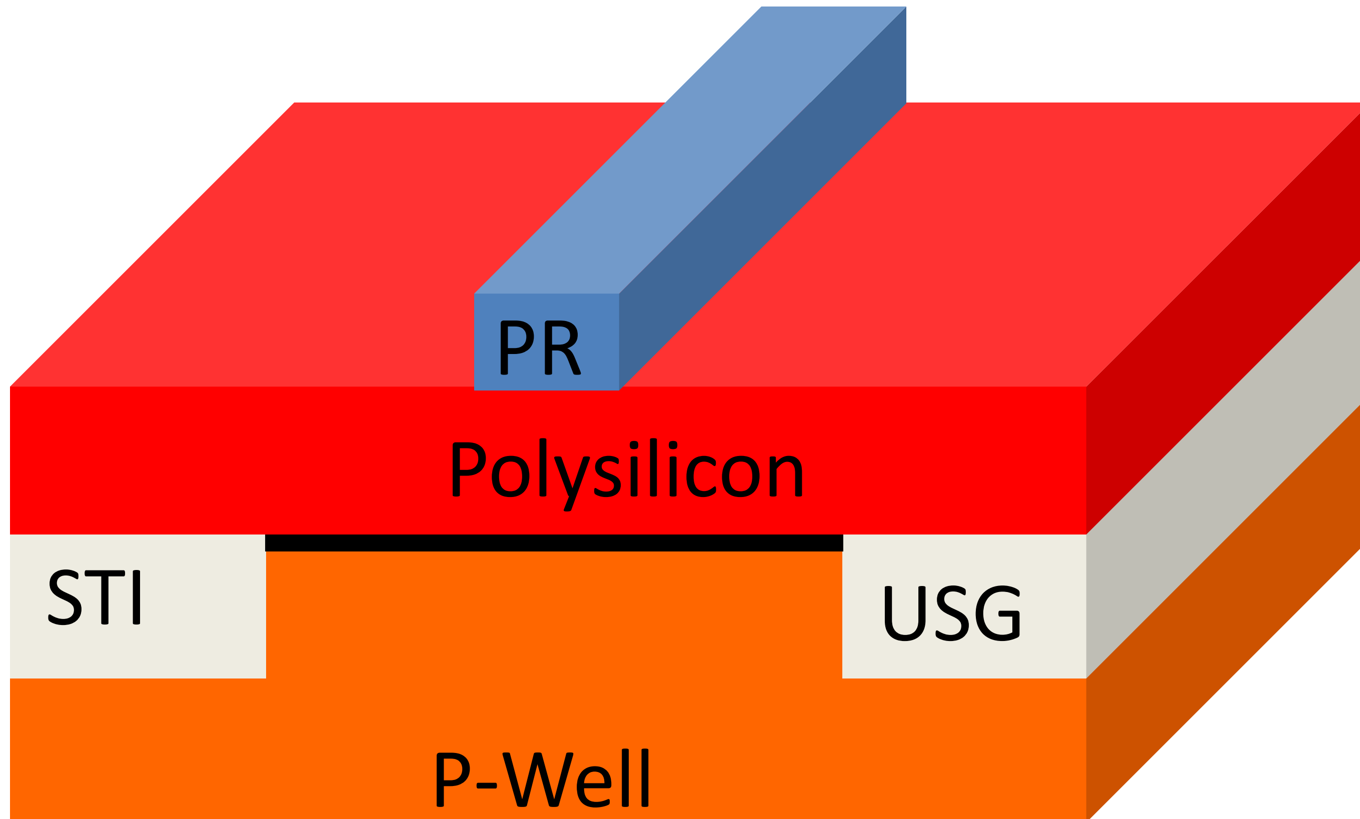
Alignment and Exposure



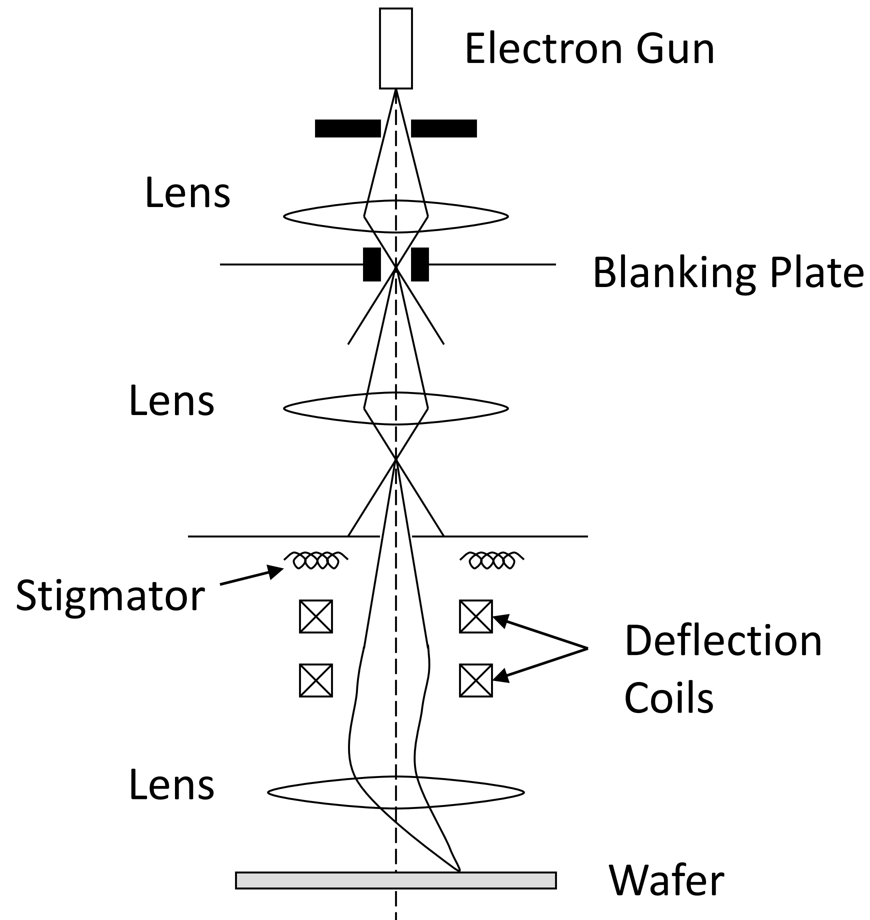
Post Exposure Bake



Development



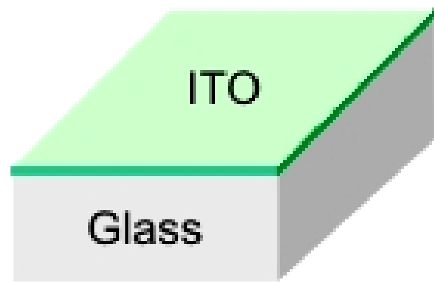
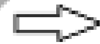
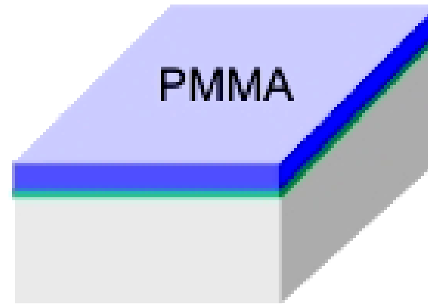
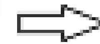
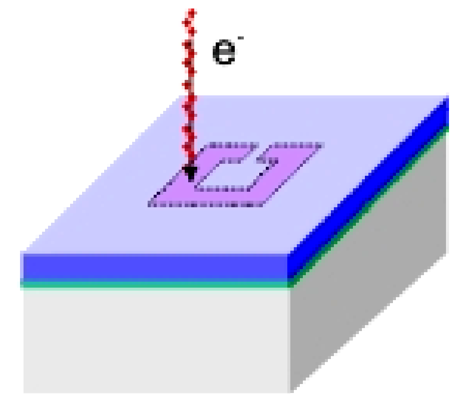
Electron Beam Lithography System

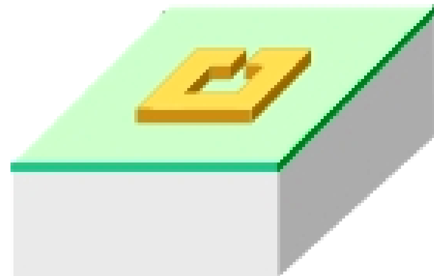
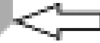
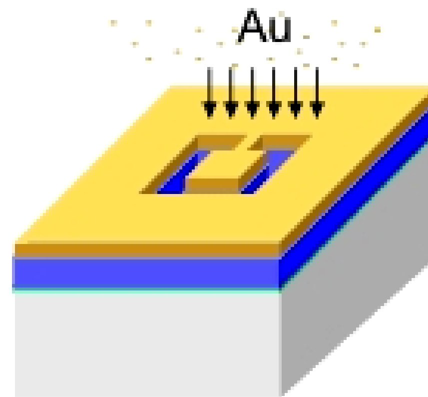


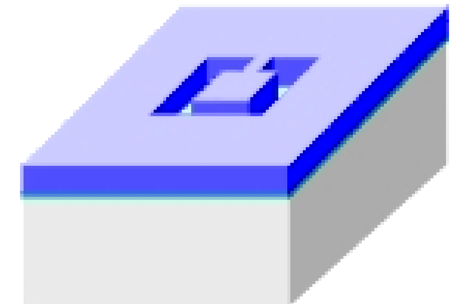
E – Beam Writing

- **Advantages**
  Better resolution
  Direct writing, no mask needed
  Arbitrary size, shape, order

- **Disadvantages**
  Serial process
  slow, small area
  Compatibility
  conducting, no high T process

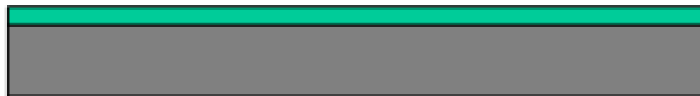

ITO
Glass


PMMA
Spin coating


e-
E-beam writing


Lift-off


Au
Au evaporation


Developement

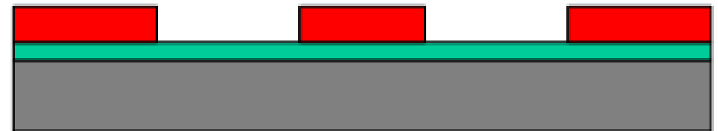
Etching/remove photoresist

1



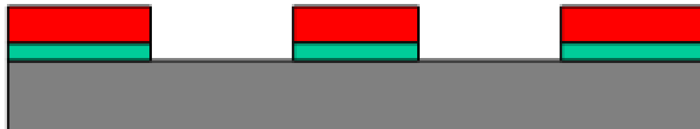
deposit thin film of desired material

2



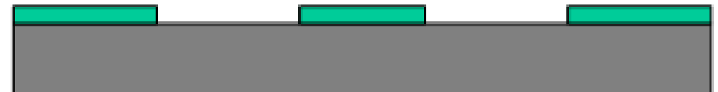
coat and pattern photoresist

3

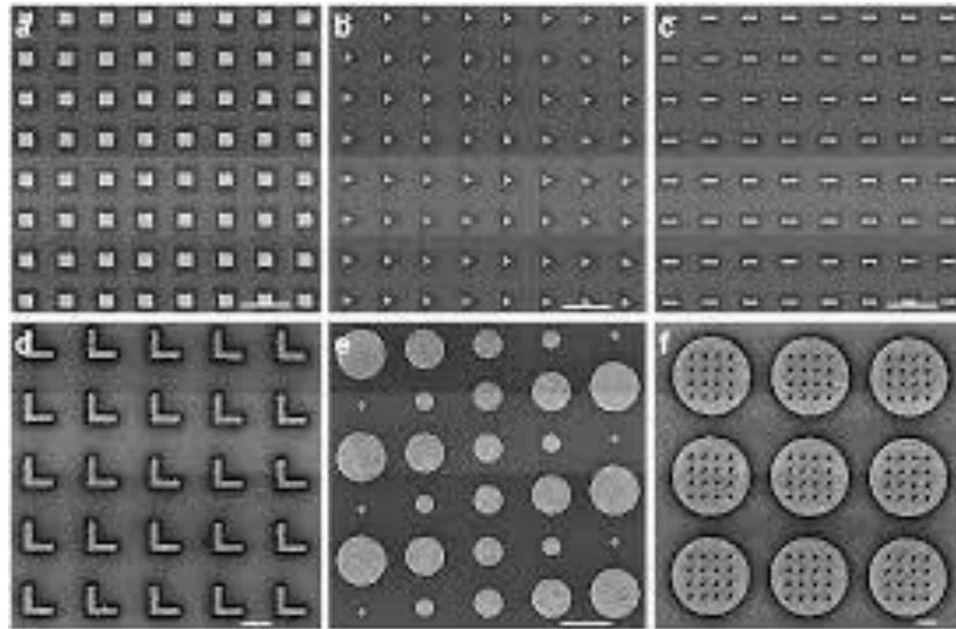


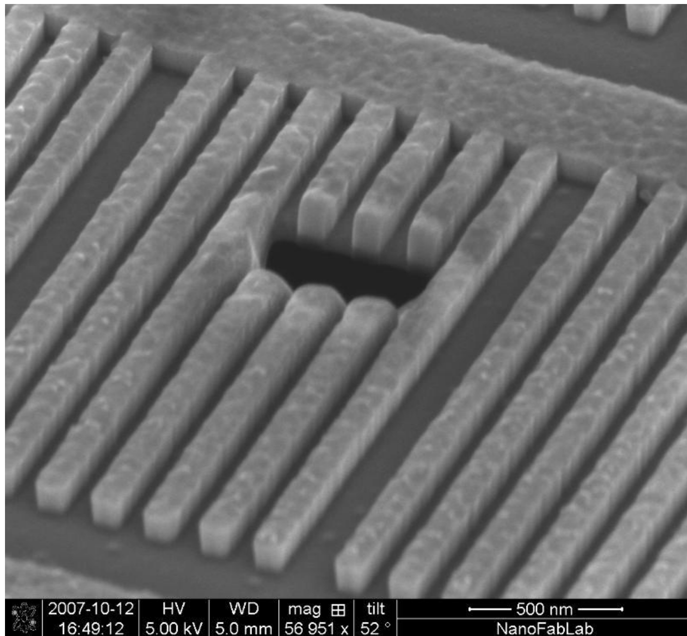
etch film using photoresist as mask

4



remove photoresist


a
b
c
d
e
f


2007-10-12
16:49:12
HV
5.00 kV
WD
5.0 mm
mag
56 951 x
tilt
52 °
500 nm
NanoFabLab