Electron Beam and X-Ray Lithography

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Electron Beam Lithography: Application

- Electron beam Lithography (EBL) is used primarily for two purposes
  - very high resolution lithography.
  - fabrication of masks (by etching process)

- It uses Serial Lithographic system

Electron Beam Sources

- Thermionic Emitters

  Electrons released due to thermal energy

- Photo Emitters

  due to incident radiations (photons)

- Field Emitters

  due to applied current and quantum mechanical property of electrons.

Procedures of EBL

- Sample is coated with a thin layer of resist

  Polymethylmethacrylate (PMMA)

- PMMA breaks down into monomers upon exposure to electrons.
- The exposed regions can be rinsed away (developed) using a chemical

  Methyl-isobutyl-ketone (MIBK)

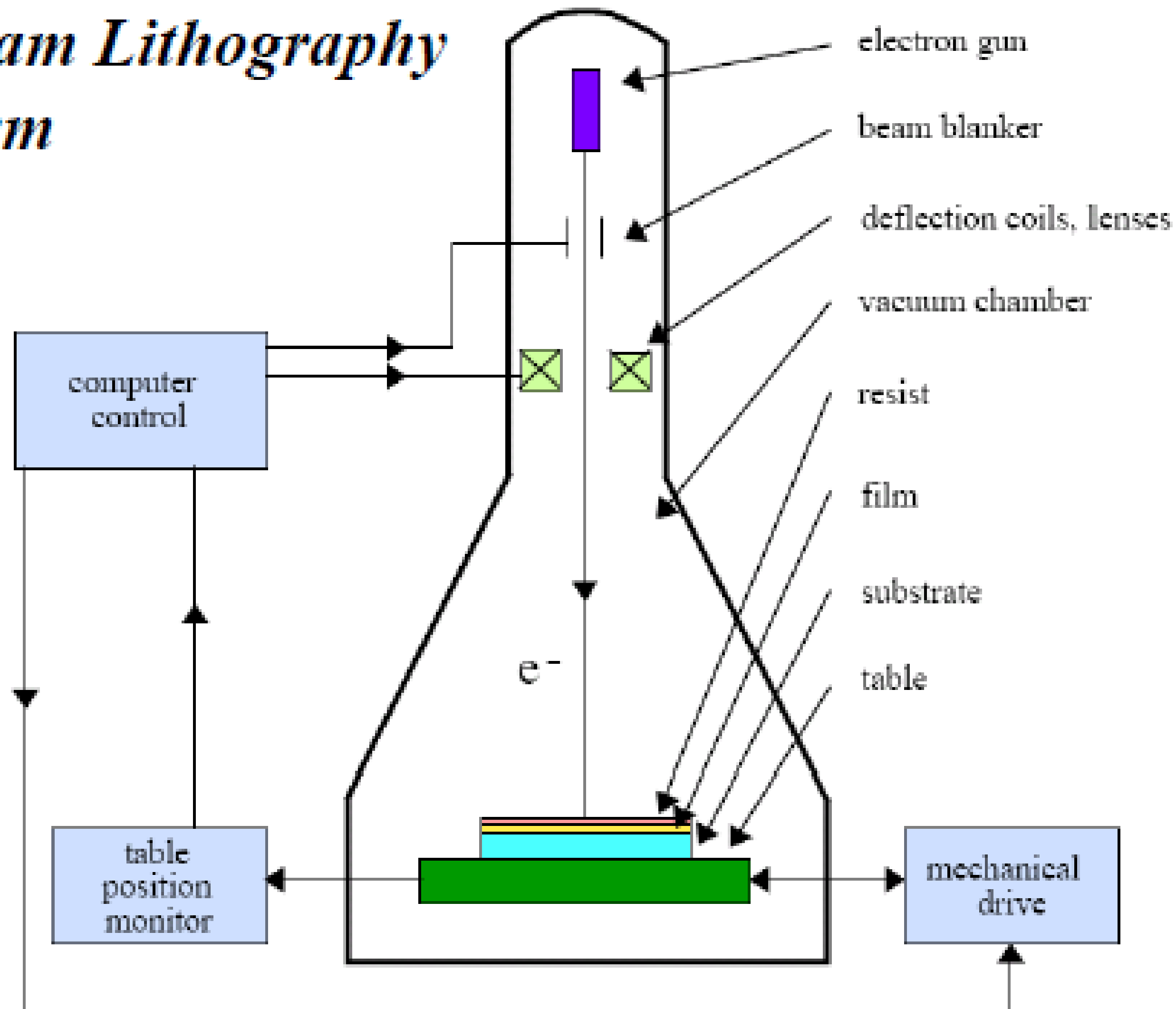
Advantages of EBL

- Print complex patterns directly on wafers
- Eliminates the diffraction problem
- High resolution up to 20 nm(photolithography ~50nm)
- Flexible technique

Disadvantages of EBL

- Slower than optical lithography.
- Expensive and complicated
- Forward scattering
- Backscattering
- Secondary electrons

Machine structure



EBL Components

- Deflection coils and lenses: to focus the electron
- Beam blanking: turning the beam on and off
- Stigmators: is a special type of lens used to compensate for imperfections in the construction and alignment of the EBL Colum.
- Vacuum: to isolate the electron beam from interferences

X-Ray Lithography: Application

- X-ray lithography is primarily used in nanolithography
  - 15 nm optical resolution
  - Utilizes short wavelength of 1 nm
  - Simple: Requires no lenses
  - Allows for small feature size

Procedures of X-Ray Lithography

- PMMA is applied to the surface of silicon wafer
- PMMA hardens when contacted with x-rays
- X-ray mask is applied on top of silicon wafer before exposure
  - Absorber
  - Membrane
- Synchrotron radiation (0.2 – 2 nm)
- Gap between substrate and mask

Advantages of X-Ray Lithography

- Short wavelength from X-rays
  - 0.4-4 nm
- No diffraction effect
- Simple to use
  - No lens
- Faster than EBL
- Uniform refraction pattern
- High resolution for small feature size

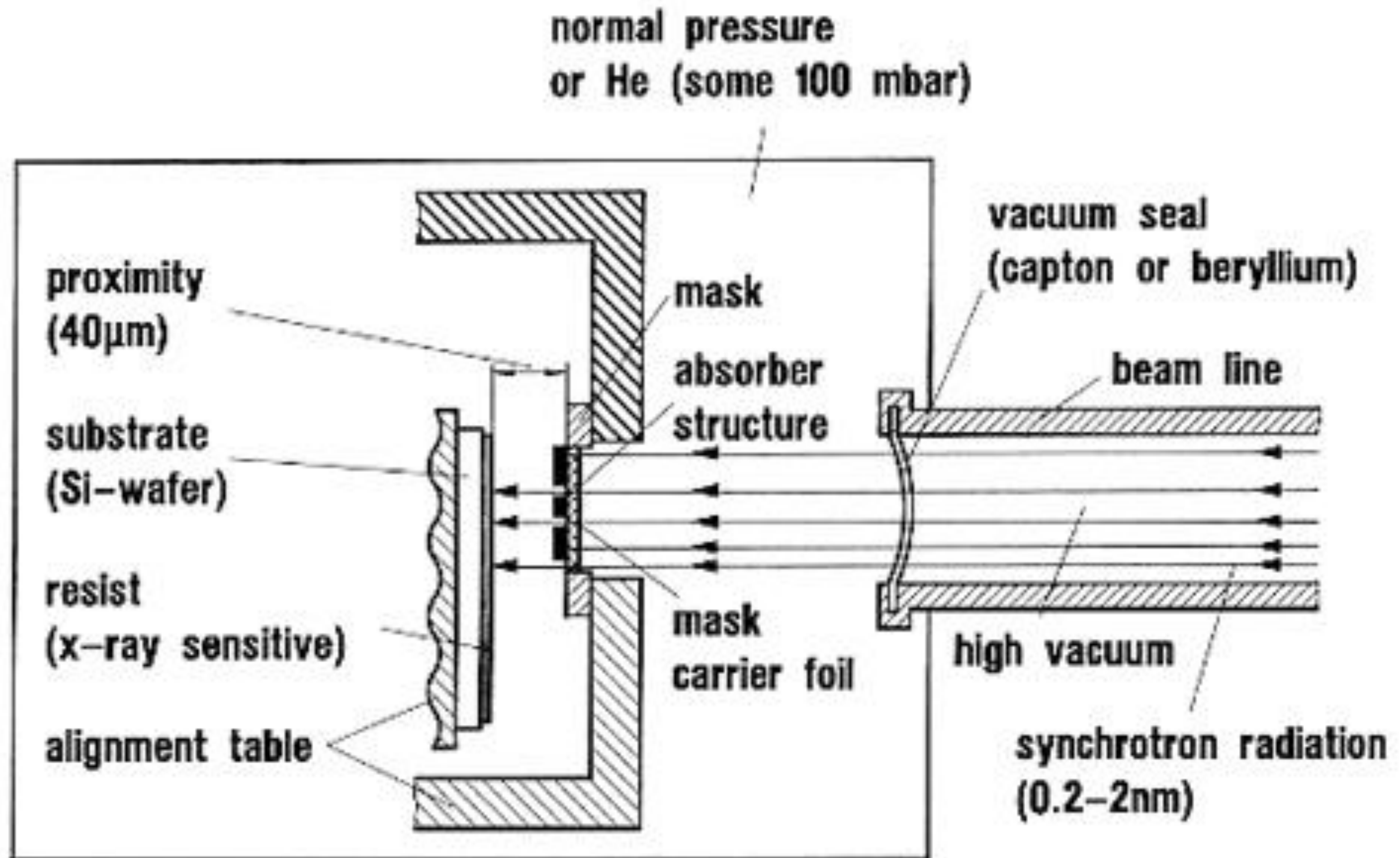
Disadvantages of X-ray Lithography

- Thin lens
  - Distortion in absorber

- Cannot be focused through lens

- Masks are expensive to produce

X-Ray Lithography Machine Structure



Components

- Absorber – reduce scattering of X-rays
- Membrane – allows X-rays to travel through
- Vacuum- to isolate the X-ray from interferences

QUESTIONS?

Works Cited

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