Electron Beam Lithography

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ICNTAA
- Patterning techniques
- The electron beam lithography
- Applications of the EBL
Patterning Techniques

Criteria about different techniques

- Resolution
- Speed
- Easy fabrication
- Cost
The electron beam lithography

- **Types of EBL**
  1. Electron Beam Direct Write
  2. Electron Projection Lithography

_Bragg-Fresnel lens for x-rays Paul Scherrer Institute_
Electron Beam Direct Write

- An electron gun or electron source that supplies the electrons.
- An electron column that 'shapes' and focuses the electron beam.
- A mechanical stage that positions the wafer under the electron beam.
- A wafer handling system that automatically feeds wafers to the system and unloads them after processing.
- A computer system that controls the equipment.
Electron Beam Direct Write

Types of electron guns
- Thermoionic
- Field emission

Write-field (WF)

Scanning methods
- Raster scan
- Vector scan

Raith 150 Manual (Nanostructure Physics Dept. KTH) Anders Liljeborg
Electron Projection Lithography

Electron Beam Direct Write → Limited throughput

Electron Projection Lithography → Huge penetration depth of electrons

New solutions

- SCALPEL (Bell Laboratories and Lucent technologies) 1995
- PREVAIL (IBM) 1999
Electron Projection Lithography

- SCALPEL
  - High contrast
  - Image reduction

- PREVAIL
  - Larger effective field
Electron beam resists

1. Important parameters
2. Types of resist
3. Resist limitations
EBL resists

Important parameters
☐ Resolution (nm)
☐ Sensitivity (C/cm^2)

Types of resist

• Positive resist
  Polymethyl methacrylate (PMMA)
• Negative resist

Resist limitations

- Tendency of the resist to swell in the developer solution.
- Electron scattering within the resist.
  - Broadens the diameter of the incident electron beam.
  - Gives the resist unintended extra doses of electron exposure.
Applications of Electron Beam Lithography

- Research
  - Nanopatterning on Nanoparticles
  - Nanowires
  - Nanopillars
  - Gratings
  - Micro Ring Resonators
  - Nanofluidic Channels

- Industrial / Commercial
  - Exposure Masks for Optical Lithography
  - Writing features
Some other Applications of EBL

- Cryo-electric devices
- Optoelectronic devices
- Quantum structures
- Multi-gate Devices
- Transport mechanism for semi and superconductor interfaces
- Optical devices
- Magnetism
- Biological Applications
  - Nano-MEMS
  - Nanofluidics
Thank You