Lithography Tool Package

5. Post-processing and characterization

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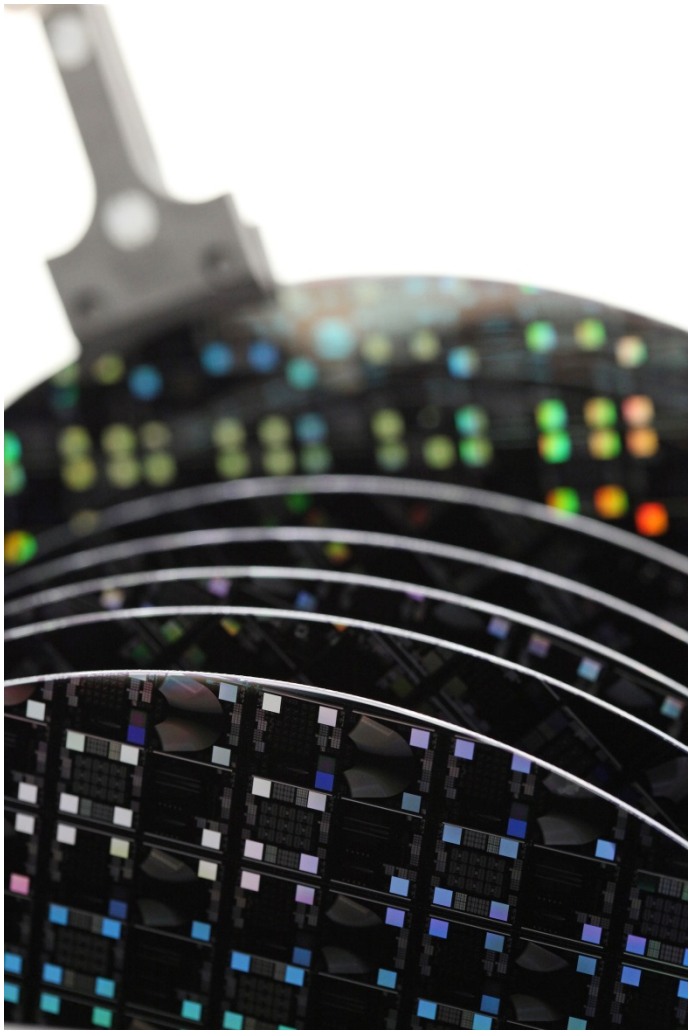

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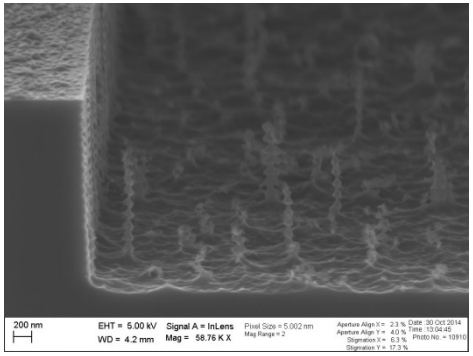
Outline

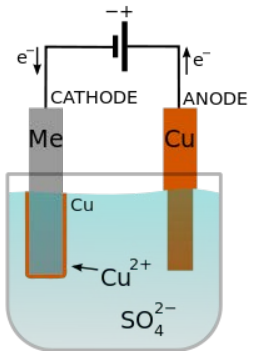
1. Introduction
   - Process steps in UV lithography
2. Spin coating
   - Resist composition
   - Pre-treatment
   - Principle
   - Softbake
   - Spin curve
3. Exposure
   - Hardware
   - Process parameters
   - Resolution
   - Alignment
4. Development
   - Principle
   - Effects
   - Resist tone, photo-chemistry, and contrast
5. **Post-processing and characterization**
   - Post processing
   - Characterization methods
6. Process effects and examples
   - Process effects
   - Real life process examples

After lithography: pattern transfer

- **Etching**
  - Resist pattern is transferred to substrate or hard mask
  - Wet: liquid chemical, possibly heat
  - Dry: gas, possibly plasma
  - Scumming leads to micro-masking → roughness

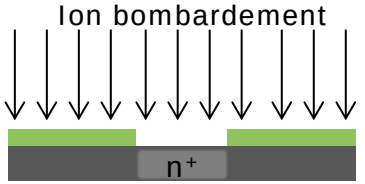


- **Electroplating**
  - The resist pattern inhibits growth of the metal film
  - Film growth by electro-chemical reduction of ions (electrolyte)
  - Requires conductive substrate or seed layer
  - Scumming leads to partial film growth



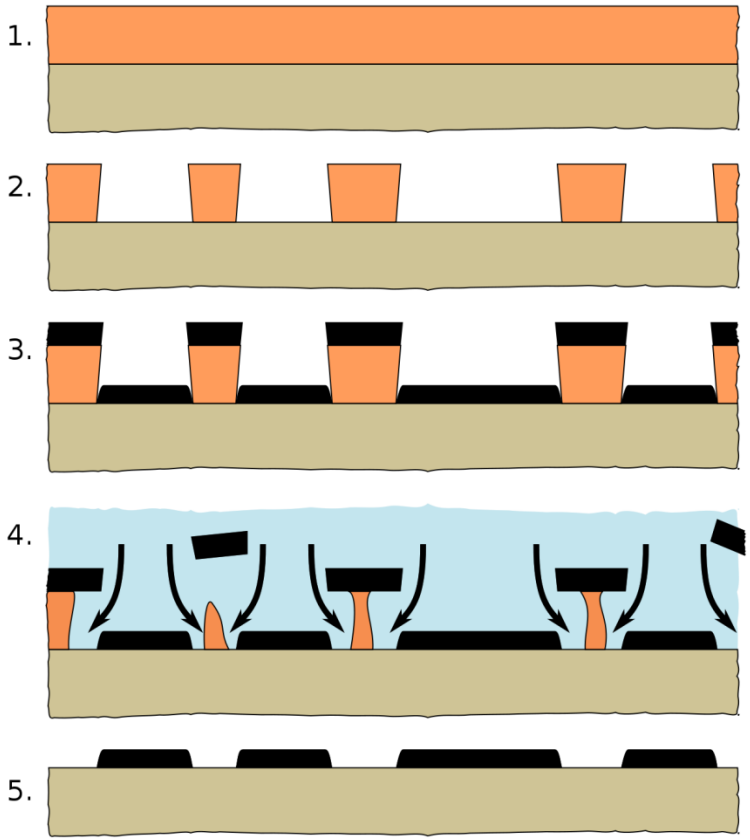
https://en.wikipedia.org

- **Implantation**
  - The resist pattern is used for selective doping of the substrate



After lithography: pattern transfer

- **Lift-off**
  - A thinfilm (usually metal) is deposited on top of the resist pattern
  - Requires directional deposition (non-conformal)
  - After deposition the resist is dissolved, leaving only the part of the film that was deposited on the substrate
  - Best result with negative sidewalls
  - Scumming leads to poor adhesion/contact
  - Method: solvent and ultrasonic agitation



After lithography: post-processing

De-scum

- Before pattern transfer
- Methods:
  - Plasma ashing (low power and short time)
  - BHF (silicon substrate)

Hardbake

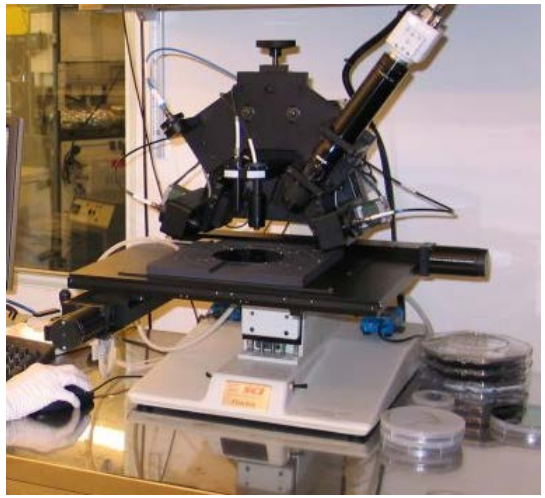
- Before pattern transfer in order to increase the mechanical, thermal, or chemical resistance, and/or increase adhesion
- Method:
  - Baking at 120–150 °C

Resist strip

- After pattern transfer
- Methods:
  - Plasma ashing (high power and long time)
  - Solvent and ultrasonic agitation

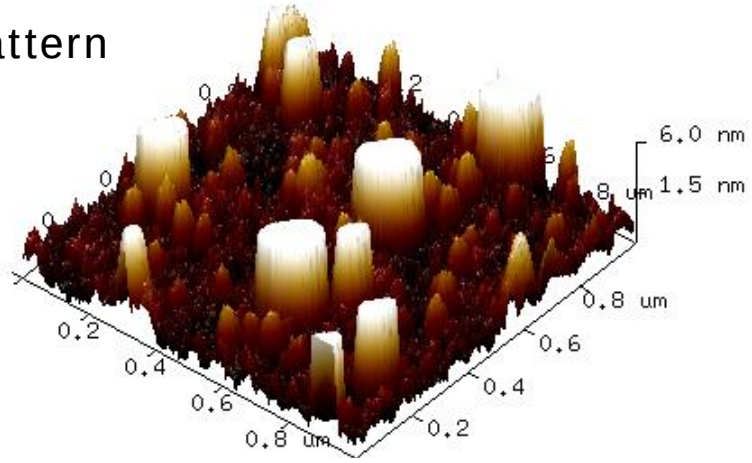
Inspection: characterization methods

- Reflectometry/Ellipsometry
  - Determines film thickness and refractive index using spectral reflectance/polarization
  - Complicated theory and modelling
  - For characterizing coating thickness and uniformity



- Profilometry
  - Mechanical (stylus) or Optical (interferometry/confocal microscope)
  - Measuring film thickness and/or pattern dimensions
  - For checking and documenting resist pattern

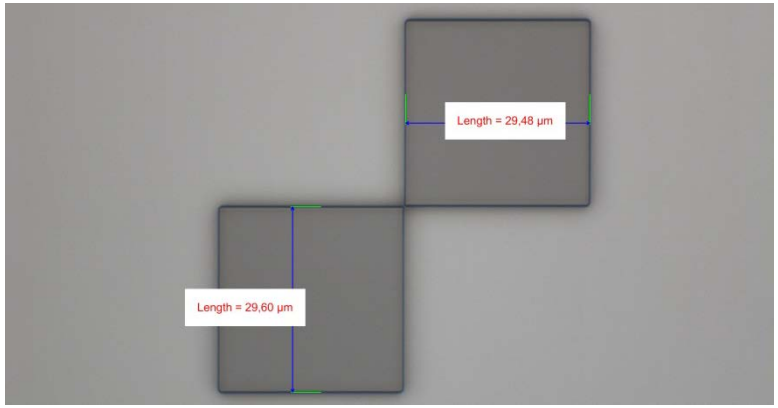
- Atomic Force Microscopy
  - Measuring pattern dimensions
  - Measuring surface roughness
  - For documenting resist pattern

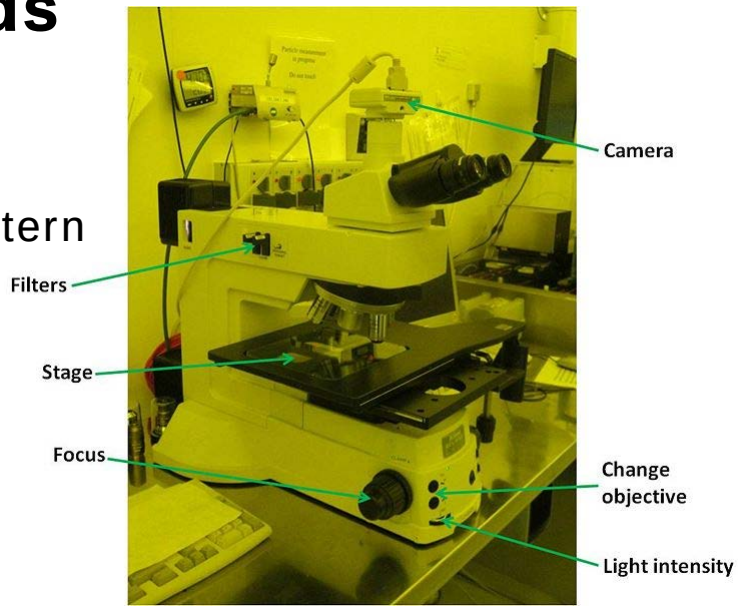


Courtesy of Sonny Massahi

Inspection: imaging methods

- Optical microscopy
  - Measuring pattern dimensions
  - For checking and documenting resist pattern





- Scanning Electron Microscopy
  - Measuring pattern dimensions
  - Imaging resist profiles
  - For checking and documenting resist pattern
- Characterization TPT covers SEM