Fabrication-I

- Cleaving GaAs, Si,
- Sample cleaning and preparation,
- Spinning resists,
- Optical lithography, positive and negative resists,
- Optical developers,
- Optical Litho lift off process,
- Plasma etching and other resist cleaning methods,
Fabrication-I Cleaving GaAs, Si

The Wafers

The Cleaving device
Or manually

SiO₂ ~ a bit strong in cutting but it doesn’t need that much forces.

GaAs ~ is brittle, need some care in cutting
Fabrication-I  Sample cleaning and preparation

Acetone

Ultrasound~10 mint

Dry the wafers from the acetone using air

Remove the Acetone using Isopropanol and dry again

UVO
Fabrication-I Sample cleaning and preparation

The Resist
Negative photoresist & Positive photoresist
The spinning
Baking

Optical lithography~ ma N 415 negative photoresist.

<table>
<thead>
<tr>
<th>Proc</th>
<th>RPM/s</th>
<th>Time (s)</th>
<th>RAMP/s</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2000</td>
<td>40</td>
<td>2</td>
</tr>
<tr>
<td>2</td>
<td>4000</td>
<td>40</td>
<td>4</td>
</tr>
<tr>
<td>3</td>
<td>6000</td>
<td>40</td>
<td>6</td>
</tr>
<tr>
<td>4</td>
<td>8000</td>
<td>40</td>
<td>8</td>
</tr>
</tbody>
</table>
-optical lithography

1. Ready substrate with negative photoresist.
2. UV to make the polymer bonds stronger.
3. Remove the unexposed resist by developer ~ma D332S.
4. Evaporation.
Fabrication-I  Optical lithography

Optical Lithography Device
The Masks: made of glass
The size: 4“ X 4“
The pattern: not transparent for UV
Fabrication-I Optical Litho lift off process

- UV
- Evaporation
**Fabrication-I** Plasma etching and other resist cleaning methods

- **Dry etching:** (Important to GaAs)
  - **Plasma Etching** The wafer is in direct contact with the plasma, (later).
  - **Two types of process:**
    - **Sputter etching** (using inert gases like argon) acceleration, momentum transfer moves the surface atoms.
    - **Chemical etching:** neutral or activated gas, forms etch volatile product.

- **RIE - Reactive Ion Etching** like Plasma, combination of two process, not isotropic, the holder electrode is smaller.

- **Magnetically Enhanced Reactive Ion Etching (MERIE)** – a low pressure RIE (10e-3), low ion density.

- **Ion Milling** – ion of inert gas are used to erode the surface by bombardment.

- **RIBE - Reactive Ion-Beam Etching** Similar to RIE, the wafers are separated from the plasma by a grid that accelerate ions toward the wafers.
## Fabrication-I Plasma etching and other resist cleaning methods

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Plasma Etching</th>
<th>RIE</th>
<th>RIBE</th>
<th>Sputter Etch</th>
<th>Ion Milling</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mechanism physical</td>
<td>Chemical</td>
<td>K.A.Chem</td>
<td>K.A.Chem-Physical</td>
<td>Physical</td>
<td>Physical</td>
</tr>
<tr>
<td>Directionality</td>
<td>+/-</td>
<td>+</td>
<td>++</td>
<td>+</td>
<td>++</td>
</tr>
<tr>
<td>Pressure (tor)</td>
<td>0.1-5</td>
<td>0.01-1</td>
<td>10e-4</td>
<td>0.001-1</td>
<td>&lt; 10e-4</td>
</tr>
<tr>
<td>Equipment configuration</td>
<td>Parallel with planar As = Ao</td>
<td>Planar Ao &gt; As</td>
<td>Planar with grid</td>
<td>Planar with target</td>
<td>Ion-beam accelerator</td>
</tr>
</tbody>
</table>
Fabrication-I Plasma etching and other resisit cleaning methods

- **Gas Inlet**
- **Substrate**
- **Process Champer**
- **Top Electrode**
- **Lower Electrode (water cooled)**

13.56 MHz
Plasma etching and other resist cleaning methods

- Plasma State: Create highly reactive species of oxygen, fluorine, or chlorine.
- Completely chemical (isotropic) or Kinetically assisted chemical reaction (need parallel electrode of equal area).
- Etching Steps:
  - Absorption from the surface of the material,
  - The Chemical Reaction,
  - Desorption of the products.
  - O₂ – Cleaning Organic (Removing the PMMA),
  - CHF₃ – Etching the SiO₂,

<table>
<thead>
<tr>
<th>Substrate</th>
<th>Etching Depth/Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>SiO₂</td>
<td>20 nm/mint</td>
</tr>
<tr>
<td>Si</td>
<td>2 nm/ mint</td>
</tr>
<tr>
<td>GaAs</td>
<td>~ 0.00001 nm/mint</td>
</tr>
</tbody>
</table>
• Thanks for all of you 😊