In-Process Characterization

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OUTLINE

- Wet Etch Rate Measurements
- Dry Etch Rate and Selectivity Measurements
- Photographic Documentation
- Crystallographic Orientation
- Wafer Type (n or p)
- Resistivity, Sheet Resistance
- Junction Depth
- Transparent Film Thickness
- Opaque Film Thickness
- Thickness Calibration Standards
- Lithographic Focus and Resolution
- Lithographic Linewidth
- Lithographic Overlay
- Spin Speed Measurement

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OUTLINE (CONTINUED)

- Particulates
- Oscillating Crystal Film Thickness
- Residual Gas Analysis
- Emission Spectroscopy
- Temperature
- Ion Implant
- Capacitance Voltage
- Surface Charge Analysis
STEP ETCH APPARATUS

Lower 1/4 inch every 30 seconds
ETCH STEPS IN OXIDE

5000 Å

BARE SILICON
ETCH STEPS IN OXIDE SPIN-ON DOPANT FIND SLOW AND FAST ETCH RATES

8000 Å

SPIN-ON DOPANT ON OXIDE

OXIDE

BARE SILICON

SLOW

FAST
In Process Measurement

PAINT RESIST STRIPES, ETCH BARE, FOUR POINT PROBE, FIND XOX TO MASK BORON

BARE SILICON WITH SPIN-ON DOPANT

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DRY ETCH SELECTIVITY AND ETCH RATE
## ETCH RATES

### Summary of Etch Rates and Deposition Rates for RIT Processes

<table>
<thead>
<tr>
<th>Wet Etch Process Description</th>
<th>Date</th>
<th>Rate</th>
<th>Units</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1:1 Buffered Oxide Etch of Thermal Oxide, 300'K</td>
<td>12/11/2004</td>
<td>1122</td>
<td>Å/min</td>
<td>EMCR650</td>
</tr>
<tr>
<td>10:1 Buffered Oxide Etch of Thermal Oxide, 300'K</td>
<td>10/15/2005</td>
<td>586</td>
<td>Å/min</td>
<td>Mike Aquilino</td>
</tr>
<tr>
<td>10:1 BOE Etch of PECVD TEOS Oxide, no anneal, 300'K</td>
<td>10/15/2005</td>
<td>2062</td>
<td>Å/min</td>
<td>Mike Aquilino</td>
</tr>
<tr>
<td>10:1 BOE Etch of PECVD TEOS Oxide, anneal 1000°C - 60 min, 300'K</td>
<td>10/15/2005</td>
<td>814</td>
<td>Å/min</td>
<td>Mike Aquilino</td>
</tr>
<tr>
<td>10:1 BOE Etch of PECVD TEOS Oxide, anneal 1100°C - 6 hr, 300'K</td>
<td>10/15/2005</td>
<td>562</td>
<td>Å/min</td>
<td>Mike Aquilino</td>
</tr>
<tr>
<td>Pad Etch on Thermal Oxide, 300'K</td>
<td>12/11/2004</td>
<td>623</td>
<td>Å/min</td>
<td>EMCR650</td>
</tr>
<tr>
<td>Pad Etch of PECVD TEOS Oxide, 300'K</td>
<td>6/8/2006</td>
<td>1230</td>
<td>Å/min</td>
<td>Dale Ewbank</td>
</tr>
<tr>
<td>Hot Phosphoric Acid Etch of Thermal Oxide at 175°C</td>
<td>10/15/2005</td>
<td>&lt;1</td>
<td>Å/min</td>
<td>Mike Aquilino</td>
</tr>
<tr>
<td>Hot Phosphoric Acid Etch of TEOS Oxide, no anneal, at 175°C</td>
<td>10/15/2005</td>
<td>17</td>
<td>Å/min</td>
<td>Mike Aquilino</td>
</tr>
<tr>
<td>Hot Phosphoric Acid Etch of TEOS Oxide, 1000°C 60 min Anneal, at 175°C</td>
<td>10/15/2005</td>
<td>3.3</td>
<td>Å/min</td>
<td>Mike Aquilino</td>
</tr>
<tr>
<td>Hot Phosphoric Acid Etch of TEOS Oxide, 1100°C 6 Hr Anneal, at 175°C</td>
<td>10/15/2005</td>
<td>3.8</td>
<td>Å/min</td>
<td>Mike Aquilino</td>
</tr>
<tr>
<td>Hot Phosphoric Acid Etch of Si3N4 at 175°C</td>
<td>11/15/2004</td>
<td>82</td>
<td>Å/min</td>
<td>EMCR650</td>
</tr>
<tr>
<td>50:1 Water/HF(43%) on Thermal Oxide at room T</td>
<td>10/15/2005</td>
<td>187</td>
<td>Å/min</td>
<td>Mike Aquilino</td>
</tr>
<tr>
<td>50:1 Water/HF(43%) on PECVD TEOS Oxide, no anneal, at room T</td>
<td>10/15/2005</td>
<td>611</td>
<td>Å/min</td>
<td>Mike Aquilino</td>
</tr>
<tr>
<td>50:1 Water/HF(43%) on PECVD TEOS Oxide, anneal 1000°C - 30 min, at room T</td>
<td>10/15/2005</td>
<td>115</td>
<td>Å/min</td>
<td>Mike Aquilino</td>
</tr>
<tr>
<td>50:1 Water/HF(43%) of PECVD TEOS Oxide, anneal 1100°C - 6 hr, 300'K</td>
<td>10/15/2005</td>
<td>107</td>
<td>Å/min</td>
<td>Mike Aquilino</td>
</tr>
<tr>
<td>KOH etch rate of PECVD Nitride (Low σ)</td>
<td>2/4/2005</td>
<td>30</td>
<td>μm/min</td>
<td>EMCR870</td>
</tr>
<tr>
<td>KOH etch rate of PECVD Nitride (Low σ)</td>
<td>2/4/2005</td>
<td>10</td>
<td>Å/min</td>
<td>EMCR870</td>
</tr>
</tbody>
</table>

### Plasma Etch Process Description

| Lam 430 FACNT.N.RCP, 125 watts, 200 sccm SF6 only, Pressure 260 mTorr, Gap 1.55 | Date    | Rate  | Units | Comment |
| Resistant Etch Rate using Lam 430 FACNT.RCP | 2/4/2005 | 1200  | Å/min | Dr. Fuller |
| PECVD Nitride (Low σ) Etched with Lam 430 FACNT.RCP | 2/11/2005 | 1000  | Å/min | Dr. Fuller |
| Thermal Pad Oxide using Lam 430 recipe FACNT.RCP | 6/7/2006 | 5200  | Å/min | Dr. Fuller |

### CVD Deposition Rates & Process Description

| Factory Nitride 810 LPCVD | Date    | Rate  | Units | Comment |
| Factory Poly 610°C | 2/4/2005 | 45    | Å/min | EMCR870 |
| Poly (MEMS) 650°C | 1/21/2007 | 70    | Å/min | Dr. Fuller |
| Poly (MEMS) 650°C | 6/13/2006 | 160   | Å/min | Dr. Fuller |
OPTICAL CRYSTAL ORIENTATION

Light Reflections from KOH Etched Wafers

(111) n-TYPE
Primary Flat
Secondary Flat

(111) p-TYPE
Primary Flat
Secondary Flat

(100) n-TYPE
Primary Flat
Secondary Flat

(100) p-TYPE
Primary Flat
Secondary Flat

In Process Measurement

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Electrons move away from hot probe

- Schottky contact to n-type makes current very low.
- Ohmic contact to p-type makes current high.
Rhos = \( \frac{\pi}{\ln2} \times W \times \frac{V}{I} \) ohm-cm

if \( S \ll W \) and \( S \ll \text{Wafer Diameter} \)
MEASURE WAFER SHEET RESISTANCE

CDE Resistivity Mapper

$Rho = Rhos \times t$
Thickness = \frac{\text{Bulk Resistivity}}{\text{Measured Sheet Resistance}}

Bulk Resistivity is assumed to be known

Measured Sheet Resistance = (\pi/\ln2)(V/I)

The CDE Resistivity Mapper can be programmed to automatically convert measured V/I to thickness
The amount of self inductance depends on the resistivity of the wafer (ohm-cm)
Staining Solution - 1 Vol part HF, 2 Vol part Nitric Acid, 12 Vol part Acetic Acid
After mixing drop a penny in solution for about 10 sec. result in a light blue color.  Safety Stain - (does not have HF) is available from Philtec Instrument Co. Philadelphia, PA 19129-1651, (215) 848-4500, Signatone makes groove tool and wheels, (408)732-3280

\[ X_j = \frac{N \times M}{D} \]
(at RIT D=1.532 inch)
Example: If $M = 0.003$ inches and $N = 0.025$ inches, find $x_j$.

\[ x_j = \frac{N \times M}{D} \]

\[ = \frac{0.025 \times 0.003}{1.588 \text{ inch}} \]

\[ = 0.0000472 \text{ inch} \]

\[ = 1.20 \, \mu\text{m} \]
In Process Measurement

GROOVE AND STAIN AND 4PT PROBE FIND SHEET RESISTANCE AND RESISTIVITY FOR A DIFFUSED LAYER

\[
X_j = \frac{(N \times M)}{D} 
\]

After Stain

Groove

\[
Rhos = \frac{V}{I} \times \frac{\pi}{\ln 2} = 4.532 \ \text{V/I ohms/square}
\]

\[
Rho = Rhos \times X_j \ \text{ohm-cm}
\]

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SPREADING RESISTANCE PROFILOMETER (SRP)

Measure Voltage and Current

I/V

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Page 20
### OXIDE THICKNESS COLOR CHART

<table>
<thead>
<tr>
<th>Thickness</th>
<th>Color</th>
</tr>
</thead>
<tbody>
<tr>
<td>500</td>
<td>Tan</td>
</tr>
<tr>
<td>700</td>
<td>Brown</td>
</tr>
<tr>
<td>1000</td>
<td>Dark Violet - Red Violet</td>
</tr>
<tr>
<td>1200</td>
<td>Royal Blue</td>
</tr>
<tr>
<td>1500</td>
<td>Light Blue - Metallic Blue</td>
</tr>
<tr>
<td>1700</td>
<td>Metallic - very light Yellow Green</td>
</tr>
<tr>
<td>2000</td>
<td>Light Gold or Yellow - Slightly Metallic</td>
</tr>
<tr>
<td>2200</td>
<td>Gold with slight Yellow Orange</td>
</tr>
<tr>
<td>2500</td>
<td>Orange - Melon</td>
</tr>
<tr>
<td>2700</td>
<td>Red Violet</td>
</tr>
<tr>
<td>3000</td>
<td>Blue - Violet Blue</td>
</tr>
<tr>
<td>3100</td>
<td>Blue</td>
</tr>
<tr>
<td>3200</td>
<td>Blue - Blue Green</td>
</tr>
<tr>
<td>3400</td>
<td>Light Green</td>
</tr>
<tr>
<td>3500</td>
<td>Green - Yellow Green</td>
</tr>
<tr>
<td>3600</td>
<td>Yellow Green</td>
</tr>
<tr>
<td>3700</td>
<td>Yellow</td>
</tr>
<tr>
<td>3900</td>
<td>Light Orange</td>
</tr>
<tr>
<td>4100</td>
<td>Carnation Pink</td>
</tr>
<tr>
<td>4200</td>
<td>Violet Red</td>
</tr>
<tr>
<td>4400</td>
<td>Red Violet</td>
</tr>
<tr>
<td>4600</td>
<td>Violet</td>
</tr>
<tr>
<td>4700</td>
<td>Blue Violet</td>
</tr>
<tr>
<td>4900</td>
<td>Blue</td>
</tr>
<tr>
<td>5000</td>
<td>Blue Green</td>
</tr>
<tr>
<td>5200</td>
<td>Green</td>
</tr>
<tr>
<td>5400</td>
<td>Yellow Green</td>
</tr>
<tr>
<td>5600</td>
<td>GreenYellow</td>
</tr>
<tr>
<td>5700</td>
<td>Yellow - &quot;Yellowish&quot; (at times appears to be Lt gray or metal)</td>
</tr>
<tr>
<td>5800</td>
<td>Light Orange or Yellow - Pink</td>
</tr>
<tr>
<td>6000</td>
<td>Carnation Pink</td>
</tr>
<tr>
<td>6300</td>
<td>Violet Red</td>
</tr>
<tr>
<td>6800</td>
<td>&quot;Bluish&quot; (appears violet red, Blue Green, looks Blue)</td>
</tr>
<tr>
<td>7200</td>
<td>Blue Green - Green</td>
</tr>
<tr>
<td>7700</td>
<td>&quot;Yellowish&quot;</td>
</tr>
<tr>
<td>8000</td>
<td>Orange</td>
</tr>
<tr>
<td>8200</td>
<td>Salmon</td>
</tr>
<tr>
<td>8500</td>
<td>Dull, Light Red Violet</td>
</tr>
<tr>
<td>8600</td>
<td>Violet</td>
</tr>
<tr>
<td>8700</td>
<td>Blue Violet</td>
</tr>
<tr>
<td>8900</td>
<td>Blue</td>
</tr>
<tr>
<td>9200</td>
<td>Blue Green</td>
</tr>
<tr>
<td>9500</td>
<td>Dull Yellow Green</td>
</tr>
<tr>
<td>9700</td>
<td>Yellow - &quot;Yellowish&quot;</td>
</tr>
<tr>
<td>9900</td>
<td>Orange</td>
</tr>
<tr>
<td>10000</td>
<td>Carnation Pink</td>
</tr>
</tbody>
</table>

**Nitride Thickness** = (Oxide Thickness)(Oxide Index/Nitride Index)

Eg. Yellow Nitride Thickness = (2000)(1.46/2.00) = 1460
INCIDENT WHITE LIGHT, THE INTENSITY OF THE REFLECTED LIGHT IS MEASURED VS WAVELENGTH

**MONOCHROMATOR & DETECTOR**

**WHITE LIGHT SOURCE**

**OPTICS**

**WAFFER**

3000 Å OXIDE

7000 Å OXIDE

Oxide on Silicon 400-30,000 Å
Nitride 400-30,000 Å
Neg Resist 500-40,000 Å
Poly on 300-1200 Ox 400-10,000 Å
Neg Resist on Ox 300-350 300-3500 Å
Nitride on Oxide 300-3500 300-3500 Å
Thin Oxide 100-500 Å
Thin Nitride 100-500 Å
Polyimide 500-10,000 Å
Positive Resist 500-40,000 Å
Pos Resist on Ox 500-15,000 4,000-30,000 Å
To measure film thickness, focus on the feature that will be measured. The black circle in the center of the view is the area that will be measured. If the black circle is too large, go back and select a different objective lens.
Big enough for easy Nanospec Measurements
FT500

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The light source is unpolarized, upon traversing the polarizer the light becomes linearly polarized. Turning the polarizer adjusts the azimuth of linearly polarized light with respect to the fast axis of the quarter-wave plate in such a way as to vary the ellipticity of the light incident on the surface. This ellipticity is adjusted until it is just cancelled by the ellipticity introduced by the reflection. The result is again linearly polarized light. The analyzer polarizing prism is rotated until its axis of polarization is perpendicular to the azimuth of the linearly polarized light, creating a null. Thus no light is transmitted to the detector. The common technique is to fix the quarter-wave plate with fast axis at 45° to the plane of incidence, and to alternately move the polarizer and analyzer, continuously reducing the transmitted light until a null is reached. The relevant light parameters $\Delta$ and $\Psi$ are readily calculated from the instrument parameters ($P$, polarizer angle, $Q$, quarter-wave plate angle, and $A$, analyzer angle. Values for film thickness and index of refraction are found. Thickness values that correspond to these parameters repeat with multiples of the light source wavelength so the approximate thickness must be known.
In Process Measurement

ELLIPSOMETER

Rudolph Ellipsometer

Variable Angle Spectroscopic Ellipsometer
In Process Measurement

INTERFERROMETRIC FILM ETCH/DEPOSITION RATE MONITOR

LASER $\lambda = 6328$ Å

REFLECTANCE

MOVING INTERFACE

DETECTOR

$\lambda/2n$

t

CONSTRUCTIVE INTERFERENCE
WHEN FILM THICKNESS IS MULTIPLE OF $\lambda/2n$
In Process Measurement

SURFACE PROFILOMETER

Stylus

Film

Readout

Film Thickness

1,000 Å < Max < 1,000,000 Å

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STEP HEIGHT = \((\Delta S/S)(\lambda/2)\)

SODIUM LIGHT SOURCE
LAMBDA = 5890Å

OBJECTIVE LENS
WITH 10% REFLECTIVE COATING ON BOTTOM

WAFER WITH TOPOLOGY
OPTICAL TECHNIQUES FOR HEIGHT AND DISPLACEMENT

3D Surface Topography
Heights 0.1 nm to 5 mm
Resolution 0.1 nm

http://www.veeco.com
In Process Measurement

VEECO DYNAMIC OPTICAL PROFILER

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In Process Measurement

VEECO WYCO NT1100 OPTICAL PROFILOMETER

Used to measure RMS surface roughness

RIT’s Optical Profilometer

900W, 20 sccm, 5mT, 90 min, 7225Å

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In Process Measurement

**OPTICAL MICROSCOPY**

- TV Camera
- Tri-nocular Eyepiece and Camera Mount
- Bright Field Dark Field Selection mechanism
- Objective lenses, 5X, 10X, 40X, 100X
- Stage
- x-y stage movement
- Focus and height measurement each division is 1 µm
- Coaxial Illuminator
- Illuminator for Transparent Samples
- Filters
- Aperture

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Put object on the microscope and obtain an image then place the micrometer under the stage as shown to measure the height change as the focus knob is turned.

Use the 100 x Objective Lens for smallest depth of focus.

Focus on top of object and set micrometer dial to zero.

Focus on bottom of object and read the height on the micrometer dial.

Dial divisions are 0.001 inch units equal to 25.4 µm accuracy is about 1/2 division or 12.5 µm, this is good for measuring thickness in the 100’s of microns range.
HEIGHT MEASUREMENT USING OPTICAL MICROSCOPE

Put object on the microscope and obtain an image then place the micrometer under the stage as shown to measure the height change as the focus knob is turned.

Use the 100 x Objective Lens for smallest depth of focus.

Focus on top of object and set micrometer dial to zero.

Focus on bottom of object and read the height on the micrometer dial.
Example: If $M=.003$ inches and $N=0.025$ inches, find $x_j$.

$$X_j = \frac{N \times M}{D}$$

$$= \frac{(0.025 \times 0.003)}{1.532 \text{ inch}}$$

$$= 0.0000472 \text{ inch}$$

$$= 1.20 \mu \text{m}$$

Poly on Oxide on Silicon
(no stain)
In Process Measurement

THICKNESS CALIBRATION STANDARDS

1,500 Å Nitride on 500 Å SiO₂

10,000 Å Oxide
1000 Å Oxide
500 Å Oxide
6,000 Å Poly on 500 Å Oxide
6,000 Å Poly on 1000 Å Oxide
1500 Å Nitride on 500 Å Oxide

Can be used with ellipsometer, nanospec, alpha step, interference microscopy and optical focus depth measurements.
Focus stars are 2 µm at outside perimeter and each tick mark is 0.5 µm. The image with the smallest diameter center in a given column is the row of best focus.

Resolution structures are 1.0, 1.5 and 2.0 µm lines and spaces in both horizontal and vertical orientation. The column with equal lines and spaces is the best exposure.
To experimentally determine the best focus and exposure for a stepper one can use a special photomask that has focus starts and resolution targets and a special stepper job that sets up an array in which each row is at a different focus setting and each column is at a different exposure setting.

The new mask and stepper job (new in January 1996) makes it possible to view the entire 7 by 7 array without moving the microscope stage. This makes it easy to compare focus stars and resolution patterns.

THE PROCEDURE:
1. Find and load the new focus exposure mask labeled FOCEX.NEW. This mask has a focus star and resolution targets with patterns from 2.0 to 0.5 micrometers.

2. Use the stepper command EXPO FOCEX.NEW
   In the stepper dialog use the following settings:
   - number of rows = 7
   - number of columns = 7
   - starting exposure = 0.1
   - exposure increments = 0.1
   - starting focus = 220
   - focus increments = 10
Calibrate the output device for the microscope for a known size object. Then display unknown device and determine size by comparing the unknown to the known size.

A filar eyepiece is an eyepiece with a mechanical dial that moves a hairline across the field of view. The markings on the dial are calibrated by measuring a known size object. Unknown size objects are measured by positioning the hairline on one edge of the object, reading the dial and positioning the hairline on the other side of the object and reading the difference. Then calculating the size knowing the calibration. This technique is limited to objects small enough to fit within the field of view. For larger objects a calibrated traveling stage with a fixed hairline within the eyepiece can be used. Newer systems use CCD camera pixel counting rather than a mechanical eyepiece.
In Process Measurement

Obtain line across resolution target.

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THE INTENSITY OF THE REFLECTED LIGHT IS MEASURED VS SLIT POSITION AS A SLIT IS MOVED ACROSS THE MAGNIFIED IMAGE

MOVING SLIT & DETECTOR

WHITE LIGHT SOURCE

OPTICS

WAFER

Reflected Intensity

Resist Lines Program

Openings in Resist Program

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The 2 micrometer line/space shown inside the box is measured and recorded at the move out for each photo step.
Using an Optical microscope at 100X find the resolution target for the current photo level and set it up so that you can compare the 4 micrometer line/space pattern to the scale below. Estimate the size of the 2 micrometer line of photoresist or the size of the 2 micrometer opening in the photoresist.
Second Level Marks on 10 µm Spaces

First Level Marks on 11 µm Spaces

Example shows alignment error of -1 µm in X and -2 µm in Y
ALIGNMENT VERNIERS
CRITICAL DIMENSION (CD) STRUCTURES

2nd Photolithography
When the Strobe Lamp Flash Rate is Equal to the Spin Speed the Marker Appears to be Stationary
In Process Measurement

AIR BORNE PARTICLE COUNTER

INPUT AIR SAMPLE

LASER

PARTICLE SIZE IS RELATED TO SCATTER ANGLE

DETECTOR ARRAY AND COUNTER

PUMP

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In Process Measurement

SURFACE PARTICLE SCANNER

PARTICLE SIZE IS RELATED TO SCATTER ANGLE

DETECTOR ARRAY AND COUNTER

ROTATING MIRROR SCANNER

LASER

WAFER WITH PARTICULATES
TENCORE SURF SCAN

Gives total surface particle count and count in 4 bins <0.5, 0.5 to 2.0, 2.0-10, >10. Bin boundary can be selected. Edge exclusion eliminated count from near the edge of the wafer.
### Example Surface Particle Count Data

**Before Cleaning (75 mm)**

<table>
<thead>
<tr>
<th>Size Range (µm)</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.2 - 0.5</td>
<td>104</td>
</tr>
<tr>
<td>0.5 - 2.0</td>
<td>562</td>
</tr>
<tr>
<td>2.0 - 10</td>
<td>19</td>
</tr>
<tr>
<td>&gt;10</td>
<td>2</td>
</tr>
</tbody>
</table>

**After Cleaning (75 mm)**

<table>
<thead>
<tr>
<th>Size Range (µm)</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.2 - 0.5</td>
<td>10</td>
</tr>
<tr>
<td>0.5 - 2.0</td>
<td>4</td>
</tr>
<tr>
<td>2.0 - 10</td>
<td>0</td>
</tr>
<tr>
<td>&gt;10</td>
<td>0</td>
</tr>
</tbody>
</table>
Thin metal film is deposited on quartz crystal making it oscillate a slower frequency the change is proportional to the thickness.
CHA FLASH EVAPORATOR
The emission of light occurs when electrons, ions or molecules in a high energy state relax to a lower energy state. In a plasma, gas molecules are broken into fragments and excited to high energy states by the applied radio frequency power. These fragments recombine giving off photons equal in energy to the difference between the excited state and the relaxed state called an emission spectrum. In general plasmas are quite complex and the emission spectrum has many spikes and peaks at different wavelengths. Some of these spikes and peaks change as the chemistry of the plasma changes. For example in etching silicon nitride once the etching is complete the amount of nitrogen in the plasma goes to zero and peaks associated with nitrogen disappear. If the nitride is over oxide than once the nitride is gone the amount of oxygen in the plasma will increase and peaks associated with oxygen will appear. Usually several signals are watched at the same time to determine end point in plasma etching.
In Process Measurement

EMISSION SPECTROSCOPY

Light Emission (Many $\lambda$) → Prism or Grating → Light (Single $\lambda$) → Detector

Emission Intensity vs. Wavelength, $\lambda$}

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Your emission spectrometer can be calibrated by looking at well known emission spectra such as Hydrogen, which has peaks at 405, 438, 458, 486, and 656 nm.
Compare the emission spectra with no wafer to the spectra with a film being etched. Find a peak that represents a byproduct of the etch. Set the spectrometer on one or more of these characteristic peaks and monitor etch completion as these peaks change. For example in O2 plasma etch of photoresist there is a peak at 483.5 nm associated with CO which disappears at the end of the etch.
In Process Measurement

O2 PLASMA STRIP END POINT DETECTION

O2, 30 sccm, 50 watts, 300 mTorr

Monitor the CO peak at 483.5 nm. During photoresist stripping there are large numbers of CO molecules. At end of Photoresist stripping the number of CO molecules is reduced.

0.0 min  TIME  8.0 min
In Process Measurement

HIGH PRESSURE MERCURY VAPOR LAMP

Wavelength (nm)

i-line, 365 nm

g-line, 436 nm

Resist Absorption
Type S Thermocouple is Platinum and Platinum/Rhodium and has a range of -100 to +1400 °C and output of about 1 mV/100 °C.

Type J Thermocouple is Iron Constantan and has a range of -50 to +400 °C and an output of about 6 mV/100 °C.
REFERENCES

1. Safety Stain - (does not have HF) is available from Philtec Instrument Co. Philadelphia, PA 19129-1651, (215) 848-4500
2. Signatone S-1100, Automatic Angle Lapping Machine, 3687 Enochs Street, Santa Clara, CA 95051, (408) 732-3280
1. How can a step etch like process be done in a plasma etch tool?
2. How can groove and stain like process be used to measure LTO? To measure Poly?
3. The interferogram shown was obtained during photoresist strip. How thick was the resist? Assume laser at 6328 Å
4. Explain how thin film interference gives oxide coated wafers their characteristic color.