OR

How we destroy your perfectly good devices and what we are doing to fix them.
Standard Process Flow

- Front-illuminated, n-channel on p-type, low-resistivity silicon
- Back-illuminated, n-channel on p-type, low-resistivity silicon
- Thick, fully depleted, back-illuminated p-channel on n-type high resistivity silicon
Thinning: As Grown vs. Ground

Stress maps
Subsurface Damage vs. Grit Size

Diamond Grit Size (µ)

Subsurface Damage (µ)

- IF-01-1-5/10-V
- IF-01-1-8/20-V
- IF-01-1-20/30-V
- RS-03-2-2/4-P
- IF-01-1-4/6-B-K01
- IF-01-1-5/10-B-K01
- IF-01-1-5/10-V
- IF-01-1-8/20-B-K01
- IF-01-1-20/30-B-K01

Legend:
- Red square: Wafer Edge
- Blue square: Wafer Center
Subsurface Damage: Removal

Around 200 nm

#2000

Ultra Poligrind

Etch

Around 50 nm

MCP/CMP
Thinning Process for BSI

- **SOI method**
  - SOI Wafer
  - Bonding
  - Process stop above oxidation
    - Note: Selective polish to stop at SiO2su surface
  - Thin layer final thickness (Si: 10µm or less)

- **Epi/Bulk method**
  - Epi / Bulk Wafer
  - Bonding
  - BG → CMP
  - Adhesive: 0.1 to 1µm
  - Si: 2 to 5µm
  - After Wet Etching

- **Issues**

<table>
<thead>
<tr>
<th>Method</th>
<th>SOI</th>
<th>EPI / Bulk</th>
</tr>
</thead>
<tbody>
<tr>
<td>BG</td>
<td>Approx.775 µm removal is required</td>
<td>Final thickness less than 10 µm is required</td>
</tr>
<tr>
<td></td>
<td>Process STOP just above oxidation</td>
<td>Good TTV(BG/CMP)</td>
</tr>
<tr>
<td>CMP</td>
<td>End Point Detection</td>
<td>Enhanced thinning process accuracy is needed</td>
</tr>
<tr>
<td>Cleaning</td>
<td>High level cleaning (Particle and metal)</td>
<td></td>
</tr>
</tbody>
</table>
Cross-section of wafer following:

1) 5 hr 1100 °C anneal to out-diffuse oxygen to the surface.
2) 9 hr 650 °C anneal to nucleate precipitates in wafer bulk.
3) CMOS simulation to grow precipitates.
How Stress Relief Causes Failures

- Device layer
  - Atomic metal and crystal defects

- Backside Oxidized layer

- Backgrind layer stress holds onto defects

- Stress relieved back side
  - Allows defects to reach the active area
Cleaning Process for TSVs

1. Brush Module

- **Chelate liquid***
- **DIW**
- **Chelate liquid***

- Atomizing nozzle
- Cleaning
- Both side brush cleaning (Chelate agent)
- Metal contamination removal
- Slurry residue removal

- **CuOx and metal complex is made and removal (No Cu etching)**

2. Spin Module

- **Chelate liquid***
- **DIW**
- **BTA**

- Pen brush cleaning
  - (Chelate agent or DIW)
- Small particle removal

- **BTA Rinse**
- **Dry**

- **Cu surface and BTA are combined for anti-corrosion.**
NCG Only Looks at the Device

Probe

Device Wafer

Active Area

Adhesive

Carrier

10um ~

~ 5um

~ 5um

120 ~ 770um
Thickness Uniformity for TSV/BSI

bf TTV | 0.79 | af TTV | 3.04

bf TTV | 0.55 | af TTV | 0.5

Diagram showing sensor, casing, isolation valve, water supply, water mist, sludge, laser beam, wheel, and chuck table.
Standard Process Flow

Dicing
Thin Wafers Chip Easily

- Chipping Leads to:
  - Particles
  - Crack Initiation Points
  - Large distance between active areas

Crack also occurs ahead of the blade
1. Half cut dice
2. Tape lamination
3. Grind
4. Stress relief
5. Tape mount

**DBG**

- X 50
- X 200

**Standard Dicing**

- X 50
- X 200
Narrow Kerf for RFID: SD

Before expanding

![Image showing before expanding with dimensions 200μm and 20μm]

After expanding

![Image showing after expanding with dimensions 200μm]

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Stealth Dicing

- Stealth dicing (SD)
  - No Particles
  - Clean edges
  - Small distance between active areas

![Diagram of Stealth Dicing Process]

**Process flow**

1. Mounting on tape
2. Laser
3. Breaking
4. Tape transfer
5. Expand
6. Pick up
SD Results (t 90 um): Sharp Edge

- Kerf is zero
- Distance to active area ~8um

Top side photo: after breaking and tape expansion (Optical microscope)
Non Linear Cutting of Multi Reticle Wafers

Mechanism of HASEN cutting

Laser output

ON
ON
ON
ON
ON
OFF

Cut time per line

Example of HASEN cutting (Side view)

Si

SD layer
Non Linear Cutting of Arrays

Arrangement of wafer die
Process for Array Die

L shape

T shape

Cut surface

The numbers of die increased

1 2 3 4 5 6

1 2 3 4 5 6

Laser

30 µm

200 µm

200 µm

100 µm

The numbers of die increased.
Fun Shapes with SD

Hansen cutting

• Processing of non rectangular die
  – By combining linear cuts polygons can be cut

• Application of HASEN cutting
  – Many different shapes of die can be processed, as long as it is a combination of the straight lines
Summary

- Front side or back side imagers
- Stress control
- Metals control
- Thickness uniformity
- Reducing space between detectors
- Particles
- Strength
- Non-linear cutting