**Processes of Silicon Wafers**

**Monocrystalline Silicon**
- Processes: Monocrystalline Silicon Ingot → Top & Tail Cut → Squaring → Monocrystalline Silicon Block
- Finished Product: Wafers → Wafering → 4 Face Grinding → OD Grinding → Monocrystalline Silicon Block → Cropping

**Multicrystalline Silicon**
- Processes: Multicrystalline Silicon Ingot → Squaring → Block → Cropping
- Finished Product: Wafers → Wafering → 4 Face Grinding → Chamfering → Multicrystalline Silicon Block

*SOLAR SILICON PROCESSING TOOLS for SOLAR CELLS*

**Contents**
- Processes of Silicon Wafers - 1
- Diamond Electroplated Band Saw - 3
- OD Blade - 5
- Grinding Wheels - 7
- Diamond Electroplated Wire - 8
Diamond Band Saw Blades

Electroplated Diamond Band Saw Blades

Several blade edge designs are available and selection depends on material to be cut and cutting conditions. Electroplated blades allow for accurate cutting and improved saw efficiency with reduced kerf loss.

### Size Table

<table>
<thead>
<tr>
<th>Length (mm)</th>
<th>Core Width (mm)</th>
<th>Core Thickness (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2,500~10,000</td>
<td>26~125</td>
<td>0.15~1.33</td>
</tr>
</tbody>
</table>

*Please consult with our salesmen for details to determine band configuration.

### Blade Edge Shapes

#### Segmented Type (Half Moon Type)
- For cutting hard and brittle materials
- Superior tool life and cutting ability in MONO silicon processing
- Allows greater flexibility in customizing blade edge width and pitch

#### Serrated Type
- Wide width band saw blades possible
- For cutting difficult-to-cut materials
- Reduced-loading saw tooth design encourages chip evacuation

#### Continuous Type
- A variety of band core width available
- Continuous rim design reduces the saw marks on the materials
- Suitable in cutting hard materials

### Cutting Conditions

<table>
<thead>
<tr>
<th>Type of Blades</th>
<th>Workpieces</th>
<th>Cutting Speed (mm/min)</th>
<th>Peripheral Speed (m/min)</th>
<th>Tension (N/mm²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electroplated Band Saw</td>
<td>MONO Si</td>
<td>10~50</td>
<td>1,000~1,200</td>
<td>100~200</td>
</tr>
<tr>
<td></td>
<td>MULTI Si</td>
<td>5~40</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Maintain optimum blade condition with periodic dressing using recommended dressing sticks
OD Blades for MONO & MULTI crystalline Silicon Ingots and Bricks

Squaring / Cropping

Used for end-cutting, removing brick inclusions and squaring MONO and MULTI silicon.

Applications

◆ Squaring MONO silicon ingot
◆ Squaring and end-cutting MONO seed silicon
◆ End-cutting MULTI silicon bricks to remove inclusions

Blade Shapes

Standard type
Balances blade life and sawing ability

Slotted type
Good cutting ability

Wave type
Special specification for reducing chipping

Cutting Condition

<table>
<thead>
<tr>
<th>Surface Speed</th>
<th>Feed Speed</th>
<th>Process</th>
</tr>
</thead>
<tbody>
<tr>
<td>1500~2000m/min</td>
<td>20~40mm/min</td>
<td>Plunge Cut</td>
</tr>
</tbody>
</table>

To improve blade performance:
◆ Supply sufficient quantity of coolant/water during cutting
◆ Insure ingot/brick is firmly attached to base to reduce triangle-shaped exit-chipping
◆ Maintain optimum blade condition with periodic dressing using recommended dressing sticks

Size Table

<table>
<thead>
<tr>
<th>Size (Inch)</th>
<th>Thickness</th>
<th>Applications</th>
</tr>
</thead>
<tbody>
<tr>
<td>φ400 (16)</td>
<td>2.5U</td>
<td>MONO-Si — Squaring</td>
</tr>
<tr>
<td>φ450 (18)</td>
<td>3.0U</td>
<td>MULTI-Si — Cropping</td>
</tr>
<tr>
<td>φ500 (20)</td>
<td>3.5U</td>
<td></td>
</tr>
<tr>
<td>φ550 (22)</td>
<td>3.5U</td>
<td></td>
</tr>
<tr>
<td>φ600 (24)</td>
<td>3.5U</td>
<td></td>
</tr>
<tr>
<td>φ800 (32)</td>
<td>4.0U</td>
<td>MULTI-Si — Sizing</td>
</tr>
<tr>
<td>φ900 (36)</td>
<td>4.5U</td>
<td>— End Cutting</td>
</tr>
<tr>
<td>φ1000 (40)</td>
<td>5.0U</td>
<td></td>
</tr>
</tbody>
</table>

*Please consult with our salesmen for details to determine wheel configuration.
Grinding Wheels for Bricks

Used for grinding bricks to final size. Metal bond and Resin bond wheels are available to fit all machine makes.

Type of Wheels

- **Grit Size**: #200 ~ #500
- **Bond Type**:
  1. **Metal Bond Wheels**
     - Mainly used for rough grinding. Metal matrix such as Cu, Sn, Fe and Co secures diamond particles firmly for long wheel life.
  2. **Resin Bond Wheels**
     - Mainly used for finish grinding.
     - Thermal cured resin matrix for good grinding ability and superior brick finish
     - Polyimide bond for heavy grinding
     - "BRIGHTSTAR" bond for super finish

Range of dimension:

- Wheel diameter / φ50~φ400
- Wheel width / 3~10mm
- Slot / applicable

Please consult with our salesmen for details.

Case Studies

**Work piece**: 156 MUTI Silicon Bricks

**Rough Grinding**

<table>
<thead>
<tr>
<th>Wheel Spec</th>
<th>Surface Speed</th>
<th>Stock Removal</th>
<th>Table Feed</th>
<th>Surface Roughness</th>
</tr>
</thead>
<tbody>
<tr>
<td>SD200 Metal</td>
<td>2,500m/min</td>
<td>0.8mm</td>
<td>400mm/min</td>
<td>—</td>
</tr>
</tbody>
</table>

**Semi-Finish Grinding**

<table>
<thead>
<tr>
<th>Wheel Spec</th>
<th>Surface Speed</th>
<th>Stock Removal</th>
<th>Table Feed</th>
<th>Surface Roughness</th>
</tr>
</thead>
<tbody>
<tr>
<td>SD500 Resin</td>
<td>2,100m/min</td>
<td>0.05mm</td>
<td>400mm/min</td>
<td>Ra0.3μm</td>
</tr>
</tbody>
</table>

**Finish Grinding**

<table>
<thead>
<tr>
<th>Wheel Spec</th>
<th>Surface Speed</th>
<th>Stock Removal</th>
<th>Table Feed</th>
<th>Surface Roughness</th>
</tr>
</thead>
<tbody>
<tr>
<td>SD500 BRIGHTSTAR</td>
<td>2,500m/min</td>
<td>0.05mm</td>
<td>400mm/min</td>
<td>Ra0.03~0.1μm or less</td>
</tr>
</tbody>
</table>

Diamond Electroplated Wire EcoMEP

EcoMEP Diamond Wire for cutting and wafering silicon and hard, brittle materials such as sapphire. Using electroplating to secure diamond particles to high tensile strength wire, EcoMEP fixed abrasive wire is superior to conventional slurry slicing by dramatically reducing process time, improving sub-surface damage and improving overall yield. Using water-based coolants enables possible reclaim and recycling of cutting chips, lowering cost of ownership.

**Advantages**

1. **Lower overall cost of ownership**
   - Reduce process time
   - More wafers per ingot ⇒ Possibility to slice thinner wafers with thinner wire

2. **Improvement of Wafer Quality**
   - Less sub-surface damage
   - Better thickness variation

3. **Reduction of Environmental Burdens**
   - Use of water base coolant ⇒ No use of slurry ⇒ Cleaner work environment
   - Possible recycle of silicon kerf

**Spec & Application**

<table>
<thead>
<tr>
<th>Application</th>
<th>Core Diameter (mm)</th>
<th>Core Dia(μm)</th>
<th>Final Diameter (mm)</th>
<th>Length per spool</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wafering</td>
<td>φ0.12</td>
<td>10~20</td>
<td>φ0.145</td>
<td>15~50m/spool</td>
</tr>
<tr>
<td>Squaring</td>
<td>φ0.25</td>
<td>30~40</td>
<td>φ0.330</td>
<td></td>
</tr>
</tbody>
</table>

Other spec of wires is available.

(Wafers for PV)
Asahi Diamond Industrial Co., Ltd.

URL: http://www.asahidia.co.jp/

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