MEYER BURGER

DW Slicing Technology and TCO Analysis

April 2014, Meyer Burger

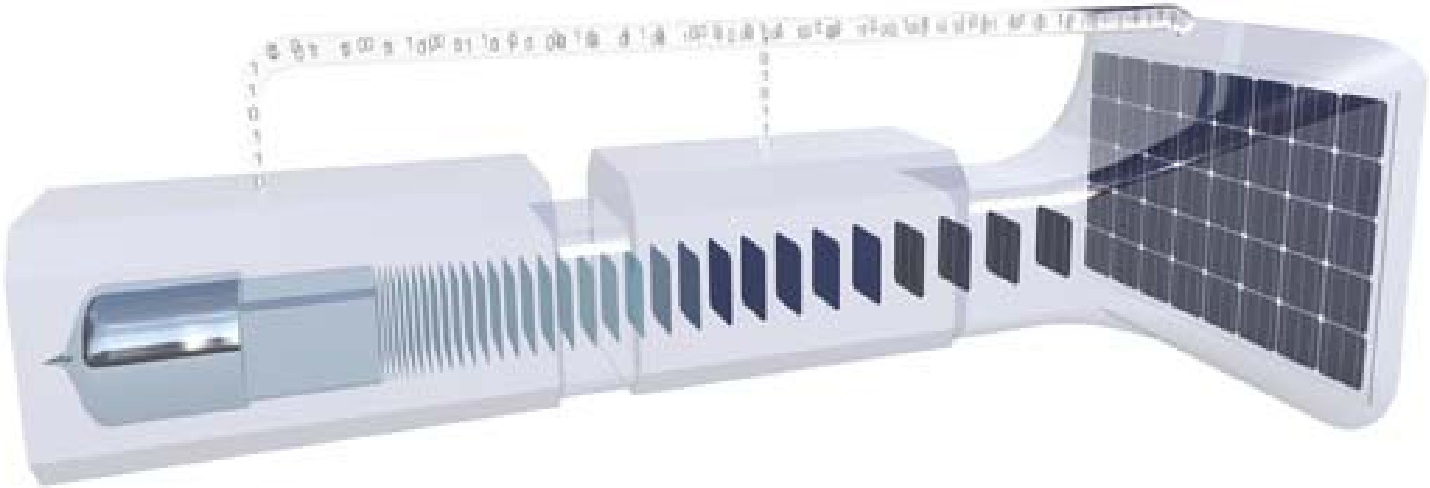
Meyer Burger Technology Ltd.

- Meyer Burger Technology Ltd is a leading global technology group. With its innovative systems and production equipment, Meyer Burger creates sustainable added value for customers in photovoltaic (solar industry), in the semiconductor and optoelectronic industries as well as other selected industries which focus on semiconductor materials.

- In its core business – photovoltaic – customers rely on comprehensive solutions and complementary technologies along the entire value chain including the manufacturing processes for wafers, solar cells, solar modules and solar systems.

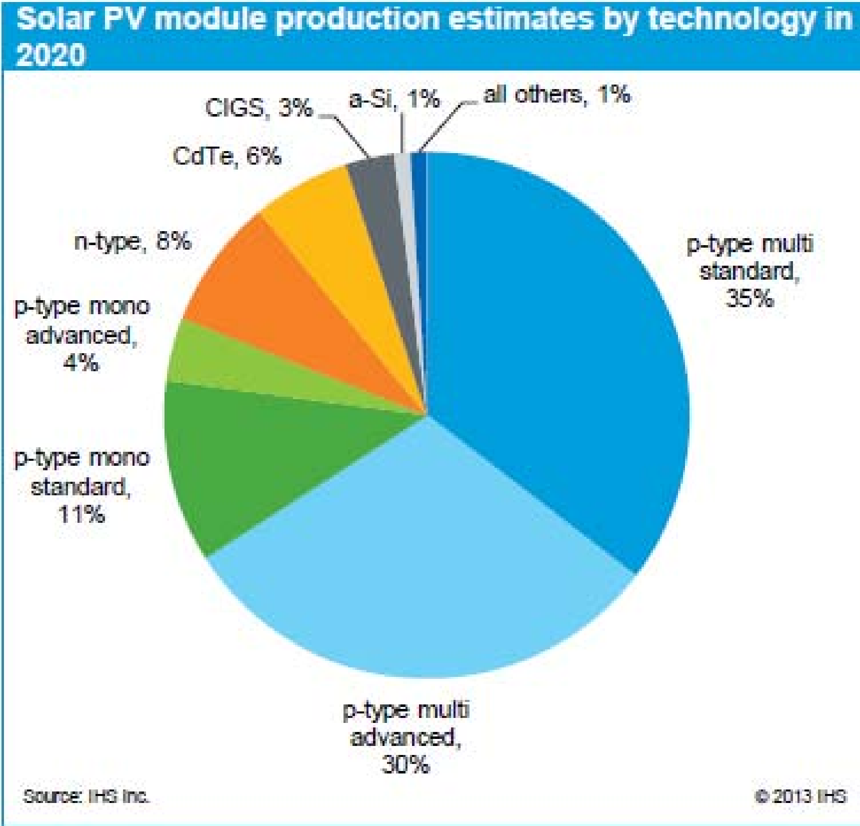
- The Group employs over 1,700 people across three continents.

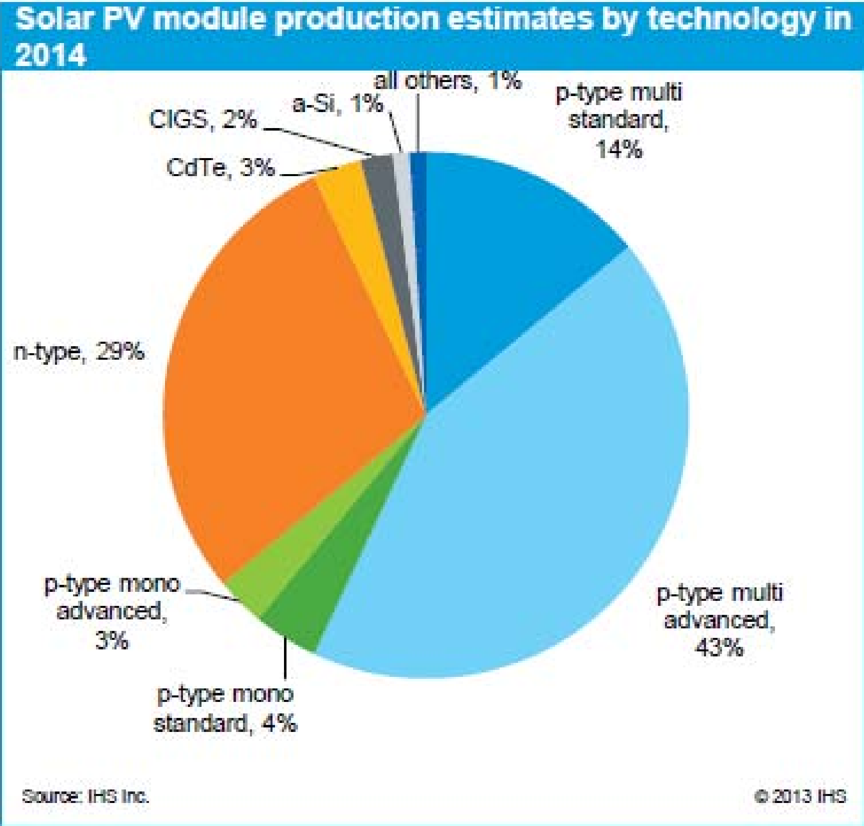
Committed to Systems & Processes



We integrate best-in-class solutions.

PV – Market Today & Tomorrow

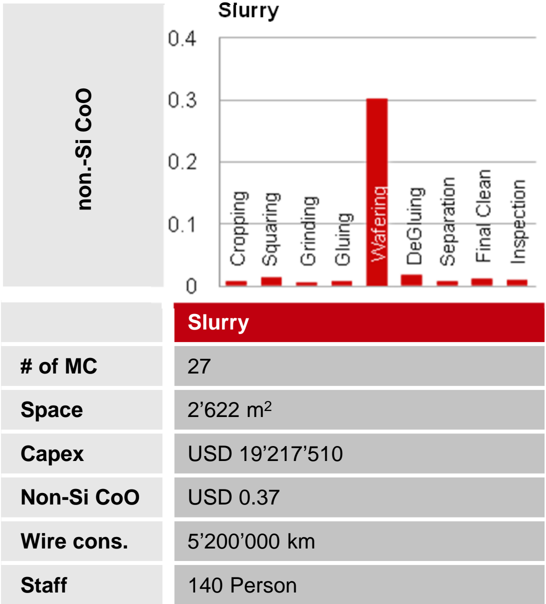




Strategy Roadmap
Integrated Process System

Fab 160 MW
Mono 156 x 156

DW288 DW water



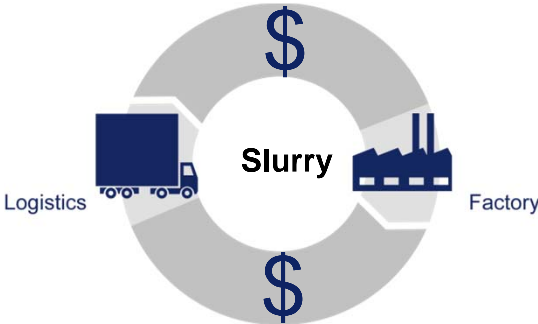
	Slurry
# of MC	27
Space	2’622 m²
Capex	USD 19’217’510
Non-Si CoO	USD 0.37
Wire cons.	5’200’000 km
Staff	140 Person

Cell Efficiency: 18 %
Wafer Thickness: 180 µm
Wire core dia.: 120 µm
Wire Price: 80 $/km

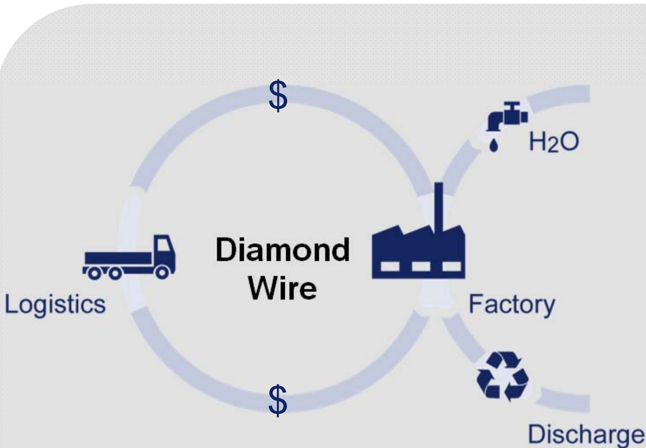
Diamond Wire (Single Equipment)
21
1’728 m²
USD 14’283’742
USD 0.26
39’000 km
110 Person

Cell Efficiency: 19 %
Wafer Thickness: 180 µm
Wire core dia.: 120 µm
Wire Price: 80 $/km

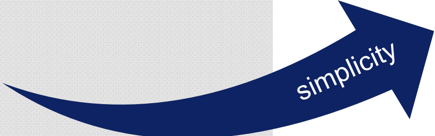
Diamond Wire Technology – Reducing Complexity



160MW Fab
- 5 Mio km wire
- 2'700 tons PEG
- 3'000 tons SiC



160MW Fab
- 38'000 km wire
- 62 tons additive



Reducing Cost $

Capex	- 30% Investment
CoO	- 30…45%
Space	- 50% wafering
Operator	- 50% wafering
Power	- 75% wafering

Reducing complexity

Wire	~ 750 x less wire
Fluidic	~ 650 x less fluids

Cutting Fluid Management

Local discharge
Meet local waste water regulations and customer specific demand

Format: Mono 156x156, 180µm wafer

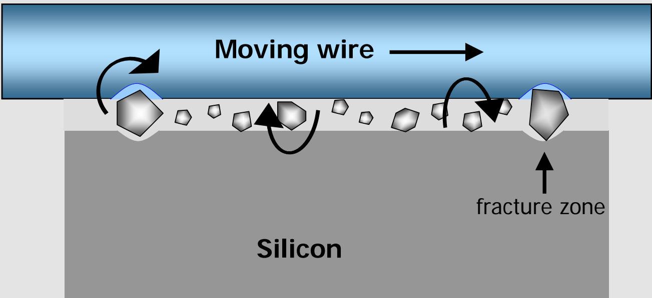
Diamond Wire vs. Slurry Wafering

Slurry

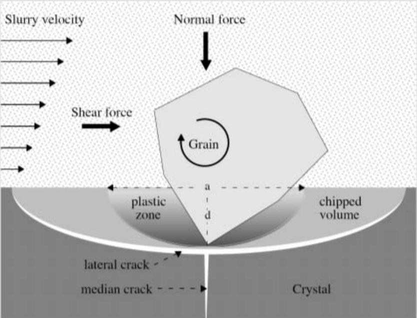
3 body erosion

Grits roll between wire and material

Grits speed max ½ wire speed



crack inducing method
material removal by breaking of surface
multi-directional scratches

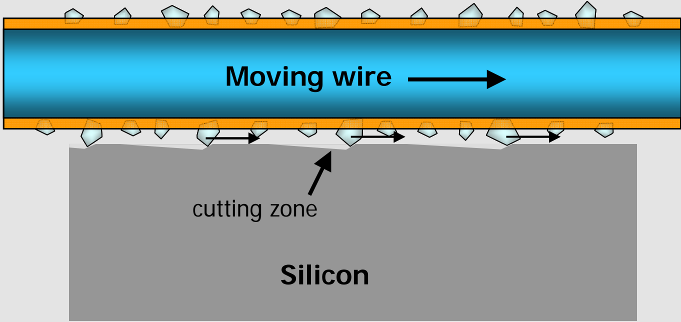


Diamond Wire

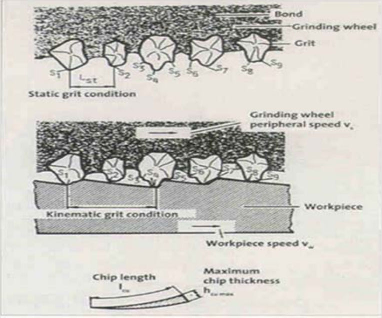
2 body erosion

Grits slides over the material

Grits speed 1/1wire speed: theory doubling removal rate



chip removing method
material removal by statistical chip size
directional relative speed



2012 Meyer Burger - Confidential and Proprietary

Technology Development

Slurry Technology

For the production of multicrystalline wafers, it is still advisable to use the tried and tested slurry process, in which Meyer Burger had a decisive influence.

Accordingly, the slurry version of the DS 271 wire saw ranks among the biggest-selling machines on the market.

Diamond Wire Technology

In the heart of the WaferLine is the advanced, environment-friendly diamond wire, water based sawing process which offers the following advantages over the conventional slurry process:

- **Lower unit wafer costs**
- **More wafers per unit of time**
- **Lower process complexity**
- **Environment-friendly**

DW 288
The Achievements

1. **Sophisticated Wire Management:**
   - Extended wire lifetime
   - Lowest cost of ownership
2. **High Speed with up to 25 m/s:**
   - Faster material removal
   - Increased capacity
3. **Stable Processes:**
   - Maximum yield
   - Simple Maintenance
4. **Perfectly Designed Consumables:**
   - Holistic approach
   - One-stop shop – reduced complexity
5. **Waterbased Process:**
   - Environmental friendly
   - Tailored for local needs

Slurry vs. DW Slicing Process

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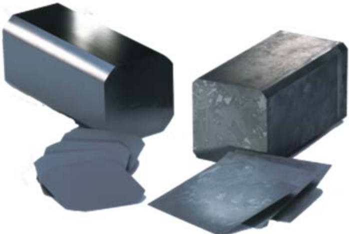
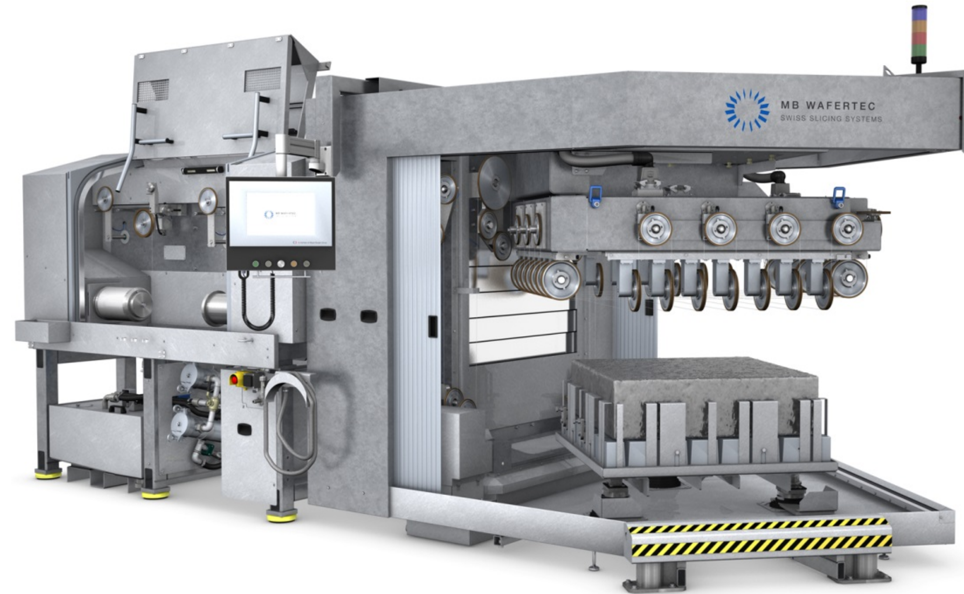


	Loose abrasive Process	Fixed abrasive Process
Monocrystalline Silicon	not competitive anymore	Lowest CoO DW288
Multicrystalline Silicon	Lowest CoO DS271	process development

BrickMaster BM860



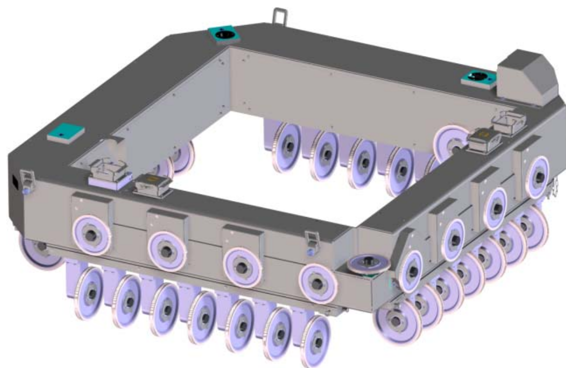
A **diamond wire** and **water based** squaring machine to cut multi blocks or mono ingots with a maximum production capacity into bricks in accordance with the desired wafer geometry.

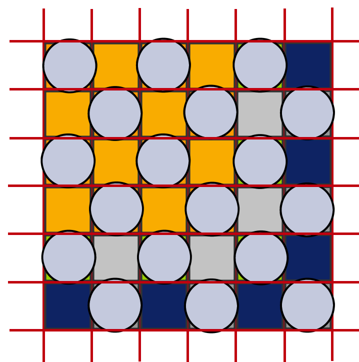
Key Benefits

- Lowest CoO due to high DW performance
  - -14% lower CoO on G6 proven in the field
- Less kerf, highest material utilization
- Environmental friendly DW, waterbased process
- Ingot size up to G6 (G8 on request)
- Highest capacity, lower footprint per MW

BM860
Ingot geometries and application

One Cutting yoke = 3 applications
The yoke is open on top and allows to cut any ingot height, limited only by the maximum stroke





G5

G6

Mono 6“ or 8“

Ø8“

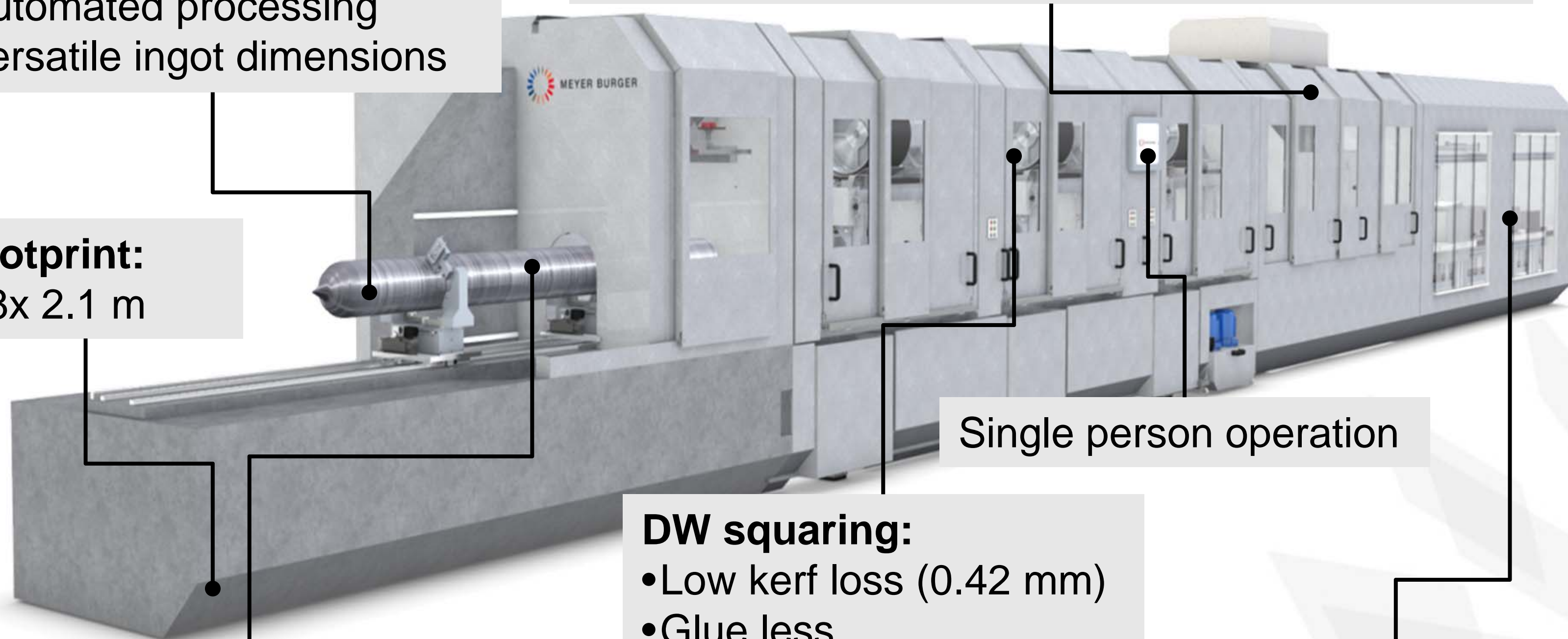
Nominal brick size: 156,7 x 156,7 mm (125 mm on request)

MB VI ProBrickLine

mono-Si pre-wafering with DW

Cropping:
- Low kerf loss (0.42 mm)
- High precision, higher yield in wafering
- Automated processing
- Versatile ingot dimensions

Grinding:
- High surface quality for high yield in downstream processes (Ra<0.06 µm)
- No edge chipping
- Increased cell efficiency



Footprint:
- 18x 2.1 m

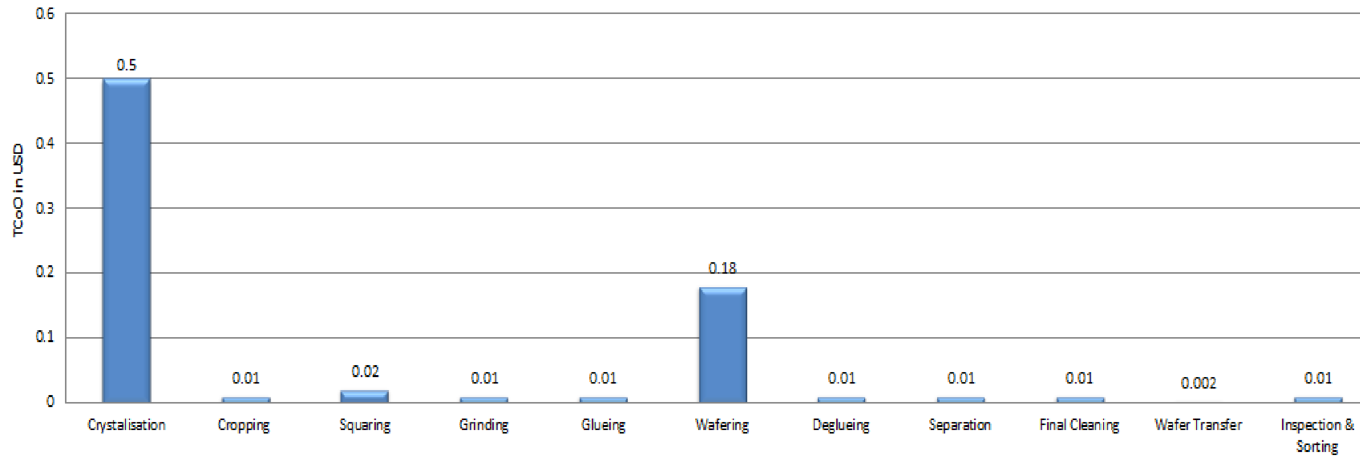
Single person operation

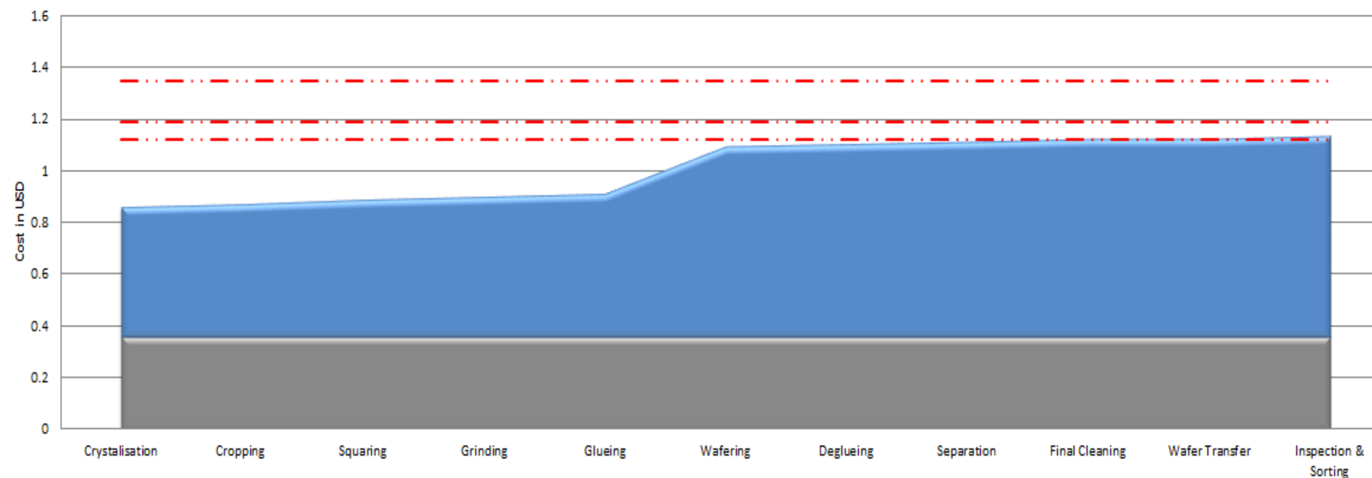
Material input:
- 1’600 mm/hour
- Ingot length up to 4’000 mm
- Ingot diameter 150 to 230 mm

DW squaring:
- Low kerf loss (0.42 mm)
- Glue less
- High precision
- Highest wire life time in the market
- Work piece 600 mm

Automated gluing:
- Yield increase in wafering up to 3%
- 1’200 glue savings

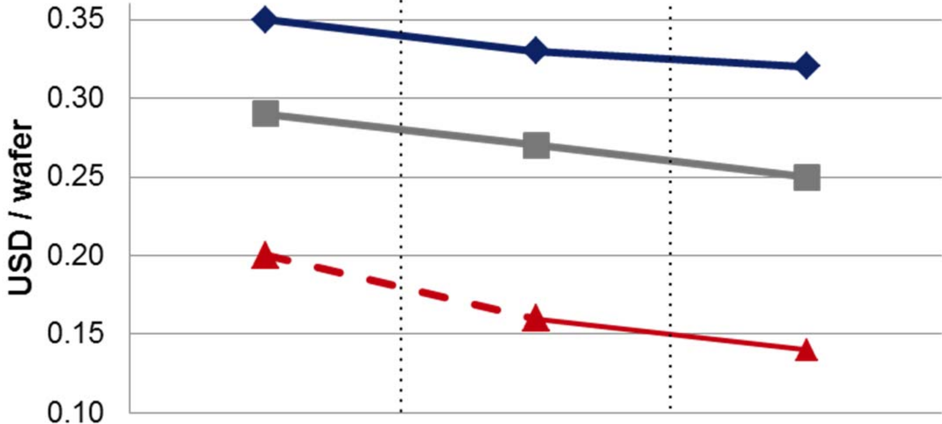
TCO WaferLine





CoO Wafering

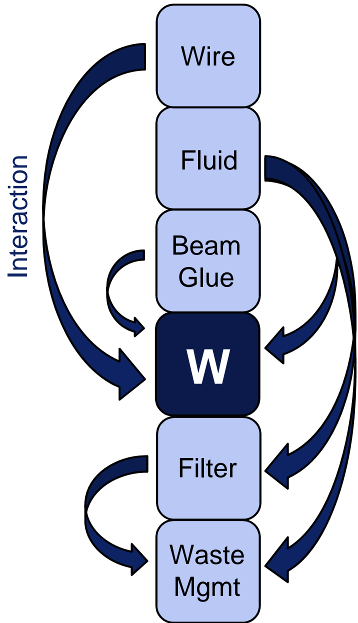
- Benchmark DS271 Slurry
- Cost reduction with DW upgrade possible
- Lowest CoO with DW288



2013	2014	2015
0.35	0.33	0.32
0.29		0.25
0.20	0.16	0.14

- 60 %

DW Wafering System



DW Wafering System

Balanced System for fast implementation, stable Production and low CoO.

DW Wafering System

Dedicated consumables

DW288

Dedicated Diamond Wire Saw Waterbased

Flocculation Stage 1
Flocculation Stage 2
Optional Oxidation (COD)
Ion Exchange (Nickel)
Neutraliz. (pH)

CF Management Tailored to local needs

Complete Diamond Wire Package

The use of complementary consumables and processes is required to attain the **highest quality wafers at the best cost of ownership.**
A consumables package consisting of:

- an environmentally friendly and completely waterbased cutting fluid
- a non-staining glue complements the diamond wire and optimizes overall performance.

Diamond Wire

- Improved wafer quality and topology
- Faster cutting feed rates and increased capacity
- Longer spool lengths = fewer wire spool changes

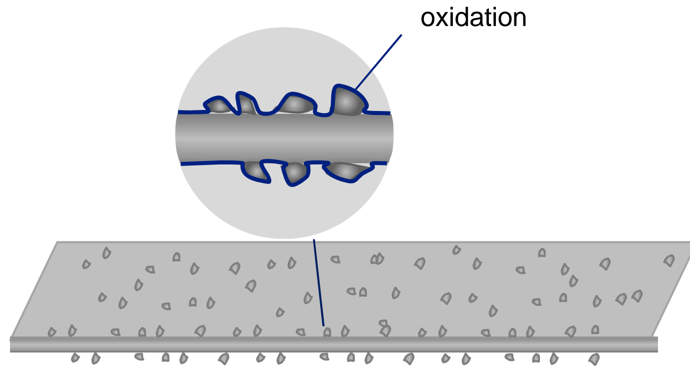
Beam

- No negative influence on diamond wire
- Maximized wire lifetime = lower CoO
- Optimal surface roughness and adhesive properties
- Dimensionally stable – no swelling

Cutting Fluid

- Cleaner wafers = no organic residue or staining
- Higher wafer surface quality
- Enhances full slicing potential of diamond wire

Cutting Fluid Influence

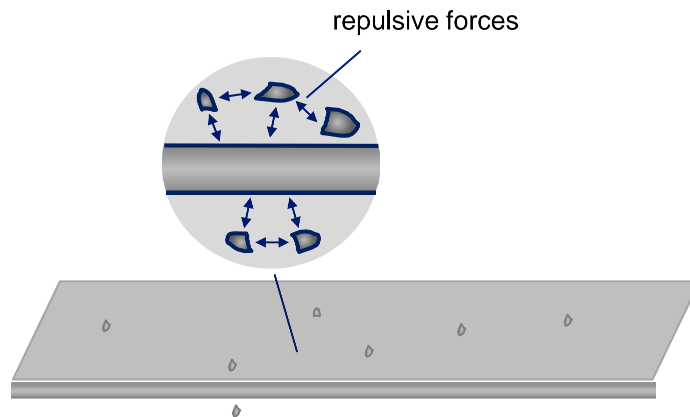


Standard Approach with standard additive:

▪Si-particles accumulate on the wafer surface.

▪Drying of wafer surface leads to covalent joined Si-particles on the wafer surface.

▪Yield loss due to dirty wafers vs extensive use of chemicals



Meyer Burger approach with DW specific additive:

▪Fast oxidation and quick build-up of strong repulsive forces between Si-particles and the wafer surface.

▪Clean Wafers and reduced chemicals in cleaning process

▪Clean Machine reduces Mayntenance cost and increases uptime

▪Range of Waste Water Treatment solutions based on existing infrastructure and local regulations – to minimize additional investment

Complete Mono and Multi Portfolio

Integrated Production Line

Subsystem

Module

Single Equipment

BrickLine

Wafering System

Cleaning, Inspection, Sorting

Cropping

Bricking

Grinding

Gluing