

## Products

- **Standard Equipment**

1. **DSS/HEM Furnace** - the new world standard for multi-crystal growth.
2. **Tabber/Stringer** - world's leading processor for sheet silicon cells.
3. **GT-PFX100** - ribbon flux station.
4. **GT-PVSCAN 8000** - high-speed optical scanning system.
5. **GT-WEX 1000** - automated wafer etching wet bench.
6. **GT-CTX** - manual and automated cell testing.

We offer standard manufacturing equipment to complement your existing manufacturing lines. GT Solar is trusted worldwide to provide expertise that ensures proper system design, operation, output and ongoing service for all standard equipment

- **Products: Standard Equipment**

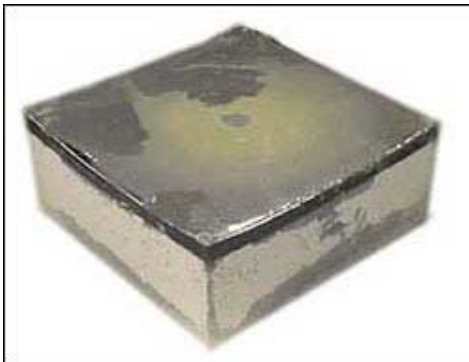
**DSS/HEM Furnace**  
**High Quality Ingots, Lower Overall Costs**



HEM Furnace



DSS Furnace



Ingot from DSS/HEM Furnace

### **GT-MX225™ HEM Furnace**

The Heat Exchanger Method (HEM) is a crystal growth process ideally suited for growing high-quality multicrystalline silicon ingots to size and weight minimums of 69cm/sq. and 240kg. The furnace is simple, automated and well insulated which results in low equipment, labor and energy costs.

Each HEM furnace grows enough silicon to make approximately 2 megawatts of solar cells per year.

### **GT-DSS240™ Furnace**

As the market leader in multi-crystalline growth technology, we felt committed to expand our line of products. The DSS (Directional Solidification System) furnace is a result of our development program. Multi-crystalline ingots can now be grown faster and at lower cost than ever before. In addition, we deliver all our furnaces, including the well-proven HEM furnaces with a solid process that enables our customers to jumpstart their production.

- Bottom-load process chamber adds operating convenience

- Standardized mezzanine module insures quick set-up

- Produces Material for High Efficiency Cells

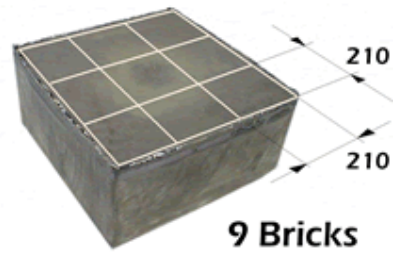
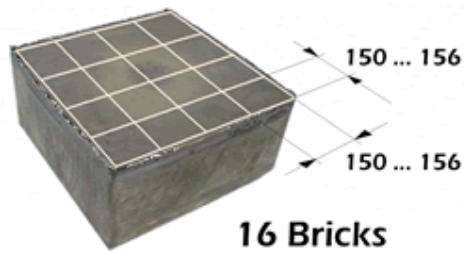
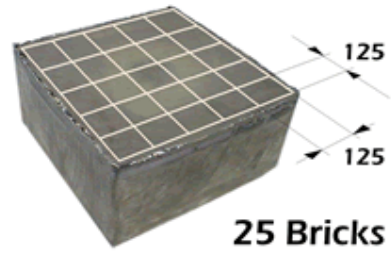
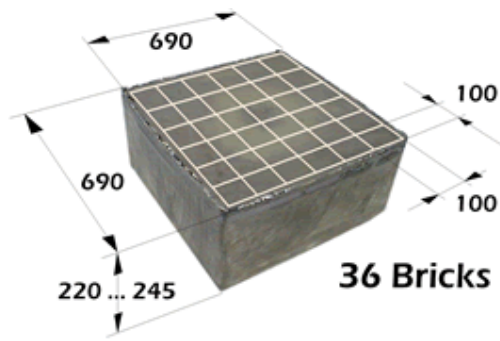
- Output of 1 Furnace: 160 ingots/year (equivalent to > 3.3 MW with 125 mm cells @ 15% efficiency)

- Ingot Size: 69 x 69 cm<sup>2</sup>

- Ingot Weight: > 240 kg to 270 kg typically

- Fully automated process

- Process guarantee included



Sectioning of ingots into bricks for different wafer sizes

- **Standard Equipment**

**Tabber/Stringer**  
**World's Leading Cell String Assembly Machine**



Tabber/Stringer Atlas



Tabber/Stringer GT-TSX100



String Layup Station

The Tabber/Stringer is the world's only machine that can process EFG and other sheet material cells in addition to saw-cut cells, with extremely high yield. Unique cellnests hold the cells until the string is completed without imposing mechanical stress that would break them. The machine can therefore handle extremely thin cells. The system uses a touchless infrared soldering station to accommodate varying cell thickness. On the cell-input side, a high-speed pick-and-place and visual inspection system aligns the cells according to settable parameters, and checks the cell edges as well as the busbars for damages. The tabber/stringer can be integrated with a completely automated lay-up station as an option. Two models are available: The GT-TSX100™, and the GT-ATLAS™. The systems are identical with the only major difference that the ATLAS™ has a higher throughput due to two cell-loading robots. The tabber/stringers are also available in a version specifically configured for the BIPV industry to automatically lay up strings of up to 3 meter in length on glass sizes of up to 3.3 x 2.2 m<sup>2</sup>.

High Throughput: > 600/750 cells/hour measured as completed strings

High Yield: > 99.5% (guaranteed)

IR Soldering with PID temperature control, uniform temperature distribution across cell

Cellnests replace conveyer, minimal mechanical stress on cells

Can process EFG and saw-cut cells as well as very thin cells

Current cell sizes up to 157 x 157 mm<sup>2</sup>

Vision inspection and orientation

Siemens S7 automation package



Cell Assembly



Finished String



String in Inspection Box

## Ribbon Flux Station GT-PFX100

The stringing process in photovoltaic module production must produce long-lasting, reliable, and clean solder bonds. This requires total control of the soldering process, and consequently precise control of the fluxing procedure. All stringing processes are discontinuous by nature. Hence, the best way to coat ribbon with flux uniformly is a continuous fluxing process. The GT-PFX100 is a continuous fluxer designed to handle all types of flux (no-clean, high or low Rosin content) and ribbon. All parameters, i.e. pull speed, flux temperature, drying temperature of the coating process are computer controlled, which guarantees the coating uniformity that the industry requires.



### • Quick List of Features

1. Input: flat reels (15" diameter), or spools (10lbs/4.5kg).
2. Output: flat reels (15" diameter).
3. Ribbon width: 1.5 mm (0.06"), 2 mm (0.08").
4. Processes four reels simultaneously.
5. Continuous coating process.
6. Uniform and reproducible coating by controlling pull speed, flux temperature, drying temperature, drying gas flow.
7. Production capacity: sufficient for cell production of about 20 MWatt/year.
8. Thermoelectric temperature control of the flux bath.
9. Handles all types of fluxes.

## **GT-PVSCAN 8000**

### **High Speed Optical Scanning**



**GT-PVSCAN 8000**



**Optics of GT-PVSCAN 8000**

GT-PVSCAN 8000 is a high-speed optical scanning system designed for the characterization of photovoltaic materials and finished cells. It can assist crystal growers in achieving a high-quality (low defect density) material and can help solar cell process engineers develop fabrication processes for higher efficiency devices.

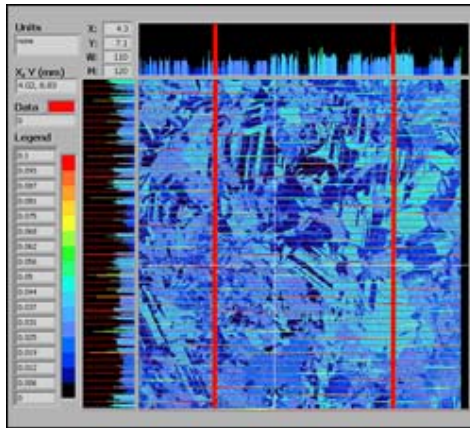
- **Measurement Modes**

1. Dislocation density
2. Reflectance
3. Light Beam Induced Current (LBIC) at two wavelengths

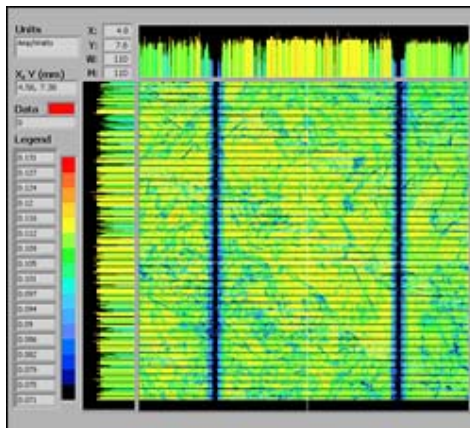
- **Benefits**

1. Two wavelengths ( $\lambda = 633 \text{ nm}$ ,  $\lambda = 980 \text{ nm}$ ) for measuring surface and bulk properties.
2. Parameters measured as a function of sample position.
3. Convenient and easy to read false color maps.
4. Provides information related to junction recombination and minority carrier diffusion length.
5. PC software control.
6. Sample size max.  $210 \times 210 \text{ mm}^2$
7. Scan time: 25 min. for  $156 \times 156 \text{ mm}^2$  cell at  $50 \text{ }\mu\text{m}$  step size
8. Practical minimum step size:  $25 \text{ }\mu\text{m}$
9. Camera assisted selection of scan area

## Examples of Measurements



Reflectance



LBIC

## **GT-WEX 1000: Automated Wafer Etching Wet Bench**

The **GT Wafer Etch Bench** (GT-WEX 1000) is an enclosed exhausted, automated wafer etching bench. It can be configured for a variety of process steps that are used in the manufacturing of photovoltaic solar cells. The tank options to choose from are for caustics, acids, water (rinsers) and dryers. Wafers are processed through the system in standard cassettes with a linear robot that picks up the cassettes at the load station, and drops off etched, cleaned, and dried wafers at the unload station.



### **Specifications**

- **GENERAL**

1. Throughput: 1000 cells/hour
2. Cell Size: 100, 125, 150 mm pseudo square and/or square
3. Cell Batch size: 100 wafers per tank
4. Mode: Automatic
5. Envelope Dimensions: 192"(4877mm) L x 55"(1397mm) W x 89"(2261mm) H
6. Bench Material: Polypropylene
7. Loading: 1 four-place cassette holder holding a total of 100 cells
8. Programming: Touch screen recipe programming (process times and temperatures, rinse cycles, dryer times and temperatures, robot speeds and movements, alarm functions)

## **UTILITIES**

Electrical: 380/460, 3 Phase, 50/60Hz, 60 amp, other voltages on request

Clean Dry Air: 10 CFM (0.28 m<sup>3</sup>/min). Peak flow: 20 CFM (0.57 m<sup>3</sup>/min) for less than 3% of the time.

N<sub>2</sub>: 4 CFM (0.11 m<sup>3</sup>/min)

Exhaust: 1800 CFM (51 m<sup>3</sup>/min)

DI Water: 28 GPM (106 l/min)

## **SAFETY**

Doors: Coded magnetic interlock switches

Exhaust loss: Photohelic® differential pressure gauge/switch

Over temperature circuits: Heated tank and dryers

Low liquid detection for heated tanks

## **OPTIONS**

Tank materials: Teflon®, PVDF, polypropylene, stainless steel

Custom component selection: Agitators, stirrers, pH monitoring, heating and cooling systems, DI water reclaim systems, waste abatement systems, etc.

Bench materials: Stainless Steel, fire retardant plastics

Safety: Fire suppression CO<sub>2</sub> systems, fire retardant plastics

Process documentation: PC based data management systems

Chemical handling: Chemical delivery and disposal systems

**GT Solar offers fully automatic cell testing/sorting equipment.**

### **GT-CTX 500A Automated Cell Tester/Sorter**

The **GT-CTX 500A Automatic Cell Tester/Sorter** has been ergonomically designed for high throughput and minimum cell breakage.



### **Specifications**

#### **GENERAL**

Throughput: Up to 1000 cells/hour

Cell Size: 100, 125, 150...157 mm pseudo square and/or square

Mode: Manual or automatic

Automation Compatibility: Can be integrated with firing furnace for complete automation from printing & firing

## **FEATURES**

Loading: 6 cassettes, 42 cells each; possible to integrate with firing furnace for complete automation.

Sorting Bins: 11 - customer definable.

Pack Size: Cells can be sorted at predetermined pack size (maximum of 100) with respect to each sorting bin.

Sorting Methods: Cells could be sorted based on any one or combination of cell characterization parameters.

Cell Temperature: Cell testing chuck's temperature is maintained at 25 °C.

Histogram: During testing, real time histogram for the current lot under test is displayed.

Reporting: A report can be printed for a tested cell, which includes IV curve and characterization values.

## **ENVELOPE DIMENSIONS**

[inch]: (L)147 x (W)36 x (H)57

[mm]: (L)3734 x (W)914 x (H)1448

## Turnkey Fabrication Lines

**WAFFAB™** for multi-crystalline PV wafers.

**CELLFAB™** for high efficiency PV solar cells.

**MODFAB™** for PV module manufacturing.

GT Solar designs turnkey PV fabrication lines that fully meet our customers' performance specifications. We achieve this by specifying the world's finest equipment -- of our own design or from a preferred supplier of the highest quality. We select only the best equipment from trusted, proven OEMs to integrate into GT Solar systems.

Our commitment does not stop with shipping the equipment. Working to exacting standards, GT Solar guarantees manufacturing processes, plus we provide thorough training, as well as market and marketing information.

## Wafer Fabrication Line

The **GTs-WAFFAB™** multicrystalline silicon wafer turnkey fabrication line is designed to produce high quality wafers. These wafers may be processed into solar cells and modules by using GT Solar's cell and module fabrication line. Systems and automation levels are configured to meet customer specification and budget.

The **GTs-WAFFAB™** lines feature GT's DSS series of directional solidification furnaces, and multi-wire wire saws. Multicrystalline ingots between 240 and 270 kg and more are grown by directional solidification. Sophisticated slicing technology is provided by the world's leading wire saw manufacturers.

## **GTs-WAFFAB™ Major Equipment**

<b>PROCESS</b>	<b>EQUIPMENT</b>
1. Crucible Preparation	Crucible Spray System, Kiln
2. Polysilicon Preparation	GTs Wet Station
3. Ingot Casting	GT-DSS240™ Furnace
4. Ingot Sectioning	Band Saw or Wire Saw
5. Ingot Wafering	Wire Saw
6. Wafer Cleaning	GTs Wet Station
7. Wafer Characterization	Type, Resistivity, Thickness, Lifetime, Damages

## **GTs-WAFFAB™ Turn-Key Services**

Proven Process Technology, providing wafers for sale from day one on  
Technical and Operational Training  
Supervision During Startup  
Ongoing Production Support  
Recommended Spare Parts  
Extended Equipment Warranty

## **GT's Expertise Jumpstarts Your Production!**

Fully Integrated Solution - Lowers PV Product Cost  
Vendor & Consumable Materials Specs - Shortens Purchasing Cycle  
Facilities Consultation - Minimizes Costly Building Errors  
QC Procedures & Guidelines - Instantly Improves Bottom Line  
Personnel Selection Guidance - Builds an Effective Team

## **Cell Fabrication Line**

The **GTs-CELFAB™** solar cell turnkey fabrication line is designed to produce high efficiency solar cells from round or square, mono or multi-crystalline silicon wafers. The equipment and process are configured to produce solar cells with typical 14% or greater efficiency depending on customer requirements. Systems and automation levels are configured to meet customer specification and budget.

## **GTs-CELLFAB™ Major Equipment**

<b>PROCESS</b>	<b>EQUIPMENT</b>
1. Wafer Characterization	Resistivity Probe
2. Surface Etch	GTs Etch Station
3. Junction Formation	Dopant Sprayer & Belt Furnace
4. Edge Etch	Plasma Etch Station
5. Oxide Etch	GTs HF Etch Station
6. AR Coating and Passivation	PECVD Furnace
7. Metalization	Screen Printers, IR Dryers/Furnace
8. Cell Characterization	GTs Cell Tester

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## **Module Fabrication Line**

The **GTs-MODFAB™** photovoltaic module turnkey fabrication line processes round or square, mono or multi-crystalline silicon solar cells. The **MODFAB™** equipment may also be used to manufacture thin film modules. Systems and automation levels are configured to meet customer specification and budget.

## **GTs-MODFAB™ Major Equipment**

<b>PROCESS</b>	<b>EQUIPMENT</b>
1. Glass Preparation	GTs Glass Wash Station
2. Cell Testing	GTs Cell Tester
3. Cell Tabbing+Stringing	GTs Tabber/Stringer GT- TSX100™
4. Circuit Formation	Bussing Station
5. Module Preparation	GTs Layup Station
6. Module Lamination	Laminator
7. Framing	Final Assembly Station
8. Performance Test	Module Tester

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Proven Process Technology  
Technical and Operational Training  
Supervision During Startup  
Ongoing Production Support  
Recommended Spare Parts  
Extended Equipment Warranty

## **GT's Expertise Jumpstarts Your Production!**

Fully Integrated Solution - Lowers PV Product Cost  
Vendor & Consumable Materials Specs - Shortens Purchasing  
Cycle  
Facilities Consultation - Minimizes Costly Building Errors  
QC Procedures & Guidelines - Instantly Improves Bottom Line  
Personnel Selection Guidance - Builds an Effective Team

## Custom Equipment

**EFG Growth Furnace** - Edge-defined film fed growth furnace.

**Dendritic Growth Furnace** - High output mono-crystalline ribbon furnace.

In the rapidly growing PV industry, companies are challenged to increase manufacturing capabilities quickly without diluting their core competencies -- or disproportionately increasing costs. GT Solar's challenge is to help such companies expand capabilities while remaining cost competitive.

We are often able to help by successfully partnering with a customer to develop new equipment. For example, building more wafer growth furnaces in-house may no longer be cost-effective or efficient, so we can work with our customer to develop a new furnace.

GT Solar designs and manufactures Custom Equipment solely for its customers' use. We have developed important equipment for the PV industry, and as a result of these opportunities has helped make our customers leaders in their field of business.

### **EFG Growth Furnace**

### **Polysilicon Growth, Continuous Feed High Efficiency**



*Photo courtesy of Schott Solar*

The Edge-Defined Film-Fed Growth Technique is another extremely efficient method to produce polycrystalline silicon for the solar cell production. From the molten silicon, hollow, multi-sided tube is grown to a length of more than 20 feet (6 m). The wall thickness of the tube is about 0.3 mm. Square shaped wafers are laser-cut from the tube for solar cell production. Polysilicon material is fed continuously into the

crucible to replace silicon that has been solidified to form the tube. The tube is pulled through a die and an argon gas barrier directly into the atmosphere resulting in high efficiency growth. GT Solar builds these pullers exclusively for a customer who is a leading manufacturer of solar cells.

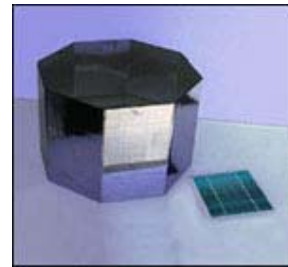
This equipment was custom designed and manufactured by GT solely for its customers' use, and is not commercialized for resale.



*Photo - Schott Solar*



*EFG Custom Equipment*



*Sample EFG Products*

### **Dendritic Growth Furnace**

### **Mono-Crystalline Ribbon, High Output Efficiency and Low Cost**



### **Silicon Ribbon Puller**

Thin single crystal silicon ribbon growth is based on the properties of dendritic growth and the formation of minimal surfaces. Two parallel dendrites up to 2" apart are pulled continuously from the silicon melt. A silicon web forms between them resulting in a ribbon of about 0.3 mm thickness used for the production of high efficiency solar cells.

The performance of these cells is indistinguishable from that of cells fabricated from Czochralski grown silicon. The wafering process is reduced to cutting the ribbon into pieces of appropriate length, which greatly reduces the overall cost of solar cells. GT Solar designs and manufactures this furnace on exclusive basis for one customer. The complexity of the growth process with precise temperature and motion control demonstrates GT Solar's expertise to build complicated and fully automated production equipment. This equipment was custom designed and manufactured by GT solely for its customers' use, and is not commercialized for resale.

## **Research & Development**

SoG Silicon Feedstock Production  
Crystal Growth Modeling

We are extremely proud of our current products, our industry, our strong commitment to ideals, and, in particular, to our passion for research and development -- for being on the cutting edge. We at GT Solar promise you the best in products and in our energetic, creative problem solving. We encourage you to discuss challenges, so that together, we may make our industry more productive and effective, and positively impact our planet.