

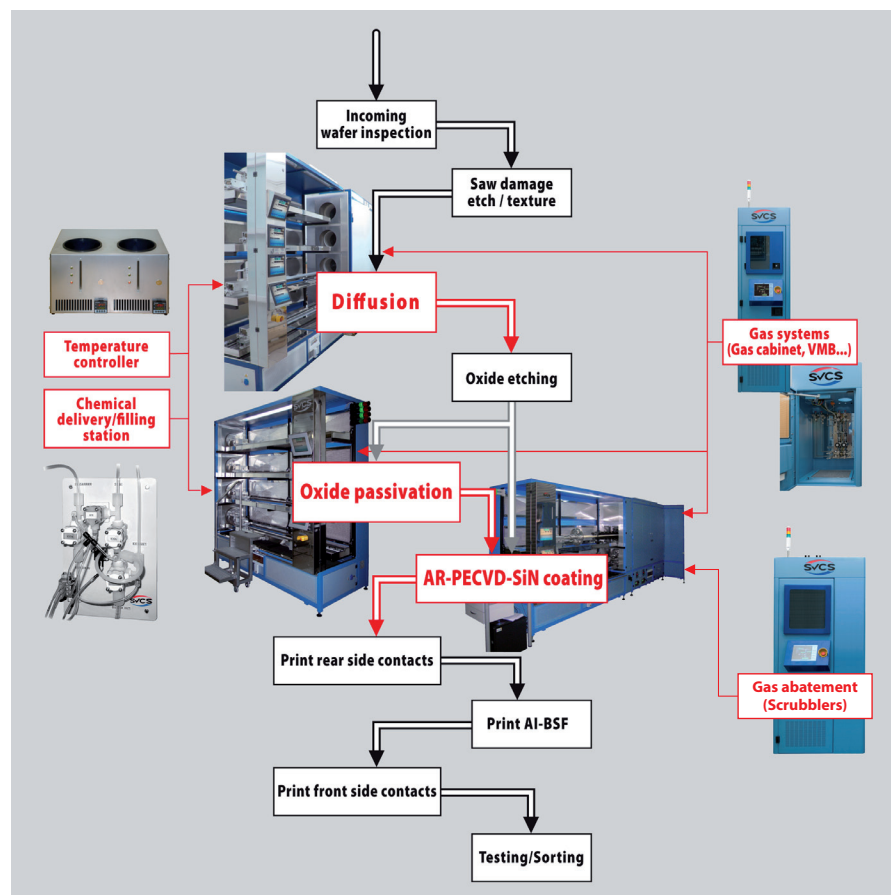


Equipment for Solar Cell Production

Semiconductor Quality for High Efficiency Solar Cells

INTRO

SVCS brings many year experience with quality inherent in semiconductor industry to solar cell production. SV SOL family of equipment includes horizontal batch diffusion furnace for phosphorus or boron doping/diffusion, PECVD or LPCVD horizontal batch furnace for antireflective coating and passivation, ultra high purity gas and liquid delivery systems for both full production and R&D/pilot environments.



 - SVCS Products

EQUIPMENT

- Atmospheric Batch Diffusion Furnace for Phosphorus/Boron Doping/Diffusion (POCl_3 , BBr_3 , etc.)
- Low Pressure Diffusion Furnace for advanced high-throughput POCl_3 process
- Horizontal Batch PECVD Furnace for Si_xN_y Antireflective coating and passivation
- Automatic/Manual Source Gas Cabinets (GC) for High Purity Gases (SiH_4 , NH_3 , O_2 , etc.)
- Automatic/Manual Valve Manifold Boxes (VMB) for independent Gas/Liquid Delivery Lines to multiple furnaces and/or other equipment
- Automatic Temperature Controller for furnace bubbler containers (POCl_3 / BBr_3 , etc.)
- Bulk Liquid Media Delivery for automatic furnace bubbler containers refill
- Horizontal Batch Diffusion Furnace for Wet/Dry Oxides (passivation, emitters masking and other on demand production cycle steps)
- Wet or pyrogenic effluent abatement systems (scrubbers)

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DIFFUSION

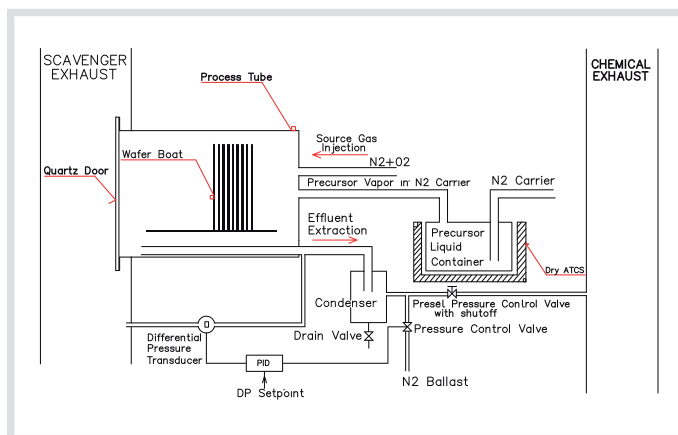
Batch Diffusion Furnace for Phosphorus/Boron Doping

The design of the SVCS diffusion furnaces for Phosphorus / Boron doping combines excellent process results with the needs of a maximum capacity for full-production system, as well as high flexibility for small-scale versions to be used for PV research and pilot production. It provides an easy-to-maintain, safe and reliable horizontal furnace platform. The SVCS design is outstanding for high efficiency, minimized footprint and low cost of ownership while offering high process flexibility.

The industrial system is equipped with up to five independently operating stacked quartz tubes with automated paddles to load and unload each process tube separately. After the boat loading, temperature ramp-up and stabilization, the process starts with the Phosphorus/Boron deposition and drive-in. Nitrogen is used as carrier gas for the $\text{POCl}_3/\text{BBr}_3$ liquids. After the adjusted diffusion time and cooling step, the tube opens to get unloaded and reloaded again. No thermal interference between the tubes is assured by an advanced water cooling system. The whole system configuration is adjustable to the production capacity. Based on proven SVSOL controlled pressure furnace technology, the equipment for low-pressure diffusion has been developed.

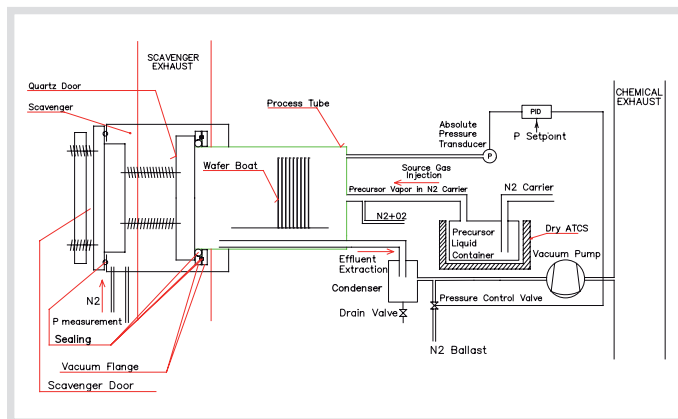
Atmospheric Phosphorus/Boron Doping (POCl_3 , BBr_3)

SVSOL-AT is a traditional solar cell manufacturing process for both mono-crystalline and/or poly-crystalline diffusion. Each slot in boat can accommodate either one wafer for both side diffusion or 2 wafers in back-to-back configuration. Proprietary diffusion recipe has been developed in closed cooperation with the Academy Research and Industry to achieve excellent uniformity as well as diffusion profile. The process chamber is sealed to enable controlled-pressure diffusion maintained by facility exhaust with nitrogen ballast negative pressure control. This configuration together with state-of-the-art cascade temperature control provides best in class process repeatability, necessary for high conversion efficiency.



Advanced Low Pressure Diffusion (SVSOL-ALPD)[®]

SVSOL-ALPD[®] is a solution for the PV industry demand for a high-throughput without compromising the wafer uniformity. The SV-SOL standard "controlled pressure" solution for Phosphorus/Boron diffusion is combined with vacuum pump and tight sealing enough to achieve low pressure environment in the process tube during dopant deposition. While half-pitch (2.38 mm) boats offer double throughput without any negative influence on industry standard uniformity, standard boats with 4.76 mm pitch, on the other hand, offer improvement of the process uniformity to 1-2 % level.



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Features and Benefits

- State of the art modular control system, in-house designed, highly tailored and in-house manufactured
- Top notch components always selected for excellent results and trouble free long life of the furnace equipment
- Up to 5 stacked quartz or SiC tube reactor chambers
- Advanced water cooling system at tube level: no thermal interference between adjacent tubes due to water cooling system
- Contactless fully automated boat-in-tube softloading
- Maintenance-friendly mechanical design
- Low Pressure option for increased throughput and uniformity

Horizontal Batch PECVD Furnace for Si_3N_4 Antireflective coating and passivation

SVSOL-PE is a new solution for anti-reflexive coating and passivation using semiconductor technology to improve silicon nitride film quality in comparison with traditional in-line production. Tube PECVD has become industry standard solution for high-efficiency solar cell manufacturing in recent years, as the throughput calculated per equipment footprint is similar to in-line technology, while the increased film quality contributes to higher cell efficiency.

Horizontal Batch Oxidation Furnace for passivation and masking

SVSOL-OXY is used for various additional oxidation processes like masking or passivation in the continuous effort to improve the solar cell quality and efficiency. Both the dry and wet oxidation is available, while the wet oxide can be made either by traditional pyrogenic method using combustion of hydrogen and oxygen in external burning system, or by steamer for production of ultra pure water vapor directly from DI water without Hydrogen and Oxygen.

SVSOL-DELI media delivery system

SVSOL-DELI provides a source of the ultra-high purity gases and liquids for solar cell production tools. Automatic gas cabinets are designed for corrosive, toxic and flammable gases, while semi-automatic and manual gas cabinets and stand-alone panels are designed for inert and non-dangerous gases. Automatic and semi-automatic systems are driven by SVCON control system that can be connected to Ethernet network and thus can be easily integrated with solar cell production equipment on one side and manufacturing execution system on the other side to provide efficient production control. All the components wetted by process media are made from semiconductor grade materials for impurity-free process results.

Typical Gas cabinets and Valve Manifold Boxes for PV applications:

Process gases SiH_4 , NH_3 , B_2H_6 , PH_3 , SiH_2Cl_2 , H_2 , Ar, O_2 , N_2O , N_2 , etc.

Delivery rate from units to thousands of slm, continuous, uninterrupted gas supply by automatic alternating changeover to replenished source vessel

Temperature controller

SVSOL-TCS temperature control system provides a stable temperature environment for liquid precursor bubbler. Completed with SV-DELI carrier gas flow control and bubbler interface, precise and safe delivery of precursor vapor to the process is assured. Various models for different flow, media and temperatures are provided.

| | |
|-------------------------------|--|
| Heating/Cooling performance | +50/-20 °C relative to ambient temperature |
| Temperature control stability | 0,1 °C |
| Time to stabilize | maximum 2 hours |

SVSOL-ABT effluent abatement system

Specific manufacturing processes generate dangerous reaction by-products which are often forbidden to be released to the environment by local regulations. SVSOL-ABT effluent abatement system is designed for physical and chemical conversion of such species into an environmentally accepted substances. Generally water based, burn-out and their combination scrubber units are available.

HIGHLIGHTS

PECVD

OXIDATION

GAS SYSTEMS

TEMPERATURE CONTROLLER

GAS ABATEMENT



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Process Innovation

Equipment for Solar Cell Production

TECHNICAL SPECS

Furnace

Wafer size: (pseudo)square standard 125 mm, 156 mm and 210 mm (or any customer specific size)

| | Diffusion | LP Diffusion | PECVD | Wet Oxide | Dry Oxide |
|--------------------------|-----------|-------------------------------------|-------|-------------|-------------|
| Wafer Load/Tube (pcs) | 400-500 | 400-500 or 800-1000 (half pitch) | 200+ | 200+ | 200+ |
| Average cycle time (min) | 60-90 | 70-90 | 40 | Process dep | Process dep |

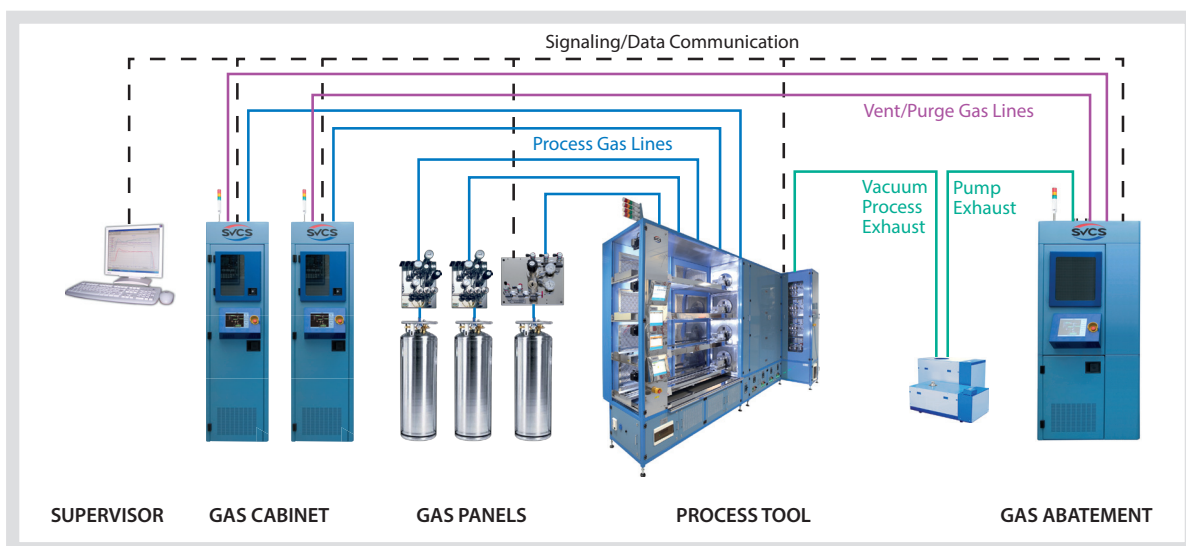
Uniformity (minimum guaranteed)

| | | | | | |
|---------------------------------------|--------|-----------------------|-------|-------------|-------------|
| On wafer (%) | 3 | 2 3 for half pitch | 5 | Process dep | Process dep |
| Wafer to Wafer (%) | 3 | 2 3 for half pitch | 5 | Process dep | Process dep |
| Run to Run (%) | 3 | 2 3 for half pitch | 4 | 3 | 3 |
| Sheet Resistance (Ω/\square) | 40-120 | 40-120 | n/a | n/a | n/a |
| Layer Thickness (nm) | n/a | n/a | 70-80 | 10...100 | 10...100 |
| Growth Rate, (nm/min) | n/a | n/a | 4 | 1...2 | 0,05...0,1 |

Options:

Options: Wafer Handling Automation (Boat / Cassette Wafer Transfer System, Boat Elevator, Stocker, etc.)

More detailed specifications available in specific data sheets and through representative and factory contacts



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