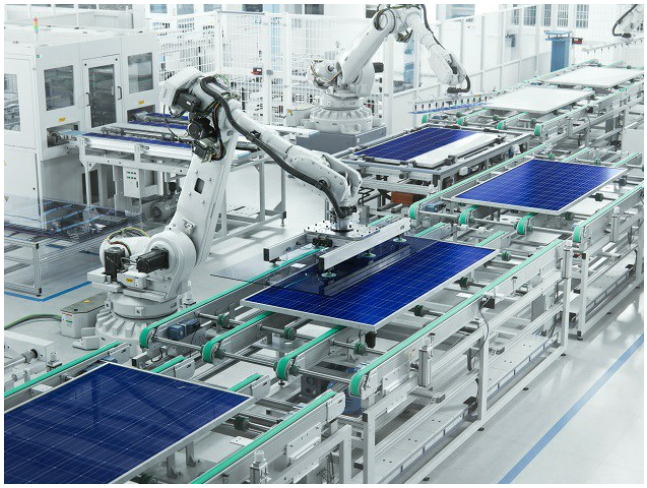
DATASHEET APPLICATION NOTE A087-EN04 - FLOW CONTROL IN PHOTOVOLTAIC (PV) SOLAR CELL PRODUCTION

APPLICATION NOTE

Flow control in solar cell production

The manufacturing process for photovoltaic (PV) solar cells - cells that convert sunlight into electricity - consists of many steps like cleaning and etching of silicon wafers, or deposition of layers using physical or chemical vapour deposition techniques (PVD/CVD).

Machines for the production of photovoltaic solar cells consist of a sequence of process chambers where the manufacturing steps take place under controlled conditions, with lock chambers in between. Each of these steps involve the supply of gaseous or liquid chemical compounds. For a company that builds two to three of such machines each week, Bronkhorst was asked to deliver mass flow devices for an accurate flow control.



Application requirements

Each of the photovoltaic solar cell manufacturing machines consists of up to ten vacuum process chambers in total, utilising several dozens of mass flow controllers to supply gases, liquids and vapours. For this application, it is necessary that the flow devices supply exactly 500 or 1000 sccm - or any desired value - but it is essential that this will occur day after day. So repeatability is as important as accuracy.

Important topics

- Accurate supply of gases, liquids and vapours
- Repeatability
- Single mass flow controllers for multiple gases

Process solution

Bronkhorst delivered mass flow controllers for the accurate and reproducible supply of gases, vapours and liquids. Usually Bronkhorst EL-FLOW Select thermal mass flow controllers were used here for gas supply. In the case of liquids, most of them were evaporated to vapours by means of a CEM (Controlled Evaporation & Mixing) system in order to react at the surface of substrates in plasma enhanced chemical vapour deposition (PE-CVD) processes.
The CEM system consists of a (thermal or Coriolis) liquid flow controller (e.g. LIQUI-FLOW or mini CORI-FLOW) , a mass flow controller for carrier gas (e.g. EL-FLOW Select) and a temperature controlled mixing and evaporation device.

The Bronkhorst flow devices are used here for applying layers on crystalline silicon wafers in traditional silicon-based solar cells, as well as for manufacturing thin layers as components of second generation amorphous-silicon-based thin-film solar cells on flexible substrates.

Let's dive somewhat deeper into the process with an example how to deposit a 'p-n junction' onto a flexible substrate, which is an essential part of the photovoltaic (PV) solar cell to convert sunlight into electrons. Two silicon layers with different dopants have to be applied on top of each other in separate process chambers. In this case, the process medium is silane (SiH_4) and hydrogen (H_2) with a trace gas, which is phosphine (PH_3) for the n-doped layer and diborane (B_2H_6) for the p-doped layer. To clean the vacuum process chambers between the deposition steps using a plasma, gaseous NF_3 is added.

A feature of the EL-FLOW Select thermal mass flow devices is that they can be provided with several (~5) calibration curves for different gases, which has the advantage that a relative low number of these mass flow controllers can be used - each for gases that are somewhat comparable. This efficient use of devices leads to cost reduction.

These devices are also suitable to be applied in adjacent application areas that use vacuum technology, such as the semiconductor industry, and to manufacture light emitting diodes (LEDs) for displays and lighting.

Recommended Products

EL-FLOW SELECT F-201CV

Min. flow 0,16…8 mln/min
Max. flow 0,5…25 ln/min

Pressure rating 64 bar

Compact design

High accuracy and repeatability

CEM EVAPORATOR W-202A

Max. 120 g/h liquid;
Max. 10 ln/min gas

Pressure rating 100 bar

Very stable vapour flow

Flexible gas/liquid ratio

LIQUI-FLOW™ L13

Min. flow 0,25 ... 5 g/h
Max. flow 5 ... 100 g/h

Pressure rating 100 bar

Compact, IP40 design

Analog, RS232 or fieldbus I/O

MINI CORI-FLOW™ M12

Flow range 0…200 g/h

Pressure rating 200 bar

Independent of fluid properties

High accuracy, fast response

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