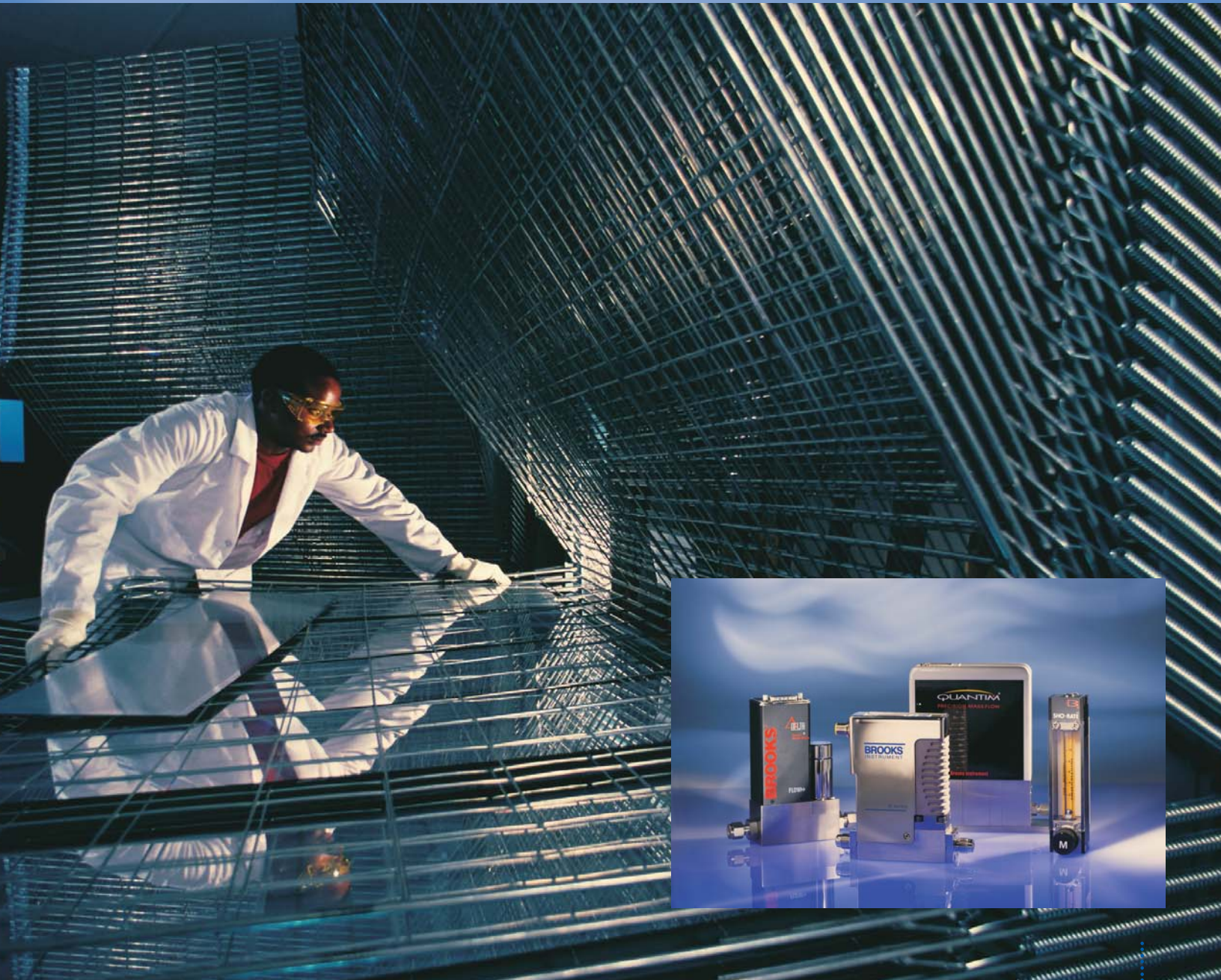


Brooks Solar Solutions



Brooks: Your Partner In Solar Solutions

Producing polysilicon and fabricating silicon or thin film photovoltaic solar cells requires repeatable, reliable flow and level control.

Brooks Instrument has over 50 years of experience supplying flow control and level solutions for solar applications. Our products are designed for the rigors of industrial processes where long term instrument stability and reliability are required.

Brooks manufactures a wide variety of flow measurement and control devices, and liquid level products to provide customers with exactly the right combination of performance and value. Our products can be applied to a wide range of applications from utility flows such as nitrogen, argon, hydrogen, and heat transfer fluids to product level monitoring to controlling the flow of difficult to handle reactive gases. Technologies available include variable area, thermal mass flow, Coriolis mass flow, and magnetic level devices. Precision pressure controllers are also available with either internal or external pressure sensors. Moreover, Brooks can combine these technologies into custom material delivery solutions such as generating vaporized liquids and producing precision spray coatings.

For value and performance in solar applications, turn to Brooks.

Brooks Instrument Technologies

Variable Area

Variable area meters and flow controllers are ideally suited for the direct visual reading of fluid flow. Brooks makes a complete line of meters that can be custom scaled for an almost limitless variety of gases and liquids. Brooks is a key supplier of variable area products to the polysilicon industry – more than half of the recent capacity additions worldwide employed Brooks variable area meters. Common applications include sweep and purge flows of inert gases, make-up hydrogen, heat transfer fluids, and pump seal flows.



Thermal Mass Flow

Thermal mass flow instruments are used for gas flow measurement and control. Brooks' thermal sensors are uniquely designed to minimize measurement and control errors that affect product uniformity and repeatability. In the production of triple junction photovoltaics, for example, thousands of Brooks mass flow controllers are used to ensure precise, repeatable process gas flows. Recently, Brooks introduced a very economical MEMS-based mass flow controller which provides a very fast response to setpoint in inert gas flow applications.



Coriolis Mass Flow

Brooks' Quantim® Coriolis mass flow controllers measure mass directly and do not require chemical specific calibration factors. This capability is perfectly suited for critical liquid flows, such as controlling liquid sprays and the flow of liquid precursors to vaporizing systems for CVD chambers. The Quantim Coriolis device can accurately measure the density of a liquid. This is beneficial in improving spray coating processes where fluids are mixed as required and the measured density can confirm the correct mixture of chemicals.

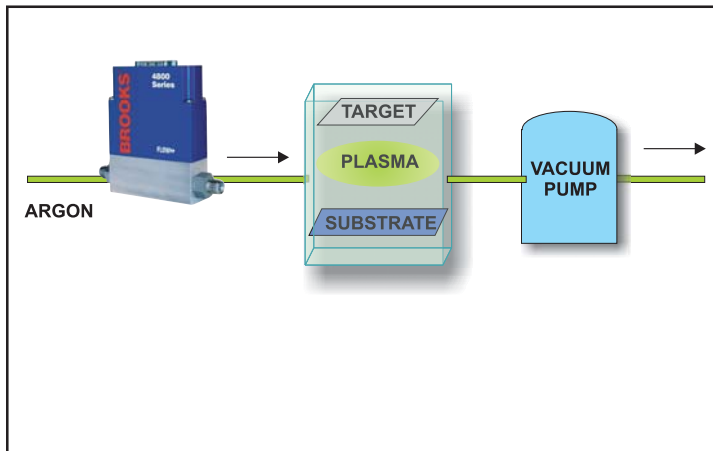


Magnetic Level Gauges

Brooks magnetic level gauges are direct-reading level gauges that permit users to easily verify product level, even corrosive or hazardous liquids, in vessels and tanks. They operate by magnetically tracking the movement of a float inside a measurement chamber. Because no power is required for operation, the technology is especially well-suited to applications that require redundant verification of liquid level. In polysilicon production, applications include chlorosilanes, water/condensate, refrigerant, and HCl fluid levels.



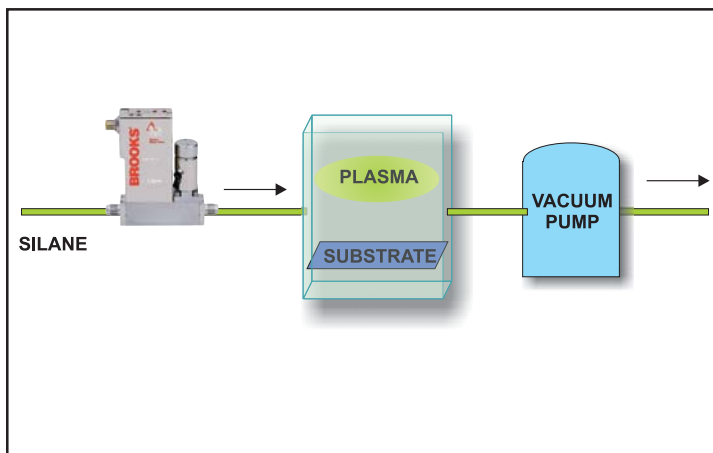
Applications



Physical Vapor Deposition

Physical vapor deposition or sputtering is commonly used for creating films of material, often metal, on a substrate. Plasma is used to remove and accelerate the atoms of interest toward the target placed in a vacuum chamber. Mass flow controllers are used to control the gas flow to the chamber. Our advanced control valve PID controller can eliminate overshoot that can quench and destabilize the plasma.

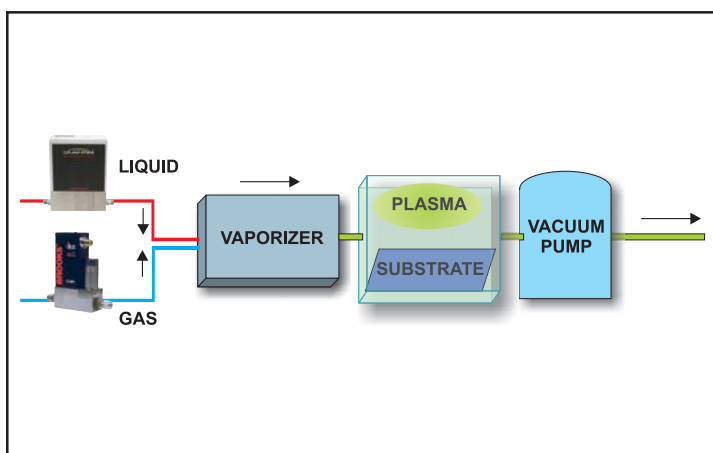
The Brooks 4800 Series is a great solution for controlling argon in a plasma process. This product has a very fast response to setpoint without overshoot along with having a very small footprint. The optional local operator interface allows for easy stand alone installation and a variety of options well suited to these applications.



Chemical Vapor Deposition, including MOCVD

Many solar thin films are deposited with chemical vapor deposition (CVD) techniques. In this process, a reactive gas is commonly used to deposit material on a substrate in a vacuum chamber. Typically, mass flow controllers with all-metal construction are recommended to eliminate the possibility of contamination from oxygen or water.

The Brooks SLA7800 Series mass flow controller is a perfect solution for CVD applications. The all-metal construction provides very high leak integrity to minimize contamination. A unique metal valve design provides fast response to setpoint and minimum valve leak-by with wide turndown. SLA7800 Series pressure controllers are ideal for bubbler and chamber pressure control.

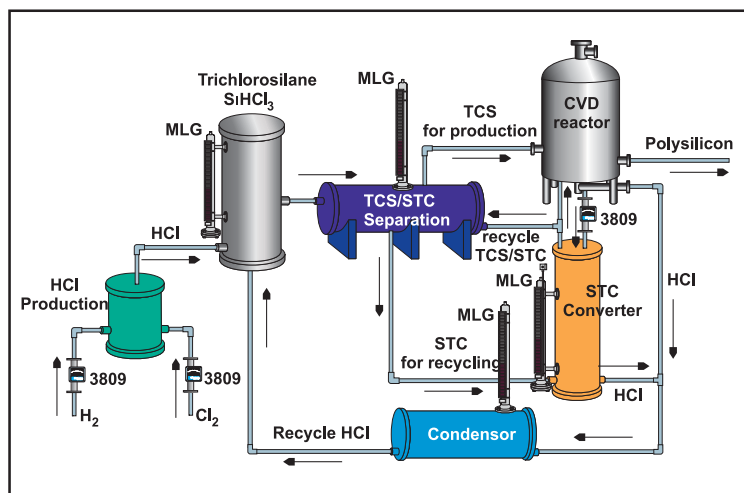


Transparent Conducting Oxides

One of the most important films in a thin film solar cell is the transparent conducting oxide. Metal organic precursors are used to deliver these atoms to the substrate. Bubblers have been used to vaporize these liquids, with the disadvantages of minimal flexibility and relatively low mass delivery.

Brooks offers powerful liquid vaporization solutions that permit flexible operation and repeatable delivery of liquid precursors. These systems feature Brooks gas and liquid flow controllers plus unique direct liquid injection vaporization modules that ensure complete vaporization, low transit times, and quick startup and shutdown. The vaporizer solutions are engineered using a modular design to support a wide range of process fluids and operating conditions.

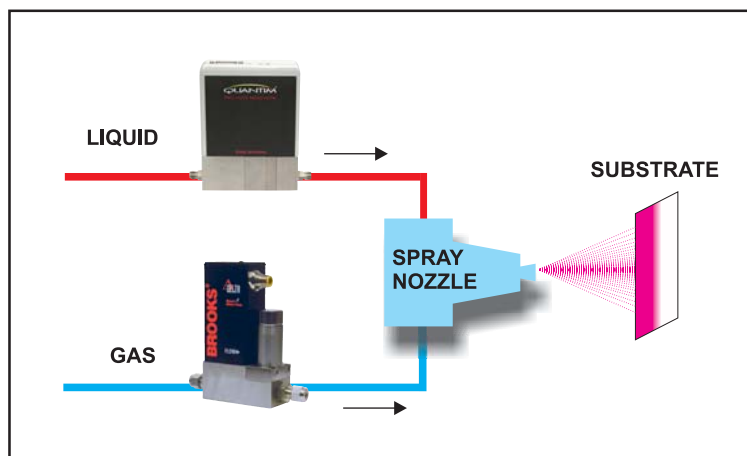
Applications



Polysilicon and Crystal Pulling

Brooks products play a key role in polysilicon production. Our glass and metal tube variable area meters are widely used for measuring flow of utility fluids such as low pressure nitrogen, nitrogen purge and sweep flows, make-up hydrogen, heat transfer fluids, and pump seal gases. They can also be fitted with flow alarms for added safety. Our magnetic level gauges can be used throughout the polysilicon plant in process liquid storage and process liquid condensate service, steam condensate, brine, refrigerant, and other level applications. Brooks' polysilicon products have been designed to assure a very long product lifespan and many offer alarms and transmitters to enhance application flexibility.

The formation of a single crystal of silicon requires the control of argon gas to purge impurities from the crystal pulling system as the crystal is grown. Brooks thermal mass flow controllers and variable area products have the capacity to control the large flow of argon used in this critical process.



Spray Coatings

Spray coating is being considered as an alternative technique for forming thin films and for applying liquid dopant to wafers. The control of liquid to the spray nozzle determines the film thickness and the gas flow to the spray nozzle determines droplet size and distribution.

Brooks' Quantum Coriolis mass flow controllers are ideally suited for active control of liquid flow to a spray nozzle. This eliminates open loop control normally found on pressure or pump only systems and ensures consistent coating over extended production runs. The built-in density measurement can be used to confirm the phosphorous concentration of a liquid spray on dopant or the solids concentration in photovoltaic liquid ink.

The photovoltaic solar industry is growing rapidly and shows great promise to be a source of clean renewable energy in the decades to come. A key factor for the long term success of this new industry is the continual reduction in the manufacturing cost of new solar technologies. Thin film deposition is a critical process in many of these new solar technologies and the efficient and effective production of these films is a critical production step in the goal of reducing the cost of production. Equally, polysilicon production greatly benefits from the advantages of Brooks flow and level products. Brooks control products are designed for industrial production environments and are ideally suited for use in solar production factories to make thin films.

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