

Speedflo™
is a multi-channel
feedback control
system for high
speed adjustment
of a reactive gas
during magnetron
sputter processes.

Speedflo™



Background to Reactive Sputtering Feedback Control

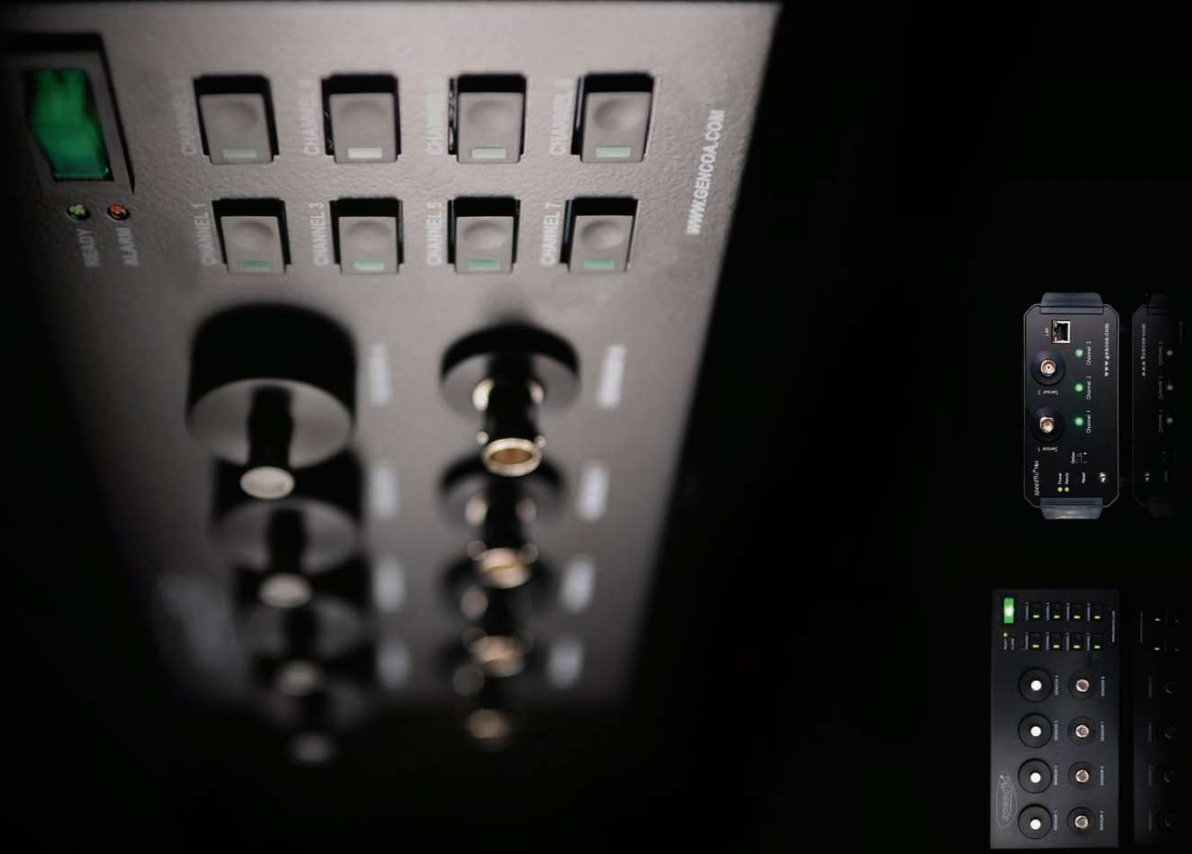
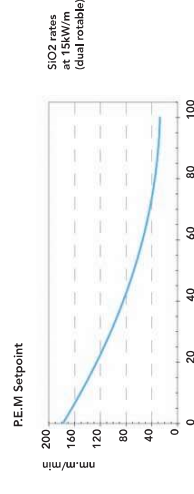
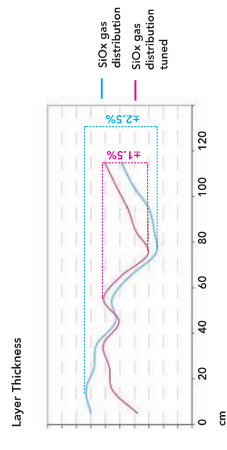
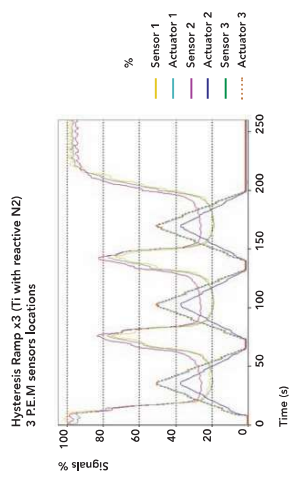
Feedback control of reactive gas enables improved deposition rates, coating properties and process reliability, which is not possible to achieve with constant flow.

It is a well known and troublesome phenomenon that reactive sputtering processes are highly unstable. A magnetron target can very quickly switch from a metallic state into a fully poisoned condition. This change will make the process unworkable and results in large variations in the sputtering rate.

One solution would be to use the target in fully poisoned mode (i.e. reaction product all over the target). However the compounds on the target sputter at a much lower rate than a pure metal, hence it is usually not desirable. A better solution is to use a feedback control system that can very quickly adjust the reactive gas flow in response to the plasma conditions, in order to hold the process in high rate metallic or transition mode.

Reactive sputtering feedback control will lead to enhanced sputter rates, improved uniformity through the simultaneous control of multiple gas inputs, and better process monitoring.

Speedflo is an advanced form of this type of control system, offering all of the advantages detailed above as well as a range of other benefits that help you to perfect your reactive processes.



Speedflo is designed for the demands of real processes. It has been proven on hundreds of different industrial plasma-based deposition machines – each with varying demands.

Robust and reliable

Speedflo's hardware and software has evolved based on the demands of real processes. Each unit is expertly assembled by Gencoac technicians and put through a rigorous series of QC tests and inspections before being shipped.

Fully supported

Gencoac's process knowledge and experience is available to you at every stage – from remote assistance to on-site support.

Flexible

Speedflo comes with a range of sensor, I/O, and communication options to meet the particular demands of your process.

Continued innovation

Gencoac's process and control expertise means that Speedflo is always at the leading edge of reactive sputtering control. New Speedflo technologies are continuously being developed, to push the operating window and help you to extract even more from your process.

Hardware options

The Speedflo controller is available in two options to suit different requirements: Speedflo and Speedflo Mini. The two controllers have identical algorithms and control software, but differ in the number of available inputs and outputs. Both controllers have ethernet connectivity for straightforward communication with the software interface.

Speedflo

8 sensor inputs and 8 MFC actuator outputs.

Speedflo Mini

2 sensor inputs and 3 MFC actuator outputs.

Speedflo



Speedflo Mini



There are many benefits to using the Speedflo technology all of which contribute to a more complete solution from Gencoac.

Control algorithm

Speedflo utilizes a proprietary advanced PDF+ control algorithm that is capable of extremely fast and accurate feedback control. In addition to the PDF+ algorithm the Speedflo controller features a digital variable structure control law that is able to maintain fast-acting and stable control, even when the MFC becomes fully open or closed. This enables feedback control that is high performance, robust and reliable.

Multiple control channels

The Speedflo controller has up to eight fully featured and independent control channels. This allows for simultaneous feedback control of eight MFCs, with options to combine various sensors and duplicate control channels. This powerful capability is especially useful for large target areas, where precise deposition uniformity must be achieved.

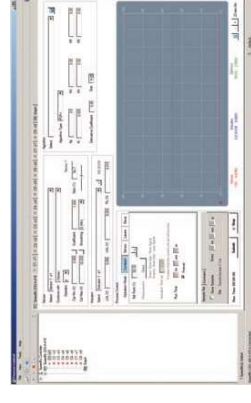
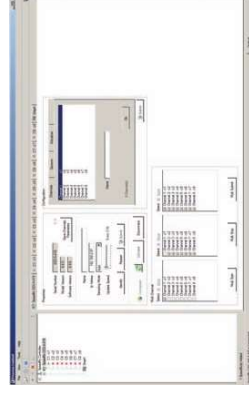
Auto-calibration and controller tuning

The time-consuming process of sensor calibration and controller tuning has been eliminated with Gencoac's latest Speedflo development. An automatic calibration and tuning procedure – unique to Speedflo – automatically detects the sensor levels corresponding to poisoned and fully metal states. The optimum controller parameters for the current sensor and process are then automatically calculated to ensure fast, accurate and robust feedback control.

Advanced user interface

A highly developed software interface includes many powerful functions to allow different methods of configuring the process control and combating difficult control situations. All of the software functions can be seamlessly incorporated into an existing PLC system.

Highly developed software interface



Plasma Emission Monitoring (P.E.M)

The visual light from the plasma contains information of all the species present via the optical emission spectrum. To monitor the intensity of any element in the plasma, a narrow band-pass filter can be used to allow through only the wavelength of light of the material or gas of interest.

P.E.M CCD

The plasma light can be captured by a CCD-type spectrometer which provides a universal picture of the process. For control purposes, the wavelengths of interest are electronically filtered and input to the controller. This type of tool delivers more information, however the integration time of the spectrometer slows down the feedback speed compared to the conventional band-pass P.E.M method.

Plasma Emission Monitoring (P.E.M)



External type P.E.M sensor head

Remote P.E.M (Penning P.E.M)

Gencoa's Penning P.E.M sensor enables remote monitoring of gas emission levels, and is ideal if substrate interference is problematic with conventional P.E.M sensors. A small plasma is generated remotely in the Penning gaugehead. A conventional P.E.M sensor can then be used to measure light intensity at a wavelength of interest. This represents the excess gas from the process.

Lambda

The Lambda sensor is an oxygen probe which provides a direct signal of the oxygen concentrations present in the vacuum. The Gencoa Lambda sensor provides a robust signal with good response speeds. Like P.E.M, it can provide information from multiple monitoring zones down the target length.

Target voltage

A convenient sensor from the process is the target voltage output from the magnetron power supply. This can be used for some material combinations as a stand-alone signal or in addition to a secondary signal such as P.E.M. Successful materials for this type of sensor are silicon and aluminum oxides and nitrides.

HiPIMS

Gencoa has developed sensor technology that enables the control of reactive HiPIMS processes for reproducible depositions and stable system performance.

Penning P.E.M sensor



Lambda sensor



Lambda cable



Voltage cable



Many of Gencoa's key staff can boast a wealth of experience in the process and control environment. This is a key factor in our ability to develop products which are perfectly suited to the actual demands of the process.

Remote and on-site assistance

Gencoa can help customers optimize their processes remotely or on-site, and offer a complete reactive gas set-up and process control package – magnetrons, gas bars, controller and process know-how.

Speedflo Simulator

Gencoa's in-depth understanding of process control has resulted in the creation of a dynamic simulation of the Speedflo system. This tool replicates the Speedflo user interface, and simulates the effect of Speedflo features such as controller gains and calibration parameters as well as system characteristics such as gas delivery pipe length.

The simulator is a highly effective tool which can aid the system user's understanding of feedback control, as well as the operation of the Speedflo system.

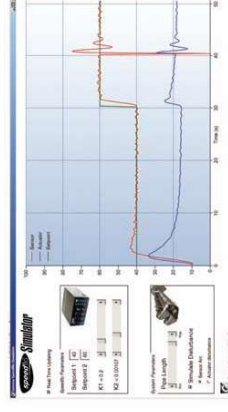
Speedflo auto-tune

Achieving high performance control of your system is a quick and easy process using Speedflo. A proprietary, state-of-the-art automatic controller tuning procedure provides optimum controller parameters for your process at the click of a button. The auto-tuning procedure is fast and effective – and works within any system or sensor configuration.

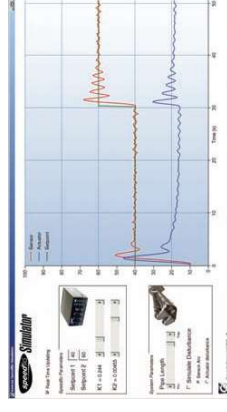
After performing an integrated system calibration and identification procedure, the auto-tuner instantly generates the optimum controller parameters for your process by using advanced inverse dynamics algorithms to analyze the collected data.

The whole procedure takes a couple of minutes and, thanks to Gencoa's unique combination of process and control expertise, is perfectly suited to the demands of real processes.

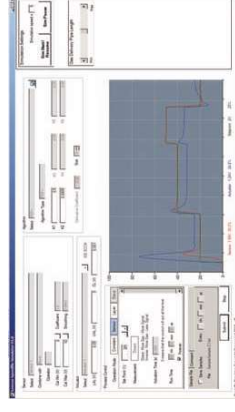
Gencoa Speedflo Simulator



Basic user interface



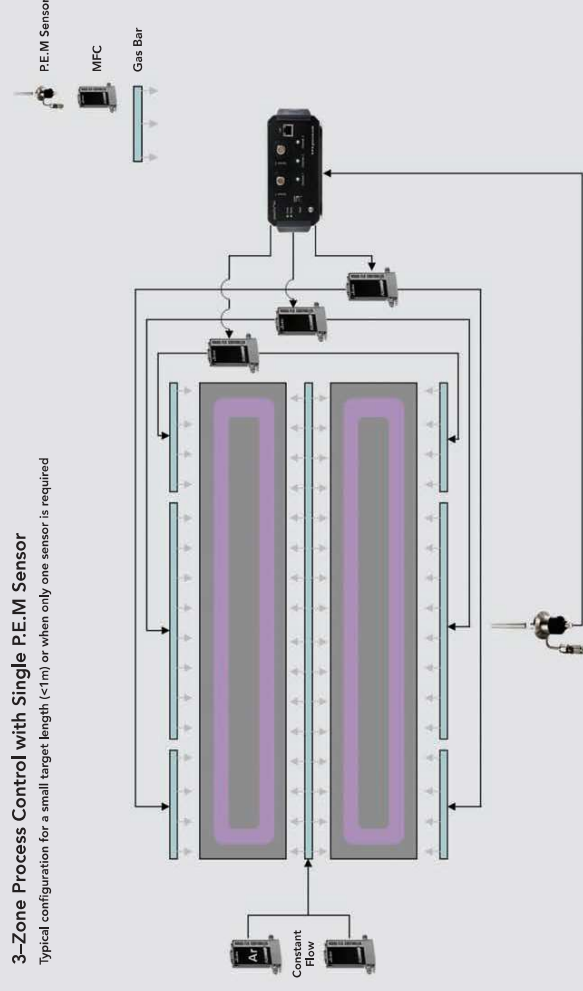
Basic user interface



Advanced user interface

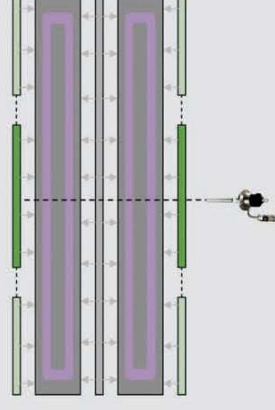
3-Zone Process Control with Single P.E.M. Sensor

Typical configuration for a small target length (<1m) or when only one sensor is required

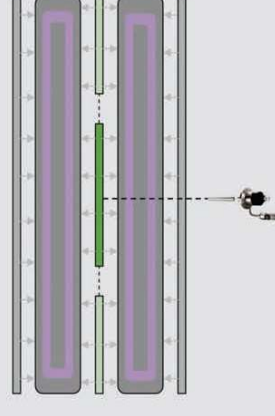


Typical control methods

Trimming gas bars on outside (typical rotatable configuration)



Trimming gas bars in centre (typical planar configuration)



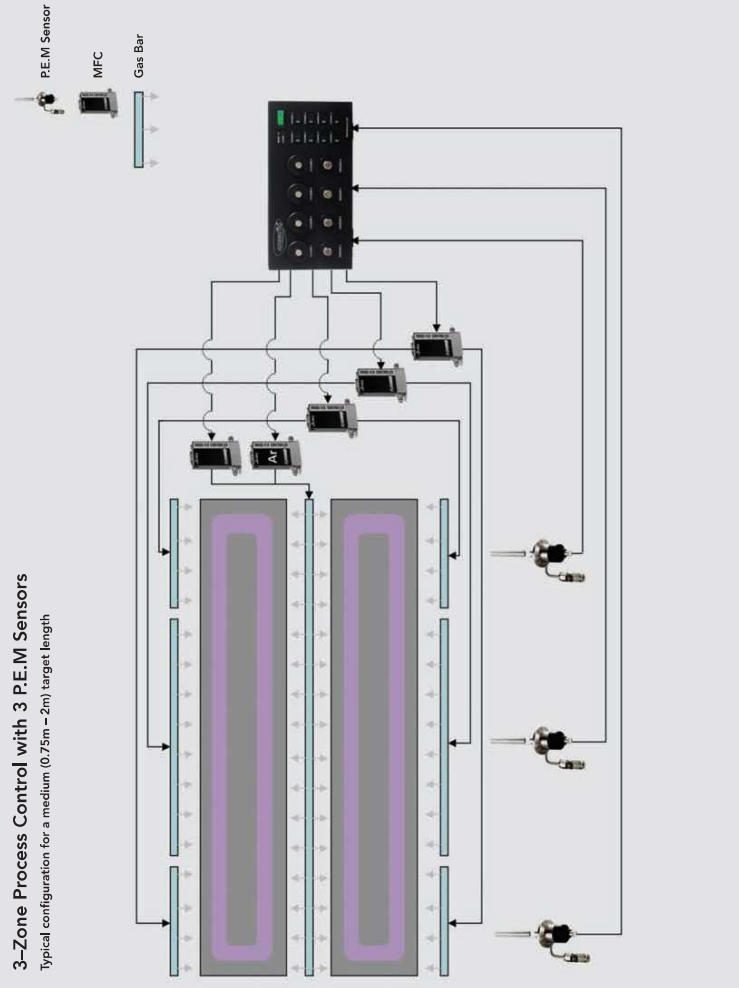
Slaved

Master (sensor feedback controlled)

Constant Flow

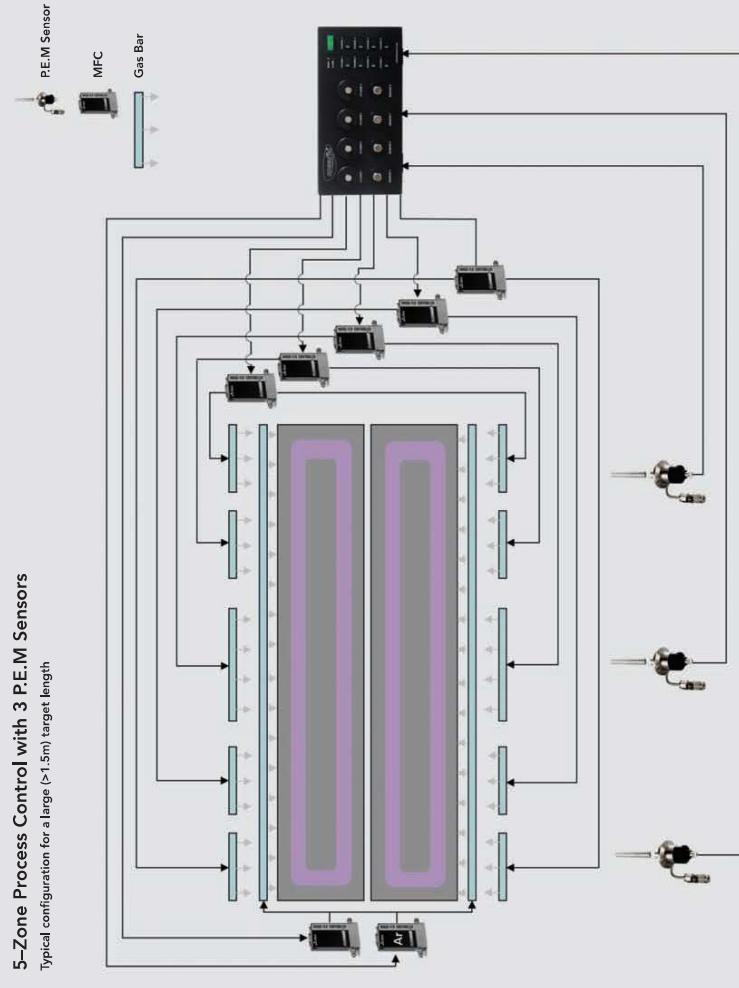
3-Zone Process Control with 3 P.E.M Sensors

Typical configuration for a medium (0.75m – 2m) target length



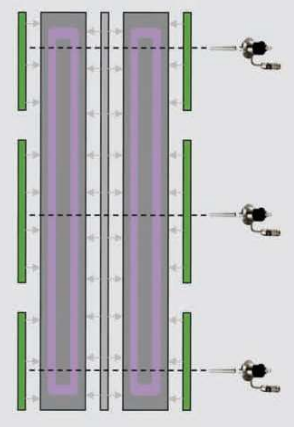
5-Zone Process Control with 3 P.E.M Sensors

Typical configuration for a large (>1.5m) target length



Typical control methods

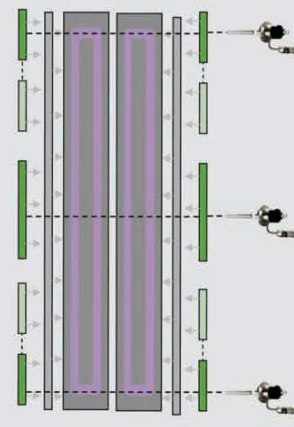
Trimming gas bars on outside (typical rotatable configuration)



- Slaved
- Master (sensor feedback controlled)
- Constant Flow

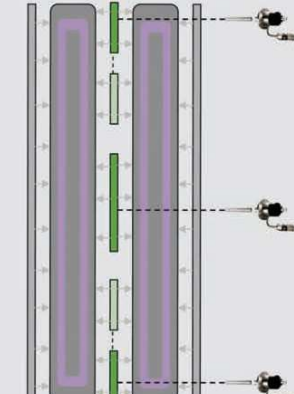
Typical control methods

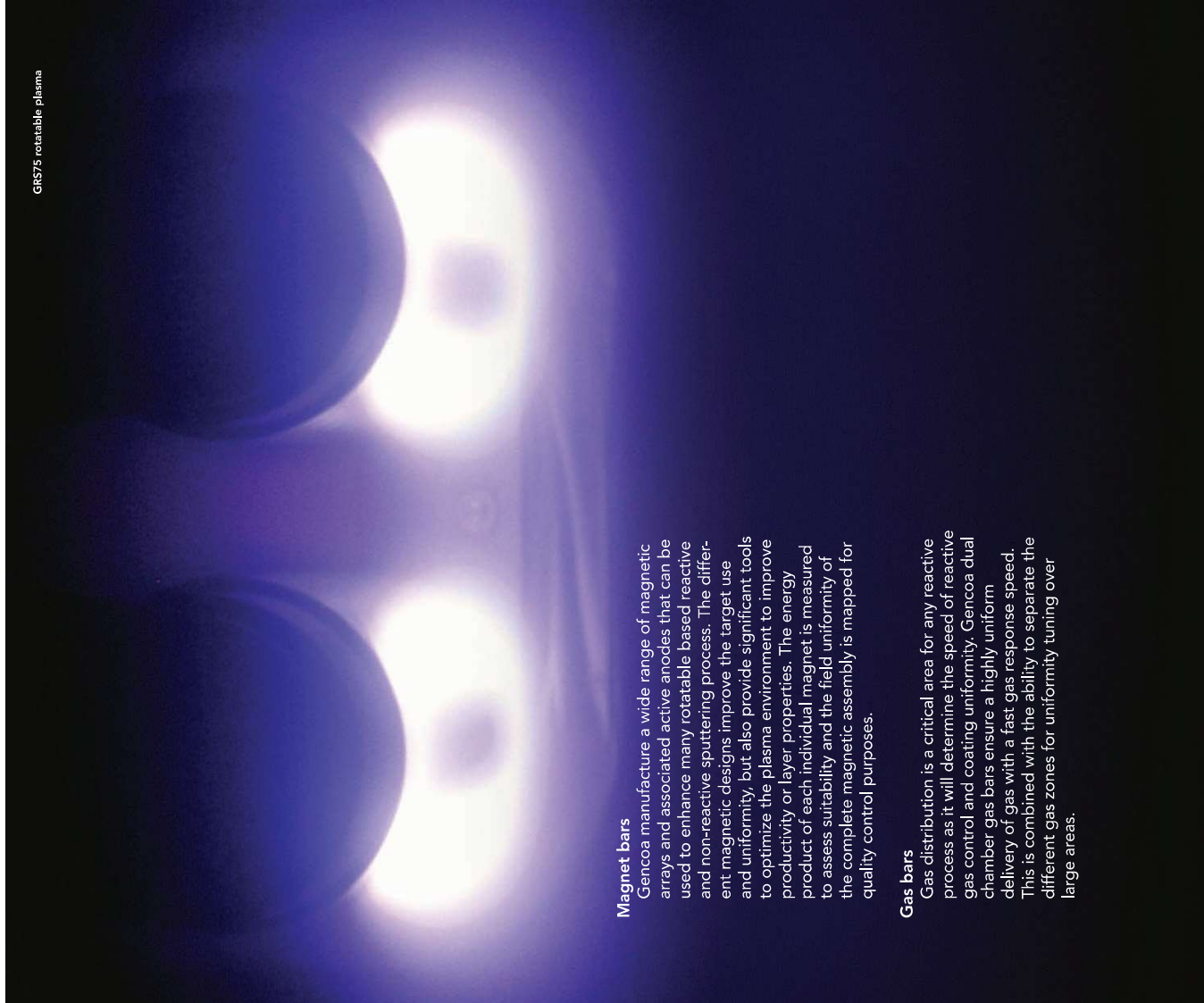
Trimming gas bars on outside (typical rotatable configuration)



- Slaved
- Master (sensor feedback controlled)
- Constant Flow

Trimming gas bars in centre (typical planar configuration)





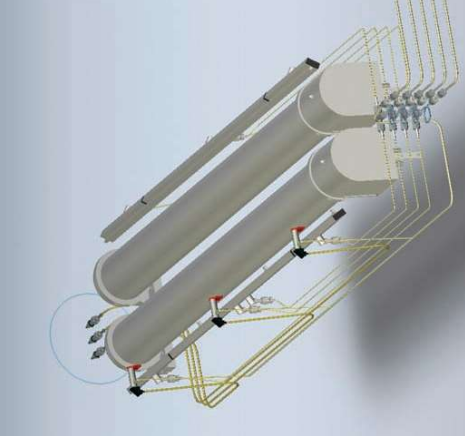
GRS75 rotatable plasma

Magnet bars

Genco manufacture a wide range of magnetic arrays and associated active anodes that can be used to enhance many rotatable based reactive and non-reactive sputtering process. The different magnetic designs improve the target use and uniformity, but also provide significant tools to optimize the plasma environment to improve productivity or layer properties. The energy product of each individual magnet is measured to assess suitability and the field uniformity of the complete magnetic assembly is mapped for quality control purposes.

Gas bars

Gas distribution is a critical area for any reactive process as it will determine the speed of reactive gas control and coating uniformity. Genco dual chamber gas bars ensure a highly uniform delivery of gas with a fast gas response speed. This is combined with the ability to separate the different gas zones for uniformity tuning over large areas.



Gas bars

Active anodes

For plasma stability and to eliminate long term drift with reactive processes performed with rotatable magnetrons, Genco have developed an anode design that combines magnetic and electrical guiding of the plasma electrons. These active anodes serve to open up different power modes and greatly help to control the uniformity and plasma density over the substrate surface.

Rotatable magnetrons

Genco offer two types of rotatable magnetron depending upon the space available within the process machine and the process requirements. The Genco GRS75 magnetron accommodates targets ranging from 75 to 100mm OD. The SCI based end-block range accommodate targets of 152mm and greater. Both types are particularly suitable for reactive processes due to the self-cleaning of reaction product from the target surface.

Planar magnetrons

Genco offer rectangular magnetrons in the widest range available on the market for both internal and external mounting, with an unrivalled range of magnetic and mechanical options available to offer the optimum solution for your specific processing needs. Built-in gas distribution within the anodes provides uniform and fast gas responses for reactive deposition.

Ion sources

Linear ion sources provide a robust and flexible means of pre-cleaning polymer and glass substrates prior to thin film deposition. Genco Linear ion sources are powered by the IM3000 power supply and gas control module, which houses a Speedflo controller.



GRS75 dual rotatable



Dual rectangular



Rectangular



Linear ion sources



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