Vacuum measurement

Circuit densities and functionality continue to increase, as the industry pursues ever-greater capabilities in semiconductor devices. Improving productivity is the single most important industry goal for the processes used to create semiconductor devices today. The factor receiving the most attention as a way to increase productivity is ensuring that the results of repeated processes are consistent. To achieve this requires certain key products that can provide higher precision and real-time measurement of the status of the chamber and wafers. HORIBA STEC offers a lineup of residual gas analyzers (RGAs) used to measure the gas that is left in the chamber after processing, and capacitance manometers used to measure pressure. HORIBA Group companies also offer related products, including many featuring the optical analysis technology developed by HORIBA Group company Jobin Yvon.

Micropole™ System

Residual Gas Analyzer

The world's smallest complete mass spectrometer system

- World's smallest and lightest.
- Features nine pairs of quadropoles.
- Can operate at low vacuum (high pressure): 1.46 Pa (11 mTorr)
- High-speed measurement. Scanning speed: 0.6 sec/mass. Resolution: 0.5 AMU. Detection limit: 1.33 x 10^{-8} Pa.
- Uses disposable sensor heads.
- No need for degassing.
- Can be connected to a NW 60.Ø34 Conflat flange.
- A variety of graph modes available for residual gas analysis.

Recent semiconductor processes have reached the nano level, and a topic of much concern is whether or not the prescribed chemical/physical response conditions can be reproduced consistently. In particular, attention has been focused on the measurement and analysis of residual gas in the reaction vessels of the various vacuum devices used in dry processes. HORIBA STEC offers a residual gas analyzer (RGA) with the world's smallest quadropole mass spectrometer.

VG series

Capacitance Manometers

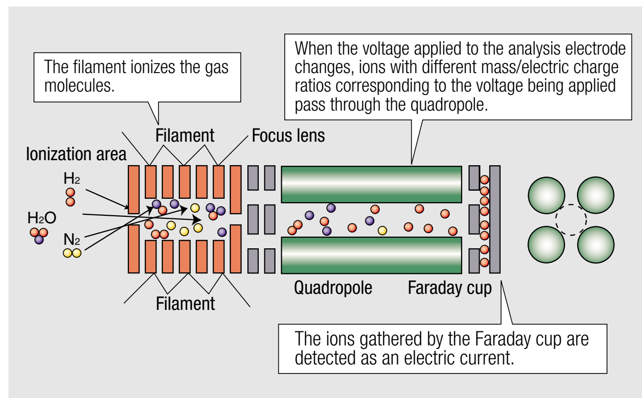
Compact static capacitance manometer

- Corrosion-resistant construction with an Inconel diaphragm.
- NW 16 clamp joint footprint size.
- Temperature control for superior stability (VG-121).
- Compact, world's lightest weight (270 g).
- Equipped with 2 independent set point outputs.

Residual Gas Analyzer: RGA

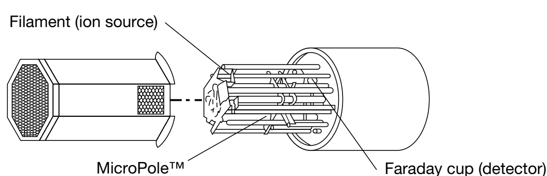
Measurement principle

The Residual Gas Analyzer consists of an ion source, a mass spectrometer, and a measurement section. The residual gas is ionized when it collides with the thermoelectrons discharged from the high-temperature filament, and the ions that are thereby created accelerate and converge onto the mass spectrometer. At the mass spectrometer, direct and alternating current voltages are applied to the four cylindrical electrodes (quadropoles), which allows the ions to be separated by mass. The separated ions are detected as electric current by the Faraday cup. The ion current is proportional to the mass (partial pressure) of the residual gas.

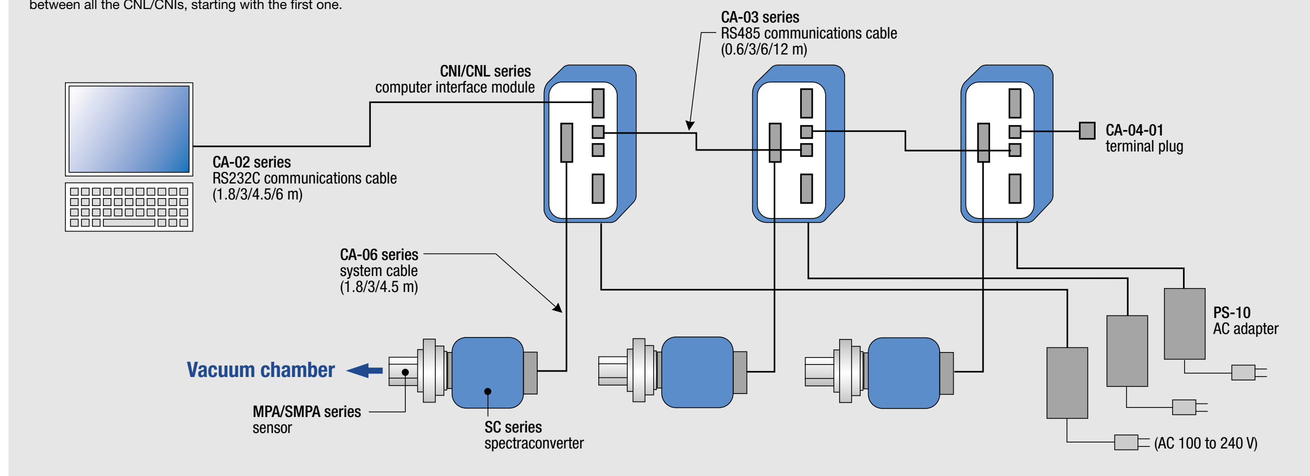


MicroPole™ Analyzer

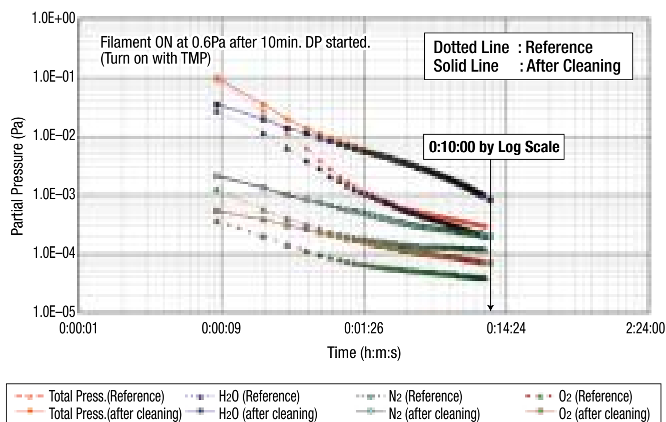
The feature that makes the Micropole™ System unique is the MicroPole™ Analyzer (MPA), a grouping of nine quadropoles that takes full advantage of ultraprecision optical etching processing technology and glass/metal joint technology. The development of the MPA has enabled the creation of the world's smallest residual gas analyzer, while offering the same or better sensitivity as conventional, larger mass spectrometers. The analyzer is a plug-in unit. It features a sensor unit that has already been calibrated for partial pressures, and offers absolute total and partial pressure measurement.



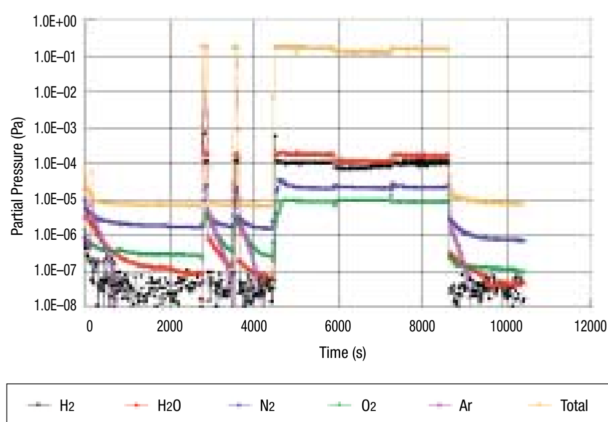
Sample layout (when multiple Micropoles use an RS485 for communication)



Wet clean recovery



Sputter process monitoring



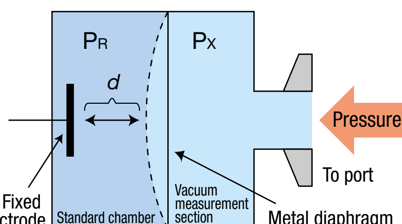
Capacitance Manometers; VG Series

▶ Capacitance manometers

The VG series of capacitance manometers are extremely precise and reliable, thanks to their use of an Inconel diaphragm. The VG-111 features temperature compensation circuits that minimize the impact of changes in the surrounding temperature, and the resulting thermal expansion and contraction, on measurement. The VG-121 actually adjusts the temperature of the partial pressure measurement section to prevent deposition of subsidiary substances and condensation of reactive gases. This gives it the reliability required for use with film deposition equipment utilized in the fields of semiconductor and liquid crystal display manufacturing.

▶ Measurement principles

The VG series of capacitance manometers are partitioned by a thin metal diaphragm that is stretched across the interior. P_R is a standard chamber in which high vacuum is maintained; P_X is connected to the vacuum measurement section. The pressure on the P_X side displaces the diaphragm, and the capacitance varies with the distance between the fixed electrode and the diaphragm (d). The changes in the capacitance between the fixed electrode and diaphragm are converted into pressure signals (electrical signals).



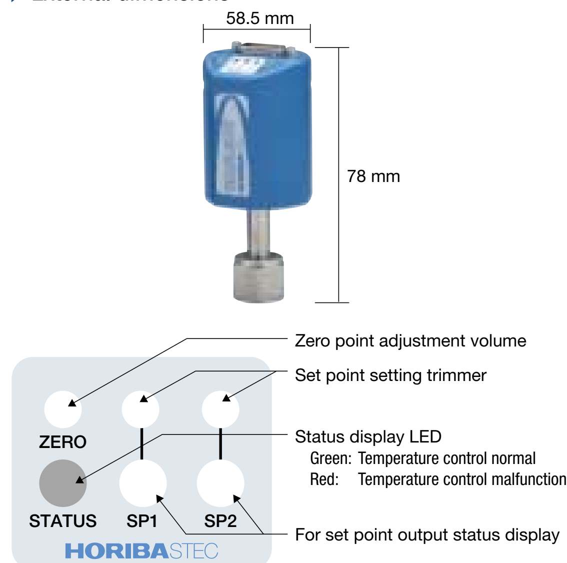
▶ Uses

- · Pressure monitor for semiconductor/LCD manufacturing processes.
- · Pressure monitor for vacuum heat treatment furnaces and vacuum dryers.
- · Pressure monitor for vacuum packing equipment.
- · Pressure monitor for injection and degassing equipment.
- · Pressure monitor for equipment used to lay down thin films.
- · Ideal for use as a pressure monitor with various other kinds of vacuum equipment.

▶ Signal chart

Pin No.	Signal name
2	Pressure signal 0 to 10 V
3	Set point A NC contact point (option)
4	Set point A NO contact point (option)
5	Power source COM
6	Power source –15V ±5%
7	Power source +15V ±5%
8	Set point A COM (option)
9	Set point B NC contact point (option)
10	Set point B NO contact point (option)
11	Set point B COM (option)
12	Signal COM

▶ External dimensions



RGA

Name	Plasma card model (SMPA-)*1						Sensor model (MPA6-)*1					
Model	1-2/45	11-2/45	7-2/65	5-2/65	5-2/100	1-4/300	1-2/45	11-2/45	7-2/65	5-2/65	5-2/100	1-4/300
Mass range (AMU)	2 to 45	2 to 45	2 to 65	2 to 65	2 to 100	4 to 300	2 to 45	2 to 45	2 to 65	2 to 65	2 to 100	4 to 300
Resolution (FWHM)	0.5 AMU	1.5 AMU	0.9 AMU	0.8 AMU	1 AMU	1.5 AMU	0.5 AMU	1.5 AMU	0.9 AMU	0.8 AMU	1 AMU	1.5 AMU
Maximum operating pressure	0.133 Pa (N_2) 1 mTorr (N_2)	1.466 Pa (N_2) 11 mTorr (N_2)	0.933 Pa (N_2) 7 mTorr (N_2)	0.666 Pa (N_2) 5 mTorr (N_2)	0.666 Pa (N_2) 5 mTorr (N_2)	0.133 Pa (N_2) 1 mTorr (N_2)	0.133 Pa (N_2) 1 mTorr (N_2)	1.466 Pa (N_2) 11 mTorr (N_2)	0.933 Pa (N_2) 7 mTorr (N_2)	0.666 Pa (N_2) 5 mTorr (N_2)	0.666 Pa (N_2) 5 mTorr (N_2)	0.133 Pa (N_2) 1 mTorr (N_2)
Minimum detected partial pressure	1.33×10^{-8} Pa (N_2)											
Minimum detected He leak rate	2×10^{-9} Pa·m³/s 2×10^{-8} atm·cm³/s		2×10^{-8} Pa·m³/s 2×10^{-7} atm·cm³/s	2×10^{-9} Pa·m³/s 2×10^{-8} atm·cm³/s			2×10^{-9} Pa·m³/s 2×10^{-8} atm·cm³/s		2×10^{-8} Pa·m³/s 2×10^{-7} atm·cm³/s	2×10^{-9} Pa·m³/s 2×10^{-8} atm·cm³/s		
Filament material	Y_2O_3/Ir (standard) or Pure W											
Maximum operating temperature	150°C (maximum baking temperature [sensor portion]: 350°C)											
Attachment flange type	Type C: Ø34 Conflat flange; Type K: KF-16 flange											
Spectraconverter model*2	SC6-18		SC6-14		SC6-11	SC6-07	SC6-18		SC6-14		SC6-11	SC6-07
Interface	RS232C/RS485 (selectable Baud rates: 9,600/19,200/38,400)											
Software	Win MPA (Microsoft Windows XP 2000, Me, NT 4.0, 95/98, 3.1, 3.11)											

*1 The Micropole analyzers are available in SMPA and MPA models. The SMPA is protected by mesh so that it can be used under extreme conditions such as those of plasma processing.
*2 Electron energy of 70 eV or 43 eV can be selected from the PC.
*AMU: Atomic Mass Unit.

VG series

Model	VG-111 (Temperature correcting model, room temperature)	VG-121 (Temperature control model, 50/100°C)			
Measurement range	1.3332×10^5Pa 1000Torr	1.3332×10^2Pa 1Torr	1.3332×10^3Pa 10Torr	1.3332×10^4Pa 100Torr	1.3332×10^5Pa 1000Torr
Precision	± 0.45%Rdg (min. 0.1% F.S.)				
Zero temperature coefficient	0.005% F.S. /°C				
Span temperature coefficient	0.04%Rdg/°C	0.02%Rdg/°C			
Resolution	0.005% F.S. or lower				
Response time	20ms				
Compression limit	300kPa				
Power source voltage	± 15VDC ± 5% 60mA	± 15VDC ± 5%			
Output	0 to 10VDC				
Mass	264 g	274 g			
CE	89/336/EEC				