Vacuum Technology
Room: C-104 - Session VT-WeA

Vacuum Measurements, Components, and Control
Moderator: P.C. Arnold, Helix Technology, Inc.

2:00pm **VT-WeA1 Eight Unconventional Gauges: A User's Impressions**, ***B.R.F. Kendall***, Elvac Laboratories **INVITED**

Conventional vacuum gauges are unlikely to fill emerging needs for accurate measurements below the mid 10E-10 Torr range. There is also an unmet need for rugged, accurate, inexpensive sensors operating in the low micron range. The solutions may lie in the development of modern versions of gauges now found mainly in the pages of the more arcane textbooks. Laboratory evaluations are given for a number of original and updated gauges likely to be useful in modern applications. For the UHV range these include the extractor, modulated Bayard-Alpert, and X-Ray-neutralized Bayard-Alpert gauges, plus several variants of the inverted magnetron and magnetron cold-cathode gauges. For the micron range, test results are given for thermistor, viscosity and molecular drag gauges. The need for fresh approaches to vacuum gauging is particularly important at this time, when the recent trend has been to restrict commercial production to a few of the most popular general-purpose types. Formation of a users' group to encourage continued production and development of reliable UHV gauges is suggested.

2:40pm **VT-WeA3 The Effect of Ambient Temperature on the Sensitivity of Hot-Cathode Ionization Gauges**, ***P. Abbott***, National Institute of Standards and Technology, *P. Mohan*, National Physical Laboratory, India

A recent comparison of the high vacuum standards of several National Metrology Institutes (NMIs) was performed over the range of 10^{-6} to 10^{-3} Pa using hot-cathode and spinning rotor gauges as transfer standards. Among the participants, their laboratory ambient temperatures varied by as much as five degrees Celsius. It is necessary to know how laboratory temperature affects the sensitivity of the hot-cathode transfer standards (spinning rotor gauges explicitly account for the gas temperature) so that individual laboratory results can be corrected accordingly. The results are presented for an experiment in which the sensitivities of several hot-cathode ionization gauges were measured for ambient laboratory temperatures between 23 and 31 degrees Celsius. It was found that all of the ionization gauges exhibited very similar behavior, and that the sensitivity dependence on temperature could be adequately modeled with a linear fit over the investigated temperature range.

3:00pm **VT-WeA4 The Method of Calibrating and Adjusting Sensitivity of Mass Spectrometer**, ***Y. Feng***, *D.T. Li*, *D.X. Zhang*, Lanzhou Institute of Physics, P.R. China

The mass spectrometer is used as a partial pressure gauge in many fields on vacuum, especially in monitoring and measurement of vacuum system. It is necessary to calibrate the parameters of the mass spectrometer in order to improve the accuracy during the pressure measurement. A vacuum system, Calibration apparatus of mass spectrometer for partial pressure analysis with dynamic flow method, has been established in our center, which can be used to calibrate some parameters of the mass spectrometer with one kind of gas or some kinds of mixed gases. In this paper, the principle of the system is introduced, and the method and results for calibrating the sensitivity of QMS422 which manufactured by BALZERS is given. In the process, we get the curve on the sensitivity change with the emit ion current, the cathode volts and the focus volts change. At last, the better method is recommended to make the mass spectrometer in the good measurement condition with the largest or the most stable sensitivity.

3:20pm **VT-WeA5 Using DeviceNet for Improved Vacuum Monitoring**, ***C.E. Karlsen***, Lawrence Livermore National Laboratory **INVITED**

DeviceNet is a new standard for an industrial, device-level network for connecting a wide variety of industrial instruments, actuators, and control computers. Over 300 manufacturers make products that are certified by ODVA to work with this standard. It reduces overall installation costs by minimizing wiring and improves measurement accuracies by eliminating transmitted analog signals. This talk will give an overview of the DeviceNet standard as applied to vacuum systems. It will cover typical costs, performance issues, design parameters, and some of the products available. It will include a study on the use of DeviceNet on the Spatial Filter Vacuum System in the National Ignition Facility (NIF) at the Lawrence Livermore National Laboratory (LLNL.).

4:00pm **VT-WeA7 Closed Loop Process Control for Reactive Sputter Deposition of Dielectric Films**, ***D. Carter***, *H. Walde, G. McDonough, G.A. Roche*, Advanced Energy Industries

Pulsed-dc reactive sputter deposition of dielectric films has be an active area of study over recent years. It has been demonstrated that transition region sputtering can produce quality dielectric films at high deposition rates making this approach attractive to the alternatives of high frequency sputtering from ceramic targets. As with all processes, time based control and repeatability are critical to the acceptance of such technology. While voltage reversal during pulsing has proven effective in stabilizing arc activity, additional controls are required to stabilize the reactive environment to ensure film composition and controlled sputtering target condition. Various techniques are available to monitor the sputtering environment including partial pressure, optical emission and sputter source impedance but all typically require the addition of costly, complex, intrusive and sometimes unreliable components if one is to be used in a feedback-control-loop system. This study looks at a non-intrusive, cost effective approach to the incorporation of a Closed-Loop-Control (CLC) system in a pulsed-dc reactive sputter deposition process for the production of Al2O3 and SiO2 thin films. This approach uses target voltage as the primary feedback parameter to directly control the setpoint to a high-speed sonic piezo-driven mass flow controller. Target transition region control is demonstrated in the aluminum-oxygen and silicon-oxygen systems and the approach is evaluated for film quality, long-term process stability, process repeatability, and susceptibility to arcs and other potential anomalies encountered in such difficult to control reactive processes.

4:20pm **VT-WeA8 Soft LaserBellows**, ***D.U. Chang***, LaserTech USA

New and innovative welding technology brought precision, high quality "soft" metal bellows to practical reality. Thin gage annular disks are laser welded automatically with the aid of computer-controlled precision guidance by a machine vision seam tracking system. The resistance to the axial motion of the bellows (spring rate) is reduced to 47% to 19% compared with conventional bellows of the same size. These "soft" bellows are especially suitable for hermetic sealing of vacuum valves and manipulators for ultra-high vacuum and semi-conductor applications. Higher positioning accuracy and low motor power are some of the benefits of these bellows. The "soft" bellows are 100% checked for weld integrity by automatic welding/inspection machines, followed by mass spectrometer leak check. Randomly selected samples go through life cycle testing. The bellows last more than 5 million cycles without failure. Finite element analysis (FEA) of the bellows was used extensively in the design of bellows. Comprehensive life cycle testing and leak testing verified the analytical prediction.

4:40pm **VT-WeA9 An Ultra-sensitive Leak Detection and Calibration System**, *Ping Chen, Xu Chen, Q. Jin,* ***Liangzhen Cha***, Tsinghua University, P.R. China

Although the minimum detectable leak rates can be as low as 10^{-12}Pa*m^3/s for most commercial dry leak detectors, but demands on lower and reliable detection limit are challenging for highly reliable vacuum devices. To meet these demands, an ultra-sensitive leak detection and calibration system is developed. In order to improve the dynamic leak detection limit, it is necessary to decrease the background noise of the vacuum system. An all-metal ultra high vacuum system consisted of a turbo-molecular pump, an ion pump, a dry roughing pump and an UHV comparative Quadrupole Mass Spectrometer is developed with a minimum working pressure of 10^{-7}Pa. The leak detection limit can still be improved if the undesirable background gas is pumped out by a getter pump during the accumulation process. By using a 10^{-7}Pa*m^3/s molecular flow platinum wire-glass reference leak[1]with an adjustable device to change the inlet trace gas pressure and (or) concentration, a range of leak rate more than 6 orders of magnitude can be directly calibrated without extrapolation. Experimental result shows that Helium leak rate lower than 10^{-14}Pa*m^3/s has been detected and calibrated reliably by this system.

[1]Liangzhen Cha, Theoretical and experimental studies of a platinum wire-glass standard leak, Vacuum,Vol 41,PP:1860-1862(1990).

5:00pm **VT-WeA10 A Compact Leak Rate Calibration System for Both Pressure and Vacuum Modes**, ***Xu Chen***, *Ping Chen, Q. Zhang, Q. Liu, Liangzhen Cha*, Tsinghua University, P.R. China

To meet the quality control of the industrial leak detection, especially the growing demand in sniffing application, a compact leak rate calibration

system is developed to calibrate the leak rate from high pressure to atmosphere (pressure mode) and from atmosphere to vacuum (vacuum mode). A new method based on constant volume change in pressure for pressure leak rate calibration is utilized. A differential capacitance diaphragm gauge (CDG) is used to markedly decrease the temperature effect. It is found that $1*10^{-5}$ Pa*m^3/s pressure leak rate at room temperature can be calibrated with an accuracy of better than ±5% (with confidential level 95%) and leak rate as low as $3*10^{-6}$ Pa*m^3/s can be calibrated with an accuracy of better than ±15% with an environmental temperature change less than ±0.1°C. The total test period is about 30 minutes. This compact system is suitable for leak rate calibration in industrial environment for both pressure and vacuum modes.

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